



**Seventh International
Conference
on
Tracers and Tracing
Methods**

**TRACER
TECHNOLOGIES TO THE
BENEFIT OF BETTER
FUTURE**

**TRACER 7
Marrakech**

OCTOBER 13-15, 2014

PROGRAMME DAY BY DAY

DETAILED PROGRAMME

Monday, October 13th 2014

8h00 - 9h00	Registration and participants welcome
9h00 - 9h30	Opening talks and remarks
9h30 - 10h	IAEA activities in the field of Radiation Technologies for Non-destructive Diagnostics and Evaluation of Industrial Processes A-15 <i>Patrick BRISSET- International Atomic Energy Agency (IAEA)</i>
10h00 - 11h	<i>Coffee break</i>
11h - 12h20	Session B1: Industrial applications and chemical engineering
11h - 11h20	A-35 : Evaluation of continuous phase axial dispersion in a two-phase countercurrent pulsed extraction column by radiotracer technique - Ghiyas Ud Din & al.
11h20 -11h40	A-59: Solid phase tracking in a pilot-scale Bioreactor using radioactive particle tracking technique - H.J. Pant &al.
11h40 - 12h	A-57: Radiotracer investigation in a Tank Furnace of a Glass Manufacturing Unit - H.J. Pant & al
12h - 12h20	A-8: Investigation of the operation efficiency of a raw material grinding mill for clinker production at PPC Colleen Bawn factory in Zimbabwe using radiotracer - Peter Baricholo & al
12h20 - 13h	Session A1: Tracer and tracer analysis
12h20 - 12h40	A-14: Easily detectable tracers for complex media using time-resolved spectroscopy: new frontiers of monitoring from geological till medical domain – T. Brichart & al

12h40 - 13h	A-50: Possibilities and constraints of the use of ^{210}Pb in dating human skeletal remains of forensic interest - A. Laissaoui
13h - 14h40	<i>Lunch</i>
14h40 - 16h	Session B2: Oil field, geothermal field and geology
14h40 - 15h	A-23: Laboratory experiments for the evaluation of tracers use in oil reservoir characterization – Bruno R. Debien & Rubens M. Moreira
15h - 15h20	A-73: The use of Radioactive Tracers for Integrated Field Scale Management of Geological Formations - E. Stamatakis & al.
15h20 - 15h40	A-65: Interwell Tracer Test to study water injection pilot in Middle Marrat, Kuwait - N.H. Quang & al
15h40 - 16h	A-80: The determination of crack zones in the roof of longwall 29-02 in Valias coal mine using radiotracer single well dilution technique - J. Thereska & S. Ahmataj
16h - 17h00	<i>Coffee break and Poster session</i>

B1 posters

A-58 Evaluation of performance of a Pilot-Scale Trickle Bed Reactor using radiotracer technique - **H.J. Pant & V.K. Sharma**

A-60 Investigation of Liquid Cooled Pebble Bed Reactor through Radioisotope Techniques – **R. Verma & al**

A-39 Overview of some Radiotracer applications in industries – **A. Hills**

A-47: Experimental Investigation of Flow of Pebbles in a Pebble Bed Nuclear Reactor - **Vaibhav B. Khane & al** (not yet confirmed)

A-77 Major Radioisotopes Applications and their benefits - **J. Thereska & P. Brisset**

A-90 Challenges and opportunities of radiotracer techniques in industrial applications in EGYPT -**H. Arafa**

A-92 Challenges and opportunities of radiotracer techniques in industrial and environmental applications in Cameroon-**M. Bakoura**

A-79 Radiotracer Residence-Time Distribution Method in the Analysis of Industrial Units: Case Studies - **E. Plasari & J. Thereska**

A-83 Residence Time Distribution Measurements in Flotation Columns Using Radioactive Tracers – **J. Yianatos & al**

A-18 Evaluation of Leaks and Passes in Reboilers From Natural Gas Processing Plants – **C. S. Calvo & al**(not yet confirmed)

A-67 A radiotracer test performed at Howard Waste Water Treatment Plant in Panamá City, Panamá - **F. Rivera & al**(not yet confirmed)

A-53 Challenges and Opportunities Presented by Radiotracer Techniques in Industrial and Environmental Applications in Kenya - **S. A. Masinza & al**

B2 Posters

A-72 Rock's Heterogeneity Evaluation in Waterflooding Oil Reservoirs from Interwell Tracer Records - **C. Somaruga & E. Alvarez Gomez**

A-63 Radon as a tracer for residual oil measurement in reservoirs - **A.M.F. Pinto & al**

A-64 Tracers for monitoring multiple hydraulic fracturing in Argentina - **C. Procak & al** (presented by **E. Alvarez Gomez**)

A-68 Radio-tracers: Field experience in the Ecuadorian Amazon Rain Forest – **J. F. Romero & al**

A-49 Evaluation of geothermal energy potentials of parts of inland basin in northeastern Nigeria - **M. Y. Kwaya & al**

A1 Posters

A-19 Synthesis and evaluation of Ferragels as perspectives solid ^{99m}Tc radiotracers – **E. M. Báez & al**(Not yet confirmed)

A-20 Extraction of $^{99m}\text{TcO}_4^-$ eluted from the $^{99}\text{Mo} / ^{99m}\text{Tc}$ generator using different formulations of TBP-TOA/cyclohexane as solvent mixture – **J. D. Catasús & al**(Not yet confirmed)

A-36 Comparative study of ^{99m}Tc and ^{131}I radiotracer marking of phosphate particles – **H. Ben Abdelouahed & al**

A-32 Optimization for low volumes of water in determination of radon 222 by LSC – **L. S. Faria & al**(Not yet confirmed)

17h20 - 18h	Session A2: New techniques, equipment and developments (on and off line, camera, tomography, particle tracking, mathematical treatment ...)
17h20 - 17h40	A-88: A new approach for coupling CAD or CFD data into MCNP6 for Monte Carlo simulation of radiotracer experiments - Zhenhua Lin
17h40 - 18h00	A-71: Radioactive Particle Tracing in an internal circulating water tank - Sung-Hee Jung& al

Tuesday October 14th 2014

9h - 10h	Session A3: Coupling Computational Fluid Dynamics (CFD), Numerical Residence Time Distribution (RTD) and tracer experiments
9h - 9h20	A-55: Flow Simulation in Aquaculture Ponds: Comparison of Several Turbulence Models - A. F. Moussoh & al
9h20 - 9h40	A-74: Computational fluid dynamics and radiotracer experimental methods for flow pattern description – Z. Stegowski & al
9h40 - 10h	A-66: Use of CFD and tracers to study the abnormal turbid phenomenon at the spillway for safety assessment of hydropower dam - N.H. Quang & al
10h00 - 11h00	<i>coffee break and poster session</i>

A2 Posters

A-70 Solid motion characterization in a three phase bubble column from the axial trajectory of a radioactive tracer obtained using axially aligned detectors - **Gabriel Salierno & al** (Not yet confirmed)

A-46 Design, Development and Demonstration of Operational Feasibility of Novel and Dynamic RPT Calibration Technique – **V. B. Khane & al**(Not yet confirmed)

A-82 Improvement of the image quality using spectrum stabilizing technique in γ -Ray column scanning tomography – **G. Xiang & al**

A-37 Tracing a radioactive point source within a bulky material – **M. S. Hamideen & al**(Not yet confirmed)

A-69 A Gamma Ray Computed Tomography using a single Source-Detector Pair - **A. Saadaoui & al**

A-4 Dual Source Computed Tomography (DSCT) - R. Varma & M. Al-Dahhan(Not yet confirmed)

A-5: Development, validation and implementation of Multiple Radioactive Particle Tracking Technique – **M. Vesvikar & M. Al-Dahhan** (Not yet confirmed)

A3 Posters

A-2 Numerical CFD and Tracer Simulations in Aquaculture Ponds: Compartmental Flow Description - **H. A. Affum & al**

A-75 Mixing Length Determination of Immiscible Multiphase Fluid Flows in Pipe Using RTD Radiotracer Data and CFD Analysis - **S. Sugiharto & al**

A-22 Determination of Flow Structure in a Gold Leaching Tank by CFD Simulation - **C.P.K. Dagadu & al**

11h - 13h	Session B3: Safety (Radioactivity, control) & Environment (Wastewater treatment, air pollution control)
11h - 11h20	A-51: Evaluation of hydrodynamics from three tertiary treatment artificial wetlands by application of fluorescent tracers – J. Laurent & al
11h20 - 11h40	A-54: ^{210}Pb and ^{137}Cs as tracers for sediment geochronology and reconstructing of historical input of pollutants in coastal environments: Application to the Oualidia lagoon - N. Mejjad & al
11h40 - 12h	A-41: Environmental impact of radiotracer studies: biota dose assessment – C. E. Hughes & al
12h00 - 12h20	A-48: Determination of water volume in stepped cascades using tracer experiments – H. Khdhiri & al (presented by J. Haag)
12h20 - 12h40	A-10: Application of Factor Cluster Analysis to the Characterisation of Atmospheric Aerosol Sources in Tetouan city (Morocco) - A. Benchrif & al.
12h40 - 13H	A-91: An Overview of Application of Bayesian Classifier Approach in Radioactive Tracer Technology. Case Study- A.S. El-aseer

13h - 14h40	<i>Lunch</i>
14h40 - 15h40	<i>Session B5-Part 1: Stable isotope tracers and radio tracer in water resources research, hydrology, sedimentology and agriculture.</i>
14h40 - 15h	A-62: Application of water tracer experiments to characterize the dynamics of rain water infiltration processes in the vadose zone of iron ore caves – P. F. P. Pessoa & al (presented by Dora Atman)
15h00 - 15h20	A-33: X-ray based sediment profiler for preparing and evaluating dredging works – K. Geirnaer & al (presented by P. Brisset)
15h20 - 15h40	A-61: A study about the radioactive disequilibrium of the Uranium and Thorium series in soil samples of the state of Minas Gerais, Brazil – C. M. Peixoto & al
15h40 - 17h00	<i>coffee break and poster session</i>
17h00 - 18h00	Special session devoted to the creation of an International society and to the evolution of the next tracer conferences P. Brisset and J-P Leclerc

B3 Posters

A-11 Pharmaceuticals into waters and associated risks – **S. I. Borrely & al**(Not yet confirmed)

A-76 Source Identification by Positive Matrix Factorization of Airborne Particulate Matter Sampled in Kenitra City (Morocco) - **M. Tahri & al**

A-44 Radiation protection and safety aspects at the application of short-lived radioactive isotopes at example of residence time measurements in a high pressure partial oxidation (HP-POX) reactor with Ar-41 - **T. Jentsch & al** (Not yet confirmed)

A-17 Hydrodynamic evaluation of constructed wetlands using natural and artificial salt tracer experiments – **M. Cade & al**(Not yet confirmed)

A-29 Radiological baseline establishment around Moroccan Triga Mark II reach's site - **T. El Khoukhi & al**

A-21: Selective adsorption studies by radiotracer technique- application of silica sorbents for ^{134}Cs and other radionuclides removal from the spent fuel storage basins and the nuclear reactor primary water circuit – **D. Chmielewska & E. Pańczyk** (Not yet confirmed)

B4 Posters

A-38: Industrial process troubleshooting with imaging technique improved by gamma-ray absorption scans – **M. I. Haraguchi & al (presented by W. A. P. Calvo)** (Not yet confirmed)

A-3 Coking phenomenon detection in gaseous phase using Gamma scanning technique – **R. Alami & al**

A-6 Gamma Column Scanning Technology in the Philippines - **D. D. Aquino & al**(Not yet confirmed)

A-34 Determination of Flow Patterns across a 90o Horizontal Bend during Two-Phase Flow Operation by Gamma Computer Tomography – **Ghiyas Ud Din & al**

A-24 Preventive Diagnosis of Alcohol Distillation Towers Using Gamma Scanning Techniques - **M. Derivet & al (presented by a colleague from Brazil)**

A-25 Screening Blockage of the Petrochemical Gas Pipeline by using Gamma Scanning Technique - **D. Saengchantr & al**

A-26 Gamma Scanning of Industrial Process Vessels in Thailand - **D. Saengchantr & al**

B5 Posters

A-42 ^{99m}Tc vs Rhodamine WT for tracing coastal hydrodynamics –
C. E. Hughes & al

A-45 Exploration of the Deposit of the Power Station Inga Canal using a Nucleonic Gauge JDT3 - **B.L. Bizimana & al (presented by D. Kabeya)**

A-52 Use of environmental isotopes to track Morocco's water resources – **H. Marah & al**

A-27 Flow Measurements in great Rivers, Southern Chile, Using Fluorescent tracer – **F. Díaz & al**

A-12 Application of neutron activation analysis for metallic pollution study in Sebou river (Morocco) - **H. Bounouira & al**

A-13 Application of neutron activation analysis for the geochemical study of El Hachef river (region of Tangier - Morocco) - **H. Bounouira & al**

A-40 Contribution of hydrochemical and isotope tools to the vulnerability of the coastal aquifer of the Mitidja plain (North East of Algiers) – **N. Hocini & al**(Not yet confirmed)

A-81 Uranine in groundwater as a tracer to assess flow velocities: two test cases in Lithuania – **V. Cidzikienė & al**(Not yet confirmed)

A-31 Estimation of Soil Erosion and Desertification by Radioactive Nuclides in Uvurkhangai Province of Mongolia – **Ts. Erkhembayar & al.**

A-84: Radiocaesium-137 as tracer in soil erosion investigations at the watershed scale - **A. Zouagui & al (presented by A. Laissaoui)**

A-85: Use of fallout beryllium-7 to assess the effectiveness of no-till management in controlling soil erosion - **A. Zouagui & al (presented by A. Laissaoui)**

Wednesday October 15th 2014

9h - 10h	Session B4: Industrial column, pipe or vessel investigations using tomography or gamma scanning
9h00 - 9h20	A-9: New Radiation Measuring Datalogger for the Column Scanning Control ColScanCK1&NibraS – A. Benahmed & al
9h20 - 9h40	A-30: Comparative study of Radiotracer and Sealed Source Techniques for Detecting the coking in distillation columns' packings – K. El Korchi & al
9h40 - 10h00	A-43: Non-Invasive Inspection of Blockage and Material Build-Up in Pipelines Using a Clamp-On Gamma-Ray Tomography System - Jaafar Abdullah & al
10h00- 11h00	<i>coffee break and poster session</i>
11h00 - 13h	Session B5: Stable isotope tracers and radio tracer in water resources research, hydrology, sedimentology and agriculture.
11h00 - 11h40	A-7: Evaluation of sedimentological issues, using tracer techniques, regarding a bottom discharge in the Paciencia Small Hydro Power Plant, Brazil – J. V. Bandeira & al (presented by Dr. Rubens Martins Moreira)
11h40 - 12h00	A-78: Investigation of sediments transport mechanisms in the golf of Durres (Albania) using radiotracers and natural radioactivity of sediments – J. Thereska
12h00 - 12h20	A-27: Flow Measurements in great Rivers, Southern Chile, Using Fluorescent tracer- Francisco Díaz& al
12h20 - 12h40	A-56: Use of Environmental radionuclide ⁷ Be to evaluate soil practises in Sehoul Catchments, Morocco - A. Nouira & al

12h40 - 13h00

A-28: The Moroccan environmental signature of the Fukushima accident - **T. El Khoukhi & al**

13h00 - 13h30

Closing session

CONTACT INFORMATION

**7th International Conference
on
Tracers and Tracing Methods**

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B1

Industrial applications and chemical engineering

A-15 B1

IAEA ACTIVITIES IN THE FIELD OF RADIATION TECHNOLOGIES FOR NON-DESTRUCTIVE DIAGNOSTICS AND EVALUATION OF INDUSTRIAL PROCESSES

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The International Atomic Energy Agency (IAEA) is actively involved in promoting various applications of radioactive materials and radiation, in tune with its mandate which states “The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world”. Applications of radiation technologies in industry are well established and have proven benefits leading to prosperity of all the stake holders. In this context, in the early years the Agency had a strong role to play in promoting industrial applications of radiation technologies (radiotracers, sealed sources, and nucleonic control and measurement systems) in its member states leading to well established regular practice and self-sufficiency in many of these countries.

The economic benefits that may be derived from the use of these technologies are large, a fact that is recognized by the governments of developing countries.

Many Regional and national Technical Cooperation Projects (about 10-15 projects each year) have been implemented in several Member States in Africa, Europe, Asia-Pacific and Latin America regions for the introduction, establishment and strengthening of activities in various radiation technologies, methods and techniques.

Many Coordinated Research projects, Technical and Consultant meetings have also been conducted to develop new techniques and strengthen networking and collaboration between developed and developing countries.

The transfer of technologies is also ensured through the publication of technical documents covering most of the aspects of various techniques or applications in specific fields.

Recognizing the need for ‘*quality control*’ and ‘*quality assurance*’ in all aspects of the practice, the Agency emphasizes the importance of quality and has urged and helped the Member States to enforce national regulations for practicing radiation based technologies such as radiotracers, sealed sources, NCS.

Nowadays IAEA is involved in the development of training and certification system, together with eLearning modules to help Members States in the promotion of the technologies through the development of a competent and sufficient manpower.

The IAEA will continue to promote and facilitate establishment of infrastructure and human resource in its Member States for safe practice of radiation based techniques.

A-35 B1 Oral

EVALUATION OF CONTINUOUS PHASE AXIAL DISPERSION IN A TWO-PHASE COUNTERCURRENT PULSED EXTRACTION COLUMN BY RADIOTRACER TECHNIQUE

Ghiyas Ud Din¹, Imran Rafiq Chughtai², Iqbal Hussain Khan³, Samar Gul¹

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The process of liquid-liquid extraction by pulsed sieve plate columns is playing a key role in process industries since decades but various hydrodynamic features of this process are yet to be explored. Phases in such columns are subject to flow counter-currently to achieve high concentration gradients for efficient mass transfer; however, axial dispersion in both phases lowers the process efficiency by lowering solute concentration gradients. This paper presents an experimental study of continuous phase axial dispersion in a pulsed sieve plate extraction column using radiotracer Residence Time Distribution (RTD) analysis. The effect of continuous phase superficial velocity on the axial dispersion in continuous phase has been investigated. The holdup and slip velocity which are other important hydrodynamic parameters were evaluated. ⁶⁸Ga in the form of gallium chloride was used as radiotracer and measurements were made using NaI(Tl) scintillation detectors. It has been observed that the axial dispersion in continuous phase decreases with increase in superficial velocity of continuous phase. A slight increase in slip velocity has been observed while there is no change in the holdups of phases for the range of continuous phase superficial velocity studied. Hydrodynamics of the system was simulated using the axial dispersion model and results are discussed.

Keywords: Liquid-liquid extraction; pulsed sieve plate column; radiotracer, residence time distribution; axial dispersion; hold-up; slip velocity

A-59B1 Oral

SOLID PHASE TRACKING IN A PILOT-SCALE BIOREACTOR USING RADIOACTIVE PARTICLE TRACKING TECHNIQUE

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Radioactive particle tracking (RPT) technique has evolved to be a well-accepted technique for investigating dynamics of different phases in laboratory-scale multiphase reactors during last two decades. Present paper describes successful implementation of RPT technique in a pilot-scale bioreactor designed for wastewater treatment. The reactor involves flow of two different phases i.e. wastewater and 'media' elements (solid phase). The wastewater flows continuously through the reactor, whereas a pre-decided quantity of the media move within the reactor. Air is introduced into the reactor from bottom through a sparger that makes the media to move in axial as well as radial direction within the reactor. The homogeneous movement or mixing of 'media' elements is critical for efficiency of the reactor. Therefore, the RPT technique was applied to track the movement of the 'media' elements. A single 'media' element was labelled with Scandium-46 radioisotope (activity : ~37 MBq) and used for tracking the movement of media within the bioreactor. Based on the results of RPT experiments, the flow behaviour of the media elements was visualized and several flow abnormalities were detected. These flow abnormalities were primarily due to the poor design of the air-distributor used in the reactor. Based on the results of the investigation, several modifications were suggested to the designer of the reactor. It is expected that the suggested modifications, if implemented, will lead to substantial technological and economical benefits to the industry.

A-57 B1 Oral

RADIOTRACER INVESTIGATION IN A TANK FURNACE OF A GLASS MANUFACTURING UNIT

*H.J.Pant, Sunil Goswami, Jayashree Biswal, Jitendra Samanthray, V.K.Sharma
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The production of glass is a very complicated process and glass technologists have been making great efforts to develop new technologies for improving the glass quality and process efficiency. These two aspects mainly depend upon flow dynamics and heat transfer behaviors of the molten glass in the glass furnace. The heat transfer behavior also depends upon the flow dynamics of the molten glass. The flow dynamics include parameters such as mean residence time (MRT), minimum residence time, maximum residence time, flow patterns, homogenization time, dead volume, glass stream velocity, bypass flow and stream circulation. At the request of a glass industry, a radiotracer investigation was carried out to measure residence time distribution of molten glass in a tank furnace of a glass production unit. The main objectives of the investigation were to measure mean residence time of molten glass in different sections of a glass production unit and mixing time of the feed material. Lanthanum-140 (^{140}La) as Lanthanum oxide (La_2O_3) was used as radiotracer to measure residence time distribution (RTD) of the molten glass. The radiotracer was monitored at fifteen different strategically selected locations using collimated and water cooled NaI(Tl) scintillation detectors. The mean residence time of molten glass in tank furnace was determined to be 31.3 h. The dead volume within the furnace was estimated to be about 28.5 %. It was found that there were two distinct parallel flow paths followed by the molten glass within the furnace with poor intermixing. Bypassing of molten glass has been observed in left flow stream in furnace and right side flow stream in forehearth. Recirculations currents of molten glass were observed within the furnace during the passage of flow. The currents were prominent in left side of the furnace. The results of the study could help the plant engineers to control and optimize the production process, and improve the quality of the glass produced.

A-8 B1 Oral

INVESTIGATION OF THE OPERATION EFFICIENCY OF A RAW MATERIAL GRINDING MILL FOR CLINKER PRODUCTION AT PPC COLLEEN BAWN FACTORY IN ZIMBABWE USING RADIOTRACER

Peter Baricholo¹, Andreas Hills², Jovan Thereska³, RAF/1/004 participants⁴

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² *NECSA, South Africa*

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⁴ *AFRA region*

Au¹⁹⁸ was used to determine the Residence Time Distribution (RTD) of limestone and clay in the production of clinker at PPC Colleen Bawn factory near Gwanda with the objective of determining hold-up and grinding efficiencies of a ball mill operating in a close circuit regime. Three experiments were conducted using Au¹⁹⁸ radiotracer and highly sensitive NaI detectors for radiation measurement. In two experiments, 50 mCi of Au¹⁹⁸ was used to tag limestone and clay which were fed into the ball mill at 85tonnes/hr and 90tonnes/hr respectively. In the other experiment 100 mCi of the tracer was used to tag limestone with a feed rate of 90 tonnes/hr. The estimated efficiency of the separator of nearly 90% shows that the performance of the separator is satisfactory. Results show that the grinding process of raw materials inside the mill was not optimal. The dynamic behaviours of limestone and clay in the mill were different with clay spending less time inside the mill compared to limestone. Clay dynamics inside the mill are abnormal. There is a portion of clay particles moving fast from the input to the exit, bypassing the grinding process. The gas flow regime flowing through the system could be higher than required for this feed regime. The high gas flow regime and the rather empty internal lining of the mill (without diaphragms or any baffle) could be the reason of the shorter residence time of raw materials (in particular clay) inside the mill. The mill is best modelled as a plug flow with a perfect mixture.

A-58 B1 poster

EVALUATION OF PERFORMANCE OF A PILOT-SCALE TRICKLE BED REACTOR USING RADIOTRACER TECHNIQUE

H.J.Pant and V.K.Sharma

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Trickle Bed Reactors (TBRs) are extensively used to carry out various processes in industry. The successful operation and efficiency of a TBR primarily depend upon various design of the liquid distributors used and associated hydrodynamics parameters such as mean residence time (MRT), holdup, axial mixing and radial mixing of the flowing phases. Therefore the knowledge of these parameters is of vital importance to model, design, optimize and predicting the behavior of these reactors. Residence time distribution (RTD) analysis approach is widely used to estimate the hydrodynamic parameters and evaluate the performance of continuous process systems. A series of radiotracer experiments was carried out to measure the RTD of liquid phase in a pilot-scale TBR with co-current flow of liquid and gas phase. The experiments were carried out at cold conditions. Water and air were used as liquid and gas phase respectively. The main objectives of the experiments were to estimate the above-mentioned hydrodynamic parameters and; evaluate the performance of the reactor and distributors used. Bromine-82 as ammonium bromide was used as a radiotracer. The radiotracer was injected at the inlet of the reactor and its passage was monitored at sixteen different strategically selected locations in the reactor using collimated NaI(Tl) scintillation detectors. The analysis of the measured RTD curves indicated minor abnormalities in radial distribution of liquid phase in the TBR. This in turn indicated satisfactory performance of the liquid distributors used in the TBR. The overall RTD of the liquid phase, measured at the exit of the reactor, was simulated using axial dispersion with exchange model (ADEM) and model parameters were obtained. The results of simulations indicated that the trickle bed reactor behaved as a plug flow system at the operating conditions used in the investigation. The results of the investigation helped to improve the design of a full-scale industrial TBR for petroleum refining applications.

A-60 B1 Poster

Investigation of Liquid Cooled Pebble Bed Reactor through Radioisotope Techniques

Rupesh Verma¹, H.J.Pant² and R.K. Upadhyay^{1*}

¹*Department of Chemical Engineering, Indian Institute of Technology- Guwahati 781039, Assam, India*

²*Isotope Applications Division, Bhabha Atomic Research Centre (BARC), Trombay, Mumbai 400085, India*

Need of the safer technology in nuclear science has led to the introduction of “Generation IV” nuclear reactors. Graphite moderated liquid cooled pebble bed reactor (PBR) is one of them, consisting of tri structural-isotropic (TRISO) micro fuel particles having fissile materials (like U²³⁵) integrated with a coated ceramic layer of silicon carbide. In a liquid cooled PBR, pebbles flow with liquid coolant against the gravity. The coolant has higher density than pebbles, therefore pebble has modest buoyancy and they float in coolant. The pebble buoyancy provides upward terminal velocity to the pebbles which cause pebbles movement inside the reactor. The velocity profile and distribution of fuel pebbles inside the reactor plays an important role in the performance of the reactor as these parameters affect the overall heat transfer from fuel pebbles to coolant. Therefore, for optimal design of liquid cooled PBR detail understanding of pebbles flow and their distribution inside the reactor is required.

In current work, a hydro-dynamically scaled down ‘cold flow’ unit of liquid cooled PBR is designed and installed. Water is used as a coolant and 1 inch polypropylene balls are used as fuel pebbles. The pebbles are continuously recirculated in the system at different rate (1 to 10 pebbles per sec). The distribution of pebbles across the cross section is investigated by using gamma-ray densitometry technique for different operating conditions. Experiments are performed for different flow rate of coolant and different pebble to reactor volume ratio (20-60%). These results will help to find the optimal operating parameter for liquid cooled pebble bed reactor. Further, data will be useful in numerical modelling and validation of CFD simulations.

A-39B1 Poster

OVERVIEW OF SOME RADIOTRACER APPLICATIONS IN INDUSTRIES

Dries Hills, South Africa

Industrial Radioisotope Technology has a proven application as a diagnostic tool for troubleshooting distillation columns and the detection of possible leaks present in refinery heat exchangers. We have indicated the value of radioactive sealed source application in revamping of a Methanol distillation column and secondly the presence of malfunctions in a main FCC distillation column.

Radioactive tracers were used to verify and confirm the presence of feed material leaking into the effluent line of a Packinos heat exchanger. The principles and state of art of radio isotope methodology as applied to industrial processing sectors, with emphasis on petrochemical refineries is described. It is intended for practitioners but also to promote the economic benefits derived from its use to industrial end users.

Radioisotope tracer technology is used as an engineering aid to compare two identical sulphur recovery plant systems in order to evaluate the performance as well is to obtain a better understanding of operational problems present. This document stresses the importance to make use of the technology before taking impact decisions.

A-47 B1Poster

EXPERIMENTAL INVESTIGATION OF FLOW OF PEBBLES IN A PEBBLE BED NUCLEAR REACTOR

Vaibhav B. Khane¹, Muthanna H. Al-Dahhan²

¹ *Chemical and Biochemical Engineering Dept., Missouri University of Science and Technology, USA*

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The Pebble Bed Reactor (PBR) is a 4th generation nuclear reactor which is conceptually similar to moving bed reactors used in the chemical and petrochemical industries. In a PBR core, nuclear fuel in the form of pebbles moves slowly under the influence of gravity. Due to the dynamic nature of the core, a thorough understanding about slow and dense granular flow of pebbles is required from both a reactor safety and performance evaluation point of view. As a part of this work, new integrated experimental and computational study of granular flow in a PBR has been performed. Continuous pebble recirculation experimental set-up, mimicking flow of pebbles in a PBR, is designed and developed. Experimental investigation of the flow of pebbles in a mimicked test reactor was carried out for the first time using non-invasive radioactive particle tracking (RPT) and residence time distribution (RTD) techniques to measure the pebble trajectory, velocity, overall/zonal residence times, flow patterns etc. The tracer trajectory length and overall/zonal residence time is found to increase with change in pebble's initial seeding position from the center towards the wall of the test reactor. Overall and zonal average velocities of pebbles are found to decrease from the center towards the wall. Discrete element method (DEM) based simulations of test reactor geometry are also carried out and simulation results are validated using the obtained benchmark experimental data.

A-77B1Poster

MAJOR RADIOISOTOPES APPLICATIONS AND THEIR BENEFITS

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Major radiotracer and radioisotope sealed source techniques are now in service to industry to optimize processes, solve problems, improve product quality, save energy and reduce pollution. Stimulated by an ever increasing demand from large production plants, many radioisotope techniques have been evolved to provide fast and effective solutions to plant and process problems. Relevant target areas for radioisotope applications are defined. Though the technology is applicable across a broad industrial spectrum, the petroleum and petrochemical industries and mineral processing sectors are identified as the most appropriate target beneficiaries of radioisotope applications: these industries are widespread internationally and are of considerable economic and environmental importance.

For industry to invest in radioisotope applications there must be clear economic, environmental or safety benefits, such as:

- the proposed investment will generate rapid economic payback; or
- it will effect worthwhile safety improvements; or
- it will have an advantageous environmental impact.

Case studies exemplify the different ways in which the benefits are derived:

1) Troubleshooting. Radioisotope technology is used to diagnose specific causes of inefficiency in plant or process operation. In this context, it should be noted that in very many cases the benefit is derived in the form of savings associated with plant shutdown minimization and loss prevention. The average benefit to cost ratio was approximately 20:1, but also was found out that in individual cases, the figure could be vastly greater than this. This estimation was found out mostly for troubleshooting services.

2) Process Optimization. The radioisotope measurements provide information that facilitates improvements either in the throughput or the product quality. While a troubleshooting project results in a “one-off” economic benefit, often realized as savings, an optimization exercise results in a permanent and ongoing increase in productivity and/or product quality, leading in turn to a continuing increase in profit. Thus, the cost: benefit ratio from this type of application is likely to be considerably greater than for troubleshooting.

The interest in radioisotope technology has been considerable since the early 1960's. The International Survey on the Use of Radioisotopes in Industry coordinated by the IAEA in 26 developed countries in the early 1960's provided reliable data on impact of radiation and radioisotope technologies at that stage. The survey is a good reference for investigating the evolution of these technologies in time. It was estimated that savings coming from applications of radiotracers and sealed sources were some hundred US\$ million/yr.

The US report titled: “The Untold Story: Economic and Employment Benefits of the Use of Radioactive Materials” estimates that (excluding nuclear power) approximately \$ 250 B production or 4% of the US GDP is associated in some way with the use of radioisotopes, in medicine, agriculture, industry, resources development and research. This report does indicate that we are dealing with very important issues.

A first approach to estimate benefits from radiotracer and sealed source services worldwide is by referring to 10 000 services per year (minimal estimation of commercial services worldwide). Experience has shown that an average benefit of US\$100 000 per service is a conservative estimation. It results in an overall estimation of at least of US\$1 billion savings generated from applications of radiotracers and sealed sources.

A-90 B1 Poster

CHALLENGES AND OPPORTUNITIES OF RADIOTRACER TECHNIQUES IN INDUSTRIAL APPLICATIONS IN EGYPT

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It was a good opportunity for Egypt to join AFRA regional projects RAF 8040 and RAF1004, we now have well trained team and fully equipped lab, so we can do jobs to apply radiotracer techniques in some applications in industry.

During our experience in applying tracer technology we have faced several challenges that made it quite difficult for us to get our first job. During our two trials in Rashpetco - British Gas Co. and Egyptian petrochemicals Co. facing the panic and the fears of the workers in the two companies to use radioactive materials was always an obstacle despite our stubborn trials to explain and reassure them by providing a special seminar held by our team and safety expert to help clarify about using isotopes in very safe way for the workers. Another challenge was although we have reduced our financial cost to be just for the minimal costs, but still the two companies preferred searching for less costly alternatives.

Key words: AFRA regional projects – Radiotracer techniques - Industry.

A-92 B1 Poster

CHALLENGES AND OPPORTUNITIES OF RADIOTRACER TECHNIQUES IN INDUSTRIAL AND ENVIRONMENTAL APPLICATIONS IN CAMEROON

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With the support of the IAEA, the government of Cameroon want to establish trough HYDRAC company, the country's first specialized facility using radiotracer techniques for industrial application. Using the SWOT analysis, the presentation will show the challenges on how to implement this technique in the country that has no previous experiences of radiotracer, and opportunities to use this technique in industries in order to expand the scope and magnitude of income generating activities, and enhance the sustainability and self-reliance of the company. The implementation status, the problem related to availability of tracers and the achievements of project will be presented.

A-79 B1 Poster

RADIOTRACER RESIDENCE-TIME DISTRIBUTION METHOD IN THE ANALYSIS OF INDUSTRIAL UNITS: CASE STUDIES

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Tracer methods are encountered in many areas of science and engineering. They have found a widespread use in chemical engineering after the work of Danckwerts, who realized that the residence time distribution (RTD) of process fluid in process equipment determines their performance. He also showed that the residence time distribution can be obtained by tracer methods if the identifiable tracer behaves identically with all other fluid molecules. In spite of this „old age” the RTD measurement and modelling for troubleshooting and process diagnosing is still the subject of many publications in most important journals of chemical engineering concerning general or practical aspects of RTDs.

Generally, RTD method relies on tracer input in the inflow of the system under investigation and on interpreting the monitored outlet tracer response of the system. Many types of substances can be “the tracer” in obtaining residence time distributions as long as the assumption of the linearity of the tracer response is satisfied, but in real industrial conditions the radiotracers are unique and most competitiveness.

The aim of this paper is to give several examples showing how the information obtained by tracer experiments is used to analyze the operation of industrial units, to eliminate troubles and to improve the economic performance of processes. These examples are chosen in such a way as to cover a wide range of industrial activities in the fields of chemical and metallurgical processes, water treatment, mineral processing, environmental protection and civil engineering.

The use of radioactive tracers in the analysis of industrial units is illustrated by some typical cases concerning a SO₂ - oxidation industrial reactor, a superphosphate granulator, a chromium ore rod mill, a shaft furnace with a settling tank in a copper melting process, a fluidized bed calciner and a pilot wastewater treatment installation.

A-83 B1 Poster

RESIDENCE TIME DISTRIBUTION MEASUREMENTS IN FLOTATION COLUMNS USING RADIOACTIVE TRACERS

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Industrial data of residence time distribution (RTD) in flotation columns is presented, which were measured in three different plants using the radioactive tracer technique for liquid (Br^{82} in aqueous solution) and solids per size classes (irradiated solid gangue). The methodology consists of tracer injection at the inlet stream of the flotation column and the simultaneous tracer concentration measurement at the outlet stream. This technique has advantages in comparison to other measurement procedures, because of its non-invasive procedure and the physical and chemical similarity among the tracer and the actual system components. Also, the activity signals can be captured by on-line sensors. The tests allowed the identification of the flow regime (dispersion) and effective cell volume occupied by the different phases. Results include flotation columns operated with effective residence times from 2 to 7 min. Different RTD model structures were evaluated and compared, including: perfect mixing, perfect mixing plus dead time, the axial dispersion approach and the Large and Small Tanks in Series (LSTS) model.

The online RTD characterization has been useful to detect process failure such as dead volumes and bypass flow identification as well as unbalanced flow distributions at industrial scale.

A-18B1 Poster

EVALUATION OF LEAKS AND PASSES IN REBOILERS FROM NATURAL GAS PROCESSING PLANTS

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A set of determinations are reported with a series of radiotracer experiments in a fractioning plant of liquids hydrocarbons from natural gases in Peru, in order to evaluate leaks / passes that could exist in three reboilers located in different processing units.

The main objective of the experiments was to identify leaks and passes of thermal fluid or liquid hydrocarbons, either from the tubes to the shell or from the shell to the tubes, in the following units: One reboiler of a debutanizer column, one reboiler of a depropanizer column, and one reboiler of the stripping column from naphta-diesel fractioning column.

A tracer technique for online detections was performed using oleic acid labeled with Iodine 131 as radiotracer with a total activity of $33,4 \times 10^8$ Bq (90 mCi), for six experiments . Additionally, a data acquisition system with a portable PC and several probes in proper positions were used.

Recording values were synchronized with radiation background (baseline), prior to each injection of radiotracer. Radiation counts were recorded at intervals from one to two seconds, depending on each case. Processing of information and data processing are graphically showed in this report, as well.

The rate or magnitude of the leak is calculated knowing the physical volume parameters between two detectors. This is the typical case of leak detection through a bypass line. The leak or leaks were detected by subsidiary peaks preceding the main peak of the DTR curve, and the leak rate was calculated from the ratio of peak areas (integration).

Some leakages of diesel to the current thermal fluid in a magnitude of 0.3 % of the total diesel were found in some cases. This is not a major problem of contamination of the thermal fluid in the case of the operation of the three reboilers evaluated. Only the reboiler of the stripping of naphtha-diesel fractioning column presents an evidence of minor contamination of the thermal fluid, despite of the pressure in the shell which is higher than the one in the tubes.

As for the reboiler of the stripping column fractionation naphta-diesel, there would be a small loss of thermal fluid in the system, in some way compensated by volume of diesel leakage. However, this situation does not change the specifications and performance of the thermal fluid.

Determinations of leakages and / or passes in the studied systems were oriented mainly to the analysis of the response curves of a radiotracer either in tubes or shell, as applicable. This technique seems to be very useful for inspections in the chemical and petrochemical industry and in general where heat transfers involved in liquid-liquid systems.

A-67 B1 Poster

A RADIOTRACER TEST PERFORMED AT HOWARD WASTE WATER TREATMENT PLANT IN PANAMÁ CITY, PANAMÁ

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This paper presents an application of Sodium Pertechnetate ($\text{Na}^{99\text{mTcO}_4^-$) for a better understanding of industry applications of radiotracers technology. An experiment has been carried out at Panama Pacifico Waste Water Treatment Plant (WWTP) located in the former Howard United States Air Force Base. The plant is located very close by the southern (Pacific) end of the Panama Canal. In this plant, like most typical WWTP, waste water undergoes a filtering process to remove objects before entering the system. After filtering, waste water is treated in two aerated tanks and two digesters where biological processes reduce organic matter and pollutants. Before discharging the effluent to the Pacific ocean, it is ensured that most of the oxygen is restored to avoid damages to the environment. The experimental design consisted in selecting the tracer injection points, position of detectors, radioisotope transportation, radiological safety considerations, tracer injection, data acquisition, treatment, and interpretation. A radiotracer experiment in the two aerated tanks was made due to four reasons. First, suitability of physical dimensions of 16.9 meters long, 7.6 meters wide and 4.5 meters deep. This represents an approximate volume of 600 m³ with flow rate of 0.04 m³/s in each tank. Second, excellent injection point because the waste water enters in the tank in a spillway and the tracer could be released directly in to the flow. Third, results could show if both tanks are operating in a similar conditions. Finally, the tracer injection operation can be seen by the technical staff. Because of the significant recirculation flow existing in both tanks the residence time distribution measurement and the mean residence time estimation were not possible. However, analyzing the detection curves, it can be conclude that the apparent mean residence time is certainly greater than the nominal value that is approximately 4 hours, waste water was totally mixed in the tank after 14 minutes of entering in the tank; and there were no dead or stagnant zones.

A-53 B10 Poster

CHALLENGES AND OPPORTUNITIES PRESENTED BY RADIOTRACER TECHNIQUES IN INDUSTRIAL AND ENVIRONMENTAL APPLICATIONS IN KENYA

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Radiotracer techniques are important non-destructive and non-invasive tools for determination of industrial process performance and efficiency optimization. Although the technology has been developed and established in most developed countries and some African countries, Kenya is still behind as there is minimal promotion of the techniques. In an effort to address this challenge and in partnership with the International Atomic Energy Agency (IAEA), the Government of the Kenya through the Kenya Bureau of Standards recently installed a flow rig, residence time distribution (RTD) modeling and tracer data acquisition system, and conducted training on radiotracer data analysis using flow rig. In this paper we report on the test results of experiments carried out during the training as well as discuss the challenges, potential applications and utility of radiotracer techniques in industrial and environmental sectors of the Kenyan economy.

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B2

Oil field, geothermal field and geology

A-23 B2 Oral

LABORATORY EXPERIMENTS FOR THE EVALUATION OF TRACERS FOR USE IN OIL RESERVOIR CHARACTERIZATION

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Petroleum has to be pushed away from oil reservoirs following a short initial phase at the start of production. This is accomplished by the injection of fluids (mainly water) in wells, a process that needs to be optimized in order to extract as much as feasible from the remaining oil. Due to the expressive value of this resource, any technique that provides information on the behavior of the injected fluid inside the reservoir (e.g. use of a tracer) is of quite valuable when evaluating exploration strategies. Once injected in a petroleum reservoir, a tracer suffers an enormous amount of dilution. Thus, a critical point regarding its use is the availability of analytical techniques able to reach very low detection limits. For this reason, radioactive compounds become an interesting choice. Tritiated water ($^3\text{H-O-}^1\text{H}$) is considered as a nearly ideal tracer for measurements involving the aqueous phase and is the first choice all over the world. Notwithstanding, the recourse to multi-tracer techniques is frequently required to get a full picture of the circulation in the reservoir on a synoptic basis. Hence the performance of alternative tracer options must be investigated before introducing them in a reservoir. Alternative tracer candidates must be previously probed in the laboratory, in tests that simulate the field performance. One of such experiments consists in approximately reproduce field conditions in what can be considered a reduced physical model of the reservoir, which can pretty nearly reproduce the interactions between the reservoir solid walls surfaces and the tracer. Those physical models used are, usually, consolidated pieces, usually with a cylindrical geometry, carved out of the reservoir rocks or any other vicarious rock whose properties have been experimentally correlated with the one in the reservoir. The experiment consists of injecting some pulse of tracer (containing, in the same solution, tritiated water as a reference) through the test sample. The flow can be forced to be unidirectional and the tracer concentration is measured in aliquots collected at the exit. The experiment can be eventually carried under heating. A rectangular pulse of tracer, often preceded and followed by a flush of distilled water, is frequently used to facilitate the interpretation. Experimental results are plotted in graphs of the normalized tracer concentration versus time (or better, versus injected porous volume) superimposing the tested tracer and the reference (tritiated water) tracer responses. These experimental results can be fed to a mathematical model; in the case of the cylindrical geometry, an advection - dispersion model including a proper reaction/sorption term can quite well typify the experimental setup and procedure. Values for the sorption coefficient (K_d) of the tracers being tested can be obtained by modelling the experimental results, thus providing much more reliable value as compared to visual evaluation. Additionally it provides a quantitative evaluation of the dynamic characteristics and eventual limitations of the tracer itself.

A-73 B2 Oral

THE USE OF RADIOACTIVE TRACERS FOR INTEGRATED FIELD SCALE MANAGEMENT OF GEOLOGICAL FORMATIONS

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An old but persistent problem facing both the oil & geothermal industry is the formation of mineral scales from produced brines in the production wells and pipelines. Lost production, formation damage and operational expenses are common results of this phenomenon.

The main objective of the current research work is to provide the relative industry with a methodology that can assist in the design and optimization of a holistic approach for the prevention of scale precipitation and the consequence formation damage.

Our proposed methodology integrates advanced laboratory procedures for the scaling potential and inhibitor effectiveness evaluation using tracer technology to innovative reservoir simulators. The proposed work focuses also on streamlining the methodology to make it technically efficient and economically attractive on an industrial scale. The know how that will be developed through this work will provide better routines for understanding and treating oil/gas/geothermal wells subject to scale formation. Better control of scale prediction will allow the reduction of chemicals used today. Once an accurate predictive model is available it can be used for many different activities in analyzing and optimizing a wide range of aspects of design and operation. The result is improved design solutions, such as equipment dimensions, control tuning values and set point trajectories, with capital and operational savings that will be realized over the lifetime of an exploitation plant.

A-65 B2 Oral

INTERWELL TRACER TEST TO STUDY WATER INJECTION PILOT IN MIDDLE MARRAT, KUWAIT

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Interwell Tracer Test was conducted to study 5-spot water injection pilot in Middle Marrat, Kuwait. The suitable tracer in form of Fluorinated Benzoic Acid was selected from the screening tests for thermal stability and adsorption under reservoir condition in the laboratory to inject into reservoir. The tracer was detected at concentration higher up to thousand times than detection limit (0.1 µg/l) in 3 production wells with the earliest breakthrough 9 days in west MG-126 and hundred days in east MG-129. Moment analysis method was applied for interpretation of tracer breakthrough curves to understand the water injection performance such as swept volumes and stratification of formation. The tracer study provided the experimental data of preferential direction of water movement in west and east that is useful in further assessment of the pilot.

A-80B2 Oral

THE DETERMINATION OF CRACK ZONES IN THE ROOF OF LONGWALL 29-02 IN VALIAS COAL MINE USING RADIOTRACER SINGLE WELL DILUTION TECHNIQUE.

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Longwall mining is a form of underground coal mining where the coal is mined in a single slice (typically 1-2 m thick). This method of mining coal always causes severe and immediate subsidence of the overlying surface strata. The height of the fractured zone above the mined out coal seam is one of the most important issues in mine working and in protection of the mine against inundation from gravel groundwater near the surface.

Radiotracer single well dilution technique has been applied to determine the cracking zone and its time characteristics, in order to investigate the restabilising process in fractured zone rocks produced during exploitation of subaquatic coal mining in Valias mine. Three wells were drilled from the surface; two of them down to the roof of the coal bed in the crack zone and the third one into the intact roof.

Na¹³¹I radiotracer (3.7 GBq) was used to follow dilution process in each test. There were performed several radiotracer injections, followed by gamma logging in several consecutive days, as well as radiotracer tests were performed in three wells in periodic way for a period of tenths of months. The evaluation of radiotracer profiles in time and position gives important data about the vertical flows and dilution rate.

The radiotracer single well dilution technique provided the preferential movement of underground water, the vertical displacement and water loss with time.

The main conclusions were: The ceiling of cracking zone is nearly 72- 75 m (from the surface) for the well 1 and 2 respectively, while referring from the coal seam the beginning of the cracking zone is nearly 40 m for both wells 1 and 2. There was no risk for inundation from underground water that is situated 10-15 m under the soil surface above the galleries roofs. The fractured zone produced during exploitation of subaquatic coal mining in Valias mine trends towards stabilisation after two years' time from the beginning of coal extraction.

A-72 B2 Poster

ROCK'S HETEROGENEITY EVALUATION IN WATERFLOODING OIL RESERVOIRS FROM INTERWELL TRACER RECORDS

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This paper introduces and compares two alternative ways to evaluate rock's heterogeneity in waterflooding processes conducted in oil reservoirs, from interwell tracer records.

One way is to evaluate heterogeneity through the **dispersivity α** , which is a parameter of the Convection Dispersion Equation (CDE). Another way, more friendly for the oil reservoir technicians, is based on the analysis of the F-PHI plots for obtaining the Lorenz Coefficient.

Furthermore an alternative way to calculate the Lorenz Coefficient from F-PHI plots is presented. In the authors' opinion, this new method is more reliable than the traditional method because it makes it possible to distinguish between injection pattern effects and heterogeneity effects on the F-PHI curve. Finally a correlation between the Lorenz coefficient and the dispersivity is found. It permits to interchange and harmonize both descriptions.

A-63 B2 Poster

RADON AS A TRACER FOR RESIDUAL OIL MEASUREMENT IN RESERVOIRS

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A method has been developed for the quantification of the amount of petroleum remaining within the porous volume of oil reservoirs using radon as a natural tracer. In order to estimate the Oil Saturation, the partition coefficient of radon between the organic and aqueous phases in the reservoir and the increase in the amount of radon in the aqueous phase, relatively to the amount initially present, are used. The methodology has been tested in a reduced scale in laboratory experiments. A porous medium block prepared in such a way to approximately reproduce the reservoir characteristics has been used in the tests. The block was built out of a sandstone rock containing uranium ore whose radon emanation rate allows precise measurements to be performed with small volume samples placed in a *coreholder*. The steps leading from the formation to the depletion of the reservoir have been simulated. ²²²Rn concentrations were measured at the system exit. The displacing fluid used consisted in synthetic hyper-hyaline water and the fluid to be expelled has been simulated with a synthetic mineral oil. The experimental results have been processed in accordance with the dynamic partition theory used to study radon transport in porous media contaminated with NAPLs. The two critical parameters required for the application of such models are the partition coefficient and the maximum concentration of radon emanated by the porous media. The method chosen for quantifying the partition coefficient has been proposed by Cantaloub. The maximum radon concentration has been measured via Liquid Scintillation Spectrometry in samples collected from the coreholder prior to the introduction of oil in the porous medium. Draining and the imbibition steps were performed in the porous core and mass balances in the aqueous phase were carried at each step. The bench tests were performed in two distinct modes. The first mode simulated the flooding process at steady-state flow condition, as used in flow through columns. The other test mode consisted in short duration imbibitions in three stages, separated by time intervals. The results evince the chances of employing radon as a natural tracer in the petroleum production industry. It can become an alternative method for evaluating of SOR along the useful lifetime of the reservoir.

A-64 B2 Poster

TRACERS FOR MONITORING MULTIPLE HYDRAULIC FRACTURING IN ARGENTINA

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An adequate knowledge of the hydraulic fracturing techniques is required to develop unconventional oil and gas reservoirs. Numerous diagnostic techniques have been developed to improve our understanding of multiple hydraulic fracture behaviour in shale and tight rocks, such as the tracers techniques. This paper presents the progress made in the implementation of tracers in hydraulic fracturing for unconventional reservoirs in Argentina. The analysis focuses on the assessment of tracer concentrations measured in water and cumulative recoveries of the different tracers injected in the fracture fluid. Cases of total trace of each stage (one tracer for the whole stage) and partial trace of each stage (different tracers for slickwater treatment and activated gel treatment) are presented and characterized in this job. Besides, flowback sequence of each stage and their relative contributions are analyzed. Throughout this paper it has been discussed the different interpretation of the data that has been obtained. Most of these tests have been performed using fluorinated benzoic acids (FBAs). The results obtained stand out their potential as tracers in this more demanding conditions and show the contribution of these tests to extend the know-how of unconventional reservoirs development.

A-68 B2 Poster

RADIO-TRACERS: FIELD EXPERIENCE IN THE ECUADORIAN AMAZON RAIN FOREST

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Ecuadorian gross oil production mainly comes from producing fields located at the Amazon rain forest. After almost 42 years of production, most of the oil fields in Ecuador are facing oil production decrease due to reservoir pressure depletion and severe water encroachment.

A Radio-Tracers pilot project using Tritium was implemented on the Tarapoa Block in 2012. Since Tritium is also produced naturally in the atmosphere, its use does not appear to have negative impact on one of the most sensitive areas in the world as is the Amazon.

The main objective of pilot project was to understand the flow direction of injected water thorough producer wells. Tritium was bullheading injected in 8 injector wells and fluid samples from 20 producer wells were collected and analyzed with a scintillation counter. Sampling continued throughout the project period to establish the tracer production profile.

The present paper present results of the application of radio-tracers in three on-shore fields: Alice, Dorine and Fanny 18B on the Tarapoa Block. Results are leading to new insights in reservoir characterization in terms of reservoir continuity of the producer reservoir and allowing to introduce remedy actions for improving oil recovery, pattern configuration and sweep efficiency.

A-49 B2 Poster

EVALUATION OF GEOTHERMAL ENERGY POTENTIALS OF PARTS OF INLAND BASIN IN NORTHEASTERN NIGERIA

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Deep basins are favorable areas for geothermal exploration and assessment of potential geothermal resources is essential for its development to advance. In this work, information on subsurface temperature from 19 oil wells and 24 water boreholes drilled to average depths greater than 100 m from the Nigerian part of the Chad basin were used to determine geothermal gradient of the area. Selected rock samples of different formations of the area were subjected to thermal conductivity test using thermal conductivity scanner (TCS) at the Polish Geological Institute Laboratory, Warsaw. Terrestrial heat flow was calculated according to the Fourier's law of heat flow and results obtained indicated geothermal gradient range of 2.81°C/100m to 5.88°C/100m with an average of 3.71°C/100m. Thermal conductivity values obtained for the different representative samples ranged from 0.58 - 4.207 W/mK with an average of 1.626 W/mK and heat flow values ranged between 45 - 90 mW/m². Evaluation of seismic profile of key marker horizon separating major sedimentary sequences indicate basement depth of more than 6500m and less than 1000m in some places. The work would be vital in the understanding of shallow crustal structures, geothermal heat distribution, the existence of useful geothermal gradient and heat distribution in this part of the Chad Basin.

Keywords: Nigeria; Chad basin; Geothermal; Heat flow; Thermal conductivity

A 1

Tracer and tracer analysis

A-14 A1 Oral

EASILY DETECTABLE TRACERS FOR COMPLEX MEDIA USING TIME-RESOLVED SPECTROSCOPY: NEW FRONTIERS OF MONITORING FROM GEOLOGICAL TILL MEDICAL DOMAIN

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Rare earth ions - that have been widely used for their intrinsic luminescent properties - currently represent the center of tracer's research. Their covalent encapsulation within nano-sized structures improves the sensitivity and specificity of tracers for a wide range of applications. The customizable surface of tracers could be accurately adjusted for each application field: e.g. stealth tracers for geological or medical use. Moreover, it is possible to combine several luminescent centers within a single nano-object in order to create a wide variety of different codes. On this point, our benchmark experiments proved their possible employment in assays that requires simultaneous injections or anti-counterfeiting tests. The detection by time-resolved spectroscopy dramatically increases the signal to noise ratio of tracers even in media as complex as oil production waters, allowing us to gain in sensitivity. Their long-term stability as well as the aptitude to storage under critical conditions increases the versatility of transport and their affordable cost.

A-50A1-Oral

Possibilities and constraints of the use of ^{210}Pb in dating human skeletal remains of forensic interest

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In forensic contexts, time since death assessment in human skeletal remains is crucial for identification, and both accuracy and reliability are required. In this paper, we present the possibilities and constraints of the use of ^{210}Pb in dating skeletonized human bones in Morocco. ^{210}Po is a member of the ^{238}U decay chain and its activity, in a closed system, grows back toward equilibrium with its parents following its half-life of 138 days. The method of dating using ^{210}Pb is based on its uptake by living human bones and retention in a closed system, and the time evolution of its daughter ^{210}Po . After death the activity of ^{210}Pb decays exponentially with time, while ^{210}Po grows during the first 2 years, and then decays along with its parent to reach the secular equilibrium. The measurement of the daughter to parent activity ratio allows quantitative determination of the time since death for fresh bone samples (not exceeding one year since death). In this case, high precision in ^{210}Po and ^{210}Pb determination is required to avoid significant errors that could invalidate the results. The use of ^{210}Pb method to date human bones is based on the assumption that after death, gain or loss of ^{210}Pb only results from radioactive decay or ingrowth from ^{226}Ra ($T_{1/2} = 1600$ y).

The method was tested on recent as well as archaeological bones of known dates of death. A calibration curve was obtained from the available data in the scientific literature. The ^{210}Pb initial activity was introduced as an increasing lineal function with time. The ^{210}Pb dating approach gives promising results only for recent bones. On the contrary, for archaeological bones, the technique has erroneously led to post-mortem intervals in the range of recent bones which constitute a serious limitation of the method. On the other hand, uranium isotopes content in bones is suggested in this work as a possible indicator in placing a studied bone within either a forensic or archaeological context.

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A-19 A1 Poster

SYNTHESIS AND EVALUATION OF FERRAGELS AS PERSPECTIVES SOLID ^{99m}Tc RADIOTRACERS

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Radiotracer applications for solid phase studies can be done employing radioactive labeling as an alternative in countries where there aren't nuclear facilities to activate materials. In the present work, supported on silica gel/zeolite nano scaled zero-valent iron (FS/FZ) were synthesized in ethanol medium under atmospheric conditions and labeled with Technetium-99m (Tc^{99m}) in order to obtain a solid state radiotracer for further industrial applications. Technetium-99m sorption and immobilization on the support material were studied. An experimental design 2^3 was carried out to evaluate the influence of different Ferragel synthesis parameters in the sorption yield ($R_{ret\%}$). It was also investigated the time needed for solid/aqueous phase separation by free sedimentation and centrifugation. Presence of Fe^0 was proved by X-Ray Diffraction (XRD). Furthermore, Ferragel stability in time and stability of the labeling (Tc^{99m}) FS and FZ in water presence were also explored. It was proved the Ferragel capacity for Tc^{99m} retention in the solid phase using both supported on materials with $R_{ret\%}$ of 99%. Both Ferragels confirmed to be perspectives as solid radiotracers

A-20 A1 Poster

EXTRACTION OF $^{99m}\text{TcO}_4^-$ ELUTED FROM THE $^{99}\text{Mo}/^{99m}\text{Tc}$ GENERATOR USING DIFFERENT FORMULATIONS OF TBP-TOA/CYCLOHEXANE AS SOLVENT MIXTURE

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Is a world tendency to use radiotracers obtained by radioisotope generators to facilitate the implementation of radiotracer techniques in developing countries which do not own nuclear installations, and also to carry out tracer applications in places far away from the radiotracer production centres. This strategy requires in most of the cases radioisotope adequation.

Extraction with the mixture 30%TBP-16%TOA/cyclohexane has been successfully used to adequate the ^{99m}Tc , eluted from $^{99}\text{Mo}/^{99m}\text{Tc}$ generator, as an organic fluid radiotracer. This work presents an optimization study of volumetric composition of this mixture, to guide the extraction process towards the best cost benefit relation according to necessary activity at a given application.

Based on experimental results, a model that predicts extraction yield (R%) as a dependent variable of TOA and TBP volumetric concentrations was established, for 3.1MBq of ^{99m}Tc . Moreover, the outcomes show that even when TBP volumetric concentration decreases from 30 to 1% and TOA concentration, from 16 to 0.3%, the least obtained extraction yield was $96.44 \pm 0.21\%$, getting a 73% of radiotracer cost reducing

A-36 A1 Poster

COMPARATIVE STUDY OF ^{99m}Tc AND ^{131}I RADIOTRACER MARKING OF PHOSPHATE PARTICLES

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Residence time distribution (RTD) in the phosphate treatment reactor is one of the most important key process variables. To determine RTD in the reactor we apply radiotracer method. This method consists of injection of an appropriate quantity of a specific radiotracer at the inlet of the process and studying the behavior of the radiotracer in the process by measuring, with appropriate detector, its concentration (counts/s) at the outlet for a continual period of time. However this radiotracer method becomes effective and profitable only if the radiotracer is the optimum one. The suitability of radiotracer should be verified to ensure the complete miscibility of the radiotracer with the phosphate particles as well as its resistance against thermal decomposition and its chemical stability under the conditions of phosphoric acid production process. Phosphate slurry has 70% by weight of liquid and has a solid phase comprising fluorapatite $\text{Ca}_5(\text{PO}_4)_3\text{F}$, quartz SiO_2 and carbonates which are in the form of dolomite $\text{CaMg}(\text{CO}_3)_2$ and calcite CaCO_3 . The problem to resolve in our study is “which phase of the phosphate slurry our injected radiotracer is following?”. For that we apply some experimental tests during which we firstly simulate in laboratory the real conditions of phosphate slurry in chemical reactor (temperature, agitation and chemical composition). Then we add radiotracer to the phosphate slurry and - after ten minutes of agitation - we proceed to phases separation using a filtration system. Finally - and using NaI(Tl) gamma ray detectors - we follow simultaneously the behavior and the quantity of the radiotracer in both phases during the separation stage. The same experiment is applied twice using successively the two types of radiotracers that are available in the country: ^{99m}Tc and ^{131}I . The comparative study of the two results corresponding respectively to test using ^{99m}Tc and test using ^{131}I proves that ^{131}I is more optimal for phosphate particles marking than ^{99m}Tc since after four hours of filtration we found that, in the case of ^{99m}Tc , 59% of the radiotracer is detected in the solid phase (stuck to phosphate particles) and 41% of the radiotracer is detected in the liquid phase of the slurry, and in the case of ^{131}I , only 21% of the radiotracer is detected in the liquid phase and 79% of the radiotracer remains in the solid phase stuck to phosphate particles. A second part of the work is focused on chemical catalysis of ^{131}I phosphate particles marking. To try to upgrade ^{131}I marking of phosphate particles we tested two types of catalyst: BaCl_2 and SrCl_2 . The first observation shows that both catalysts increase the tracer quantities in the solid phase of the slurry. The second observation shows that in presence of BaCl_2 the portion of radiotracer stuck to solid phase reaches 90% however it reaches only 84% in presence of SrCl_2 . Hence and according to the results of this study we conclude that marking phosphate particles with ^{131}I radiotracer using BaCl_2 as a catalyst allows a better miscibility of the radiotracer with phosphate particles and then enables to get a more appropriate and reliable phosphate particles RTD during their chemical treatment in real reactor.

A-32 A1 Poster

OPTIMIZATION FOR LOW VOLUMES OF WATER IN DETERMINATION OF RADON 222 BY LSC

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The Liquid Scintillation Spectrometry is the ideal method for monitoring and control of environmental radioactivity and for samples with low activity. In this work were described the analytical steps developed in the Laboratory of Low Activity located at the Center for Development of Nuclear Technology, which has a liquid scintillation spectrometer - Quantulus 1220TM. Greater attention was required due to the values found for the samples used as reference background, which were well above the desirable. The value found difficult of establishing a lower limit of detection, which is essential in the case of the limited volume of samples used (0.5 mL). In order to establish a lower limit of detection via a low-background three types of water samples were tested: deionized, distilled and old. The sample which had a lower score was submitted to degassing processes, with or without nitrogen gas, and without degassing. The cocktails Optiphase HisafeTM 3 and Opti-Fluor O were also evaluated.

A 2

New techniques, equipment and developments (on and off line, camera, tomography, particle tracking, mathematical treatment ...)

A-71 A2 Oral

RADIOACTIVE PARTICLE TRACING IN AN INTERNAL CIRCULATING WATER TANK

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A polypropylene particle with a piece of Sc-46 metal implanted into it was used as a tracer in a water flow characteristics investigation on a water-filled tank (Dia. 20 cm) and its positions along with water flow were located in three dimensional coordinates. For this purpose, the optimal detection geometry for the experiment was decided from Monte Carlo simulations for various configurations with different number of detectors. The system matrix on 1,768 points inside the tank that is required for the location of the particle was obtained from Monte Carlo simulations that have been primarily calibrated based on the measurement data. The movement trajectory of the particle was compared with a radiotracer experiment and there was 17.5% deviation between them in terms of flow recirculation lap time. It seems to be originated from the resistance of the particle (Dia. 3 mm) against water. A variety of measurement modalities such as Laser Particle Image Velocimetry, Computational Fluid Dynamics Modeling, and Gamma CT were applied in the same water tank. Each technique has advantages and drawbacks over others when it comes to application to a lab-scale industrial process that was designed in such a way to those in practice. This study shows the possibility of radiometric technology as a useful tool to investigate the flow dynamic properties of water in a industrial process system that could not be accessed with the conventional radioisotope application techniques.

A-88 A2 Oral

A NEW APPROACH FOR COUPLING CAD OR CFD DATA INTO MCNP6 FOR MONTE CARLO SIMULATION OF RADIOTRACER EXPERIMENTS

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Los Alamos National Laboratory Monte Carlo N-Particle transport code (MCNP) Version 6 (MCNP6) has been extended to include a new capability that permits tracking of neutrons and photons in an unstructured mesh that is embedded as a mesh universe. This new capability provides an easier, faster and more accurate way of building complex geometries which is a large advantage over traditional CSG (constructive solid geometry) modeling in MCNP code. The mesh geometry in MCNP6 is intended to be created through Abaqus/CAE using its solid modeling capabilities. Instead of creating through Abaqus/CAE and its inherent limitations, this paper presents a new method for the CAD conversion which has high compatibility with many CAD or model meshing softwares. The new implementations and features were tested to simulate several gamma and beta experiments.

The first example simulates the signals from a complex geometry radiation source, made for the French waste management agency (ANDRA: Agence National pour la gestion des Déchets RAdioactifs). These simulations are used for designing a long term ²²Na diffusion experiment in deep underground laboratory. The second example shows the simulation of a beta Thin Layer Chromatography scanner that is used for medical radiotracer quality control.

A-70 A2 Poster

SOLID MOTION CHARACTERIZATION IN A THREE PHASE BUBBLE COLUMN FROM THE AXIAL TRAJECTORY OF A RADIOACTIVE TRACER OBTAINED USING AXIALLY ALIGNED DETECTORS

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Deep understanding of the underlying dynamics of industrial equipment is highly convenient for their appropriate control and operation, and for eventual process intensification. Much effort has been invested in the comprehension of three phase fluidized bed dynamics without interfering with its natural behavior. The aim of this work is to obtain useful information of the solid motion in a three-phase bubble column with a noninvasive technique that involves the use of a very simple setup of gamma radiation detection. The technique is a simplified version of the powerful radioactive particle tracking technique with the advantage of not requiring a calibration stage; hence, allowing its use in industrial equipment under normal operation.

The model system examined consists of high porosity activated carbon particles suspended in tap water by air, flowing at different gas velocities within the range from 0.01 to 0.13 m/s. The liquid and the solid are in batch mode; solid concentration is 5% v/v of the liquid. The gas is injected from a perforated plate at the bottom of the column. The tracer is a composite of a tiny piece of gold (¹⁹⁸Au, $t_{1/2}=2.7$ d, $E_{peak}=412$ keV, activity 37 μ Ci) activated by neutron bombardment and embedded in a 1mm equivalent diameter polystyrene particle with an overall density and size that match with the carbon particles. The time series of gamma photon counts determined by a set of fourteen axially aligned NaI(Tl) detectors have been acquired for at least 1 hour at 100 Hz. For comparison, the liquid motion of the air-water system is also examined using a similar tracer embedded in a hollow particle made of polyethylene to match the liquid density.

The reconstruction methodology is based on considering that, for each instant, the tracer axial coordinate matches the center of the detector which provides the highest number of counts (a detailed description can be found in Salierno et al, 2013). This kind of assignment brings $2N-1$ possible axial positions, where N is the number of detectors in the array. Despite the coarse graining obtained, useful information (e.g., solid axial hold up distribution, solid mixing time and flow regime transitions) can be extracted using data mining procedures without the need of a calibration stage, which is quite cumbersome to implement within an industrial environment.

Salierno, G.L., Maestri, M., Piovano, S., Cassanello, M., Cardona, M.A., Hojman, D., Somacal, H., Discrete axial motion of a radioactive tracer reconstructed from the response of axially aligned detectors: application to the analysis of a bubble column dynamics, Chemical Engineering Science, 100, 402–412 (2013)

A-46 A2 Poster

DESIGN, DEVELOPMENT AND DEMONSTRATION OF OPERATIONAL FEASIBILITY OF NOVEL AND DYNAMIC RPT CALIBRATION TECHNIQUE

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Radioactive Particle Tracking (RPT) technique, a versatile and non-invasive radioisotopes based flow visualization technique, is capable of providing complete information about 3-D velocity field in multiphase systems. It's principle of operation is based upon following the motion of single/multiple radioactive particles (γ -emitter) throughout 3-D domain of the whole system. The radioactive particle (also called as a tracer) is dynamically similar to the tracking phase. The instantaneous particle position is then identified through monitoring the radiation intensities received by a set of Sodium Iodide (NaI) detectors arranged strategically around the system. To reconstruct the tracer particle position accurately from recorded radiation intensities, calibration needs to be performed prior to actual RPT experiments. Usually, RPT calibration is carried out in-situ and in an invasive manner. There are major shortcomings of conventional calibration methodology due to which RPT technique has limited applicability in practical applications. To make RPT technique viable for practical applications and to enhance its accuracy, a novel and dynamic RPT calibration technique is being designed and developed. RPT calibration technique is a synergistic combination of fixed non-collimated detectors based RPT technique and collimated detectors based RPT technique. Preliminary feasibility results suggested that it can be implemented as a non-invasive and dynamic calibration methodology for RPT technique. This development is a first and important step towards making RPT technique viable for practical applications. However, additional work needs to be carried out to demonstrate operational feasibility of this equipment in different multiphase systems of various sizes and to improve upon its reconstruction accuracy.

A-82 A2 Poster

IMPROVEMENT OF THE IMAGE QUALITY USING SPECTRUM STABILIZING TECHNIQUE IN Γ -RAY COLUMN SCANNING TOMOGRAPHY

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The quality of image reconstruction in γ -ray column scan tomography is often affected by Compton scattering. In order to reduce the influence of scattering effect, a kind of peak area counting method was designed for spectrum stabilization in single channel data logger. For evaluating the effectiveness of this improvement, a pair of parallel experiments is conducted in same condition, except the data acquiring methods that one uses total γ -ray counting method, while the other uses peak area counting method, then corresponding images based on the two kinds of data are reconstructed with same processing method. Comparison of these two images shows that the peak area counting method is obviously better than the total counting method in CT image quality, and so that the peak area counting method using spectrum stabilizing technique will have its better applicable value.

Keywords : Spectrum Stabilizing; Column Scan; Tomography; Image Quality

A-37 A2 Poster

TRACING A RADIOACTIVE POINT SOURCE WITHIN A BULKY MATERIAL

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The application of transmission tomography in non-destructive testing (NDT) now covers a wide range of materials and situations. Conventional medical scanners have been used to examine low density objects such as wood, ceramics, plastics and archaeological artifacts. The use of emission tomography as an industrial imaging technique has been less widespread, however. The intrinsic problems of the scattering and attenuation of photons which are associated with emission tomography, have limited the number of possible applications. The presence of these two problems limits the accuracy of quantification of tracer activity in radionuclide imaging with a gamma camera system. The practical application of emission tomography to non-destructive testing has been the subject of several studies. However, many issues have not been answered in these previous studies and are the subject of continued research to further enhance the practicability of the technique. Consequently, the aim of this work is to investigate the truly quantitative performance of emission tomography for an arbitrary distribution of radioactivity in the presence of scattered photon, photon attenuation and noise introduced during data acquisition and processing. That is, tracing the radioactive material throughout a bulky sample in different positions. Two separate methods can be considered to diminish the uncertainty in the measurements. One is by using the additional information obtained when counting by two detectors and the other is by introducing into the image processing and reconstruction.

A-69 A2 poster

A GAMMA RAY COMPUTED TOMOGRAPHY USING A SINGLE SOURCE-DETECTOR PAIR

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The gamma transmission tomography technique represents an effective solution for the control of the internal Defects and allows to obtain, after measure and appropriate treatment of the data, a mapping of the inside of the object.

The system is based on a NaI detector and a standard PC. Images are reconstructed using both MATLAB and LabWindows CVI functions. The mechanics of the system is controlled by a PC using an USB protocol and data is acquired by programs written in LabWindows CVI.

A-4 A2 Poster

DUAL SOURCE COMPUTED TOMOGRAPHY (DSCT)

R. Varma⁺ and Muthanna Al-Dahhan⁺

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Tomography of two phase flow, particularly x and γ ray based tomography has reached a level of maturity in terms of the confidence in the data obtained for research and diagnostic applications. It has been applied exhaustively to study different types of reactors and process equipments dealing with two phase flow. In contrast, tomography of three phase flow system has not evolved to the same extent. The gamma ray tomography technique (single source) has been used to study a range of two phase flow system that include gas – liquid, liquid – solid, and gas – solids flow. However, the gamma ray tomography technique used for two phase system can't be used for three phase system. In this work, an advanced noninvasive measurement technique, Dual Source Computed Tomography (DSCT) has been designed, and developed to overcome many limitations common to the various tomography techniques that exist for imaging systems with three phase flow and could be applied to a wide variety of multiphase systems to properly visualize the phase distribution. More specifically, in this study it used to determine the effects of design and operating parameters on the phase holdup distribution in anaerobic bioreactors. The DSCT is designed to use two sealed gamma ray sources of different gamma energies (Co-60 and Cs-137) and 15 NaI detectors in opposite of each source. For image reconstruction, the transmission data of gamma photons, representing the line integrals of the attenuation along a path between the source and detectors across the domain, are processed mathematically using the Alternating Minimization (AM) to obtain an image.

Keywords: DSCT, Non-invasive, Tomography, Hydrodynamic, NaI, multiphase systems, AM

A-5 A2 poster

DEVELOPMENT, VALIDATION AND IMPLEMENTATION OF MULTIPLE RADIOACTIVE PARTICLE TRACKING TECHNIQUE

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Radioactive Particle Tracking (RPT) technique has been successfully applied using a single radioactive tracer particle to measure the 3D flow field and turbulent parameters in multiphase flow systems. However, many multiphase reactors in industry (such as fluidized beds, digesters, mineral processing unit, etc.) consist of particles having different properties (size, shape, and density), while the capability of the RPT technique is to track only one single tracer particle in a time. This limitation of RPT can be overcome by introducing multiple tracer particles that can be tracked simultaneously. In this work, a new Multiple Radioactive Particle Tracking technique (M-RPT) has been designed and developed to track up to 8 radionuclide tracer particles with various energy isotopes. The new M-RPT was successfully validated and implemented to track simultaneously two radioactive particles (Sc-46 and Co-60) containing different isotopes emitting gamma radiation of distinguishable energies. The new M-RPT technique was successfully applied to track two phases (solid and liquid) simultaneously in a low L/D three phase slurry bubble column reactor. The M-RPT electronics and technique was methodically validated in three steps to simultaneously track, two stationary particles, two moving particles of same density and two moving particles of different densities. Finally, this new M-RPT can track eight different radioactive sources simultaneously and can be a valuable tool for characterization of number of multiphase processes/reactor systems of industrial interests, which use a range of particles with different properties.

Keywords: CARPT, Three phase slurry bubble column, Flow pattern, Hydrodynamics, Non-invasive

A-86 A2 Poster

PRINCIPLE COMPONENT ANALYSIS FOR RADIOTRACER SIGNAL SEPARATION

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Recently radiotracer is used successfully in many industrial applications specially in Residence Time Distribution (RTD) measurement in the industrial systems. Radiotracer signals may be subject to different sorts of noise; this leads to errors in the RTD calculations and hence leads to wrong analysis in determination of system malfunctions. Radiotracer signal recognition still represents challenges in RTD measurement. This paper presents a proposed method for radiotracer signal separation based on Principle Component Analysis (PCA) and Independent Component Analysis (ICA) algorithms. The simulation results show a considerable improvement in extracted signals when compared to original signals.

Keywords: Radiotracer, Signal Separation, Principle Component Analysis

A-87 A2 Poster

SUPPORT VECTOR MACHINES AND ARTIFICIAL NEURAL NETWORKS FOR IDENTIFICATION OF RESIDENCE TIME DISTRIBUTION SIGNALS

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This paper presents a practical comparison between the Support Vector Machines (SVMs) and Artificial Neural Networks (ANNs) as identifiers for the Residence Time Distribution (RTD) signal identification. In these identifiers, the cepstral features are extracted from the signal or from its power density spectrum (PDS) estimated using eigen-vector method, or from the Discrete Cosine Transform (DCT), then the extracted features feed the identifiers. The both identifiers have been tested using the same RTD signals. The performance of these identifiers is evaluated in the presence of different types of noise. The simulation results proved that, the ANN based identifier is more reliable in RTD signal identification but it takes more time with respect to SVM identifier.

Keywords:Support Vector Machines, Artificial Neural Networks, Residence Time Distribution

A 3

Coupling
Computational Fluid Dynamics (CFD), Numerical
Residence Time Distribution (RTD) and tracer
experiments

A-55A3 Oral

FLOW SIMULATION IN AQUACULTURE PONDS: COMPARISON OF SEVERAL TURBULENCE MODELS

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This paper presents the results of flow simulations in two aquaculture ponds using several turbulence models available in the commercial Computational Fluid Dynamics (CFD) code Fluent, with the aim of obtaining information about the hydrodynamics and its role in the effective treatment of aquaculture ponds polluted by algae. The first pond has a length of 30.5 m, a width of 7.32 m and a variable depth (1.05 m upstream and 1.65 m downstream) along a bottom slope of 1.62%. The inlet and outlet consist of rectangular pipes of 0.2 m hydraulic diameter. The second pond has a length of 20 m, a width of 10 m and a constant height of 1.5 m fitted with two rectangular pipes of 0.17 m hydraulic diameter as inlet and outlet. The two tanks have a water inlet velocity of 0.3 m/s. The Reynolds numbers in the inlet pipe are 60 000 and 51 000 on the first and second case respectively. Nine turbulence models have been tested:

- Standard k- ϵ ,
- Realizable k- ϵ ,
- Re-Normalization Group (RNG) k- ϵ ,
- Reynolds Stress Model (RSM),
- Standard k- ω ,
- Shear Stress Transport k- ω (SST),
- Transition k-kl- ω ,
- Transition SST model
- Spalart-Allmaras model.

The contours of flow velocity magnitudes and the velocity vectors are examined and some differences are highlighted between these nine models. The comparison of velocity profiles at different locations (as indicated by the red line in Figure 1) in the pond show that the choice of the turbulence model affects the hydrodynamic behavior of the ponds as shown in Figure 2. The physical analysis of the obtained results had allowed us to eliminate several of the turbulence models whereas comparison of experimental and simulated velocities measurements are now necessary to select the most adequate model in order to go further in the accurate flow description prediction. The final validation of the selected model will be done by comparison between numerical and experimental tracer experiments.

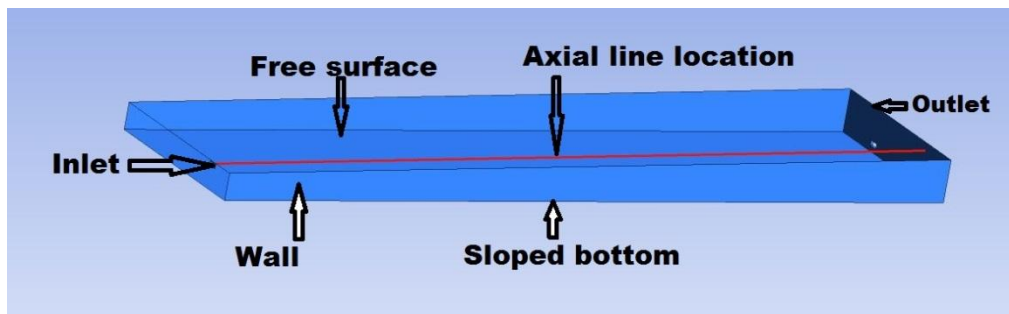


Figure 1: Scheme of the sloped bottom pond. Location of the axial line on the free surface used to show velocity profiles

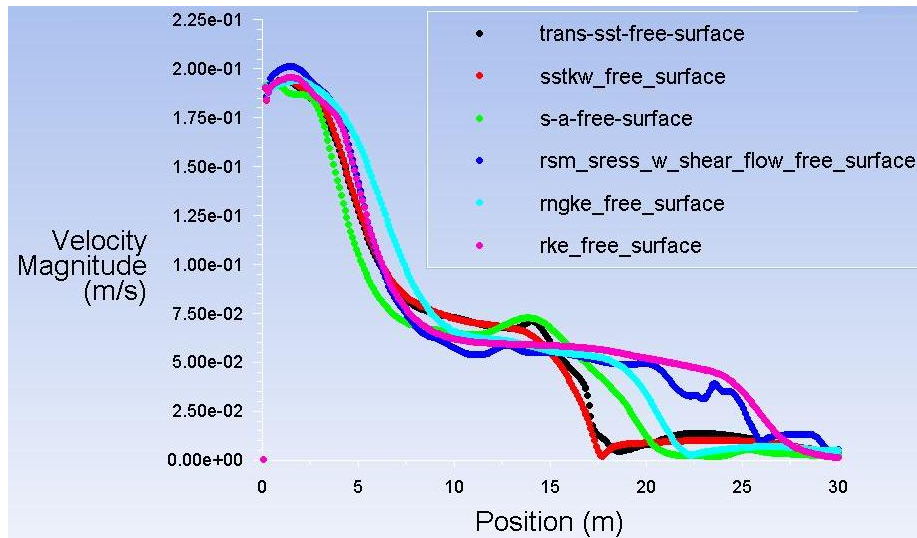


Figure 2: Comparison of free surface velocity profiles obtained with six turbulence models along an axial line (as shown in Figure 1) of the sloped bottom pond.

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A-74 A3 Oral

COMPUTATIONAL FLUID DYNAMICS AND RADIOTRACER EXPERIMENTAL METHODS FOR FLOW PATTERN DESCRIPTION

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Computational Fluid Dynamics (CFD) is an engineering software tool that uses numerical techniques to simulate fluid flow. Using this software, it is possible to build a computational model that represents a system or device that we want to study. CFD gives the power to simulate flows of a single phase or multiphase fluids including fluid and solid flows. The codes include diverse physical models and numerical methods for flow simulation. These models and methods can give some significant simulation results. Comparison of the simulation results with experimental data is the best way for CFD modeling validation.

Basic models and simulation allow obtaining flow field quantities in the reactor like: velocity, pressure, temperature and viscosity. The experimental residence time distribution (RTD) function is one way for validation of the simulation results. For RTD simulation it is necessary to apply the additional models in CFD code. In ANSYS Fluent software the RTD can be simulated using the Discrete Phase model or Species model. Both of them need additional parameters which should be properly determined.

The theoretical and practical application, of the CFD simulation and the experimental validation by RTD function, are the main goal of the presentation. Several case studies will be analyzed and presented.

A-66 A3 Oral

USE OF CFD AND TRACERS TO STUDY THE ABNORMAL TURBID PHENOMENON AT THE SPILLWAY FOR SAFETY ASSESSMENT OF HYDROPOWER DAM

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The abnormal turbid areas in the upstream side of spillway of Donduong hydroelectric reservoir was found occurring at high discharge rate ($>100\text{m}^3/\text{s}$) that raises concern of safety of the dam if turbid material is the soil eroded from the dam body. The analyses of turbid and clear water samples showed the turbid material was the fine clay particles below $50\text{ }\mu\text{m}$ at concentration of 31.5 mg/l (60 NTU) in comparison with 1.0 mg/l (1.6 NTU) in clear water.

Computational fluid dynamics (CFD) modeling (Flow 3D) and tracers in form of gold tagged mud, ethanol and NaCl were used to locate the origin of the suspended solid particles in the turbid areas. Three-dimensional modeling of upstream side of spillway was established based on the design drawing, depth grid measurement and turbidity profiles. The model was validated by matching the calculated flow currents with the measured ones at variety of discharge conditions. The stream lines simulated by virtual particle tracking showed at the high discharge rate the local vertical turbulent flows of velocity over 0.1m/s near to dam wings can bring the sediment particles from the bed and roof of dam into suspension in the turbid zone and floating to the surface that causes the turbid phenomena. This discovery then was confirmed by the detection of tracers in the turbid area after injection at the places positioned by modeling. The potential zones of sediment erosion determined by stream lines of velocity exceeding value of 0.1 m/s are located on the bed and dam roof which are protected in design by concrete and/or stones that allows conclusion of dam safety with turbid phenomena.

A-2A3 Poster

NUMERICAL CFD AND TRACER SIMULATIONS IN AQUACULTURE PONDS: COMPARTMENTAL FLOW DESCRIPTION

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This paper discusses the results of numeric tracer simulations of the residence time distribution (RTD) of two schemes of aquaculture ponds using the particle tracking approach via Discrete Phase Model (DPM) in the finite-volume based FLUENT software. The first pond has a length of 20 m, a width of 10 m and a constant height of 1.5 m fitted with two rectangular pipes of 0.17 m hydraulic diameter as inlet and outlet. The second pond has a length of 30.5 m, a width of 7.32 m and a variable depth along a bottom central slope of 1.62%. The inlet and outlet consist of a rectangular pipe of 0.2 m hydraulic diameter. Both ponds have a water inlet velocity of 0.3 m/s. The steady state solution of the pond flow field was obtained by solving turbulent Reynolds Average Navier-Stokes equations governing the flow in the pond after which the stochastic particle tracking was carried out. Particle tracking discrete phase model (DPM) was used for the RTD simulation by tracking 5000 virtual particles injected at the inlet surface and recording the time required for them to reach the outlet. The turbulent dispersion was simulated by discrete random walk. The standard k- ω model simulated pond mean residence time (MRT) of 5.43 h while the Transition SST predicted 5.6 h for the flat pond. The simulated MRT for the sloped pond were 4.3 h, 4.6 h, and 3.5 h by the k- ϵ RNG, the k- ω SST and the k- ϵ Realizable models respectively. Figure 1 illustrates a typical numerical RTD simulation. Modelling the CFD RTD as well as a visual inspection of the velocity contour plots and analysis of the velocity profiles revealed that the pond flow can be described by three main compartments or zones as depicted in figure 2. A compartment model based both on velocity profiles and numerical RTD derived from CFD simulations is proposed to obtain a simple flow model easy to handle for rapid prediction of flow behavior in aquaculture ponds.

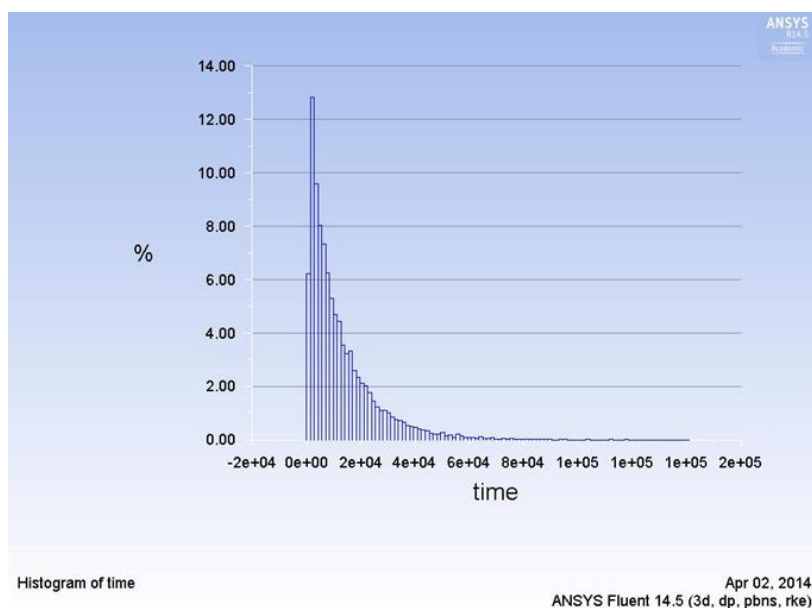


Figure 1: Histogram of RTD by particle tracking method of sloped pond obtained with k-epsilon Realizable model

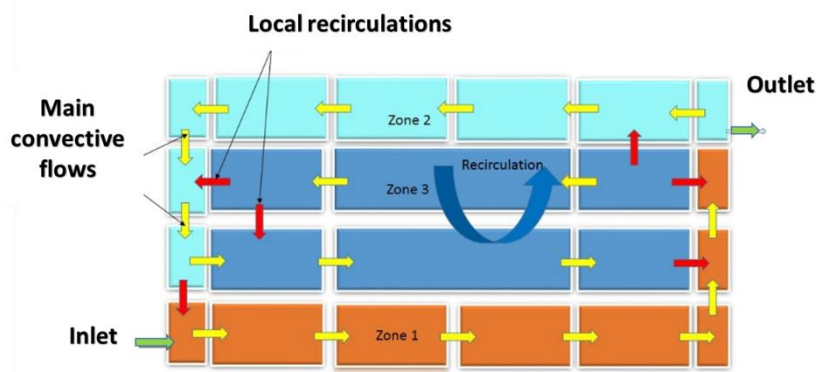


Figure 1: Diagram of fish pond compartment zones: observation consistent with that observed by Alvarado et al. (2012)

Acknowledgements

The principal author gratefully acknowledges the International Atomic Energy Agency (IAEA) with special appreciation to Dr. Patrick Brisset for sponsoring her academic fellowship at the Laboratoire Réactions et Génie des Procédés (LRGP), Nancy France where this research was undertaken. The research is actually a BioCapTech project funded by the Agency for Economic Mobilization (AME) of the Regional Council of Lorraine and European Regional Development Fund (ERDF) for which the authors would like to express their sincere thanks.

A-75 A3 Poster

MIXING LENGTH DETERMINATION OF IMMISCIBLE MULTIPHASE FLUID FLOWS IN PIPE USING RTD RADIOTRACER DATA AND CFD ANALYSIS.

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Mixing length in multiphase flow is studied due to its complexity of flow dynamics in microscale and turbulent phenomena that almost frequently occurred in the flow. One of available methods for mixing length determination is radiotracer technique when combined with simulation technique can reveal detailed fluid flow. In current study two kinds of iodine-based radiotracer solutions were injected into the 24" (0.61m) diameter of carbon steel pipe containing approximately 95% water, 3% crude oil and 2% gas. None radiotracer gas was injected. Two radiation detectors located at the distance of 80 and 100 m respectively from the injection point were used to generate residence time distribution (RTD) curves. In such water dominated system, fluid flows calculated from mean residence time (MRT) showed that the water flow is faster than the flow of crude oil in the pipe. Computational fluid dynamics (CFD) based on Eulerian-Eulerian control volume was used to simulate these fluid flows simultaneously. The mixing length predicted by CFD mixture model showed that it is started at the distance around 20 m from injection point. The model was performed under the following influential factors: gravity, differences in density, viscosity and flow velocity of each respective fluid phase.

Keywords: mixing length, radiotracer, CFD, mixture model.

A-22 A3 poster

DETERMINATION OF FLOW STRUCTURE IN A GOLD LEACHING TANK BY CFD SIMULATION.

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Experimental residence time distribution (RTD) measurement and computational fluid dynamics (CFD) simulation are the best methods to study the hydrodynamics of process flow systems. However, CFD approach leads to better understanding of the flow structure and extent of mixing in stirred tanks. In the present study, CFD models were used to simulate the flow in an industrial gold leaching tank. The objective of the investigation was to characterize the flowfield generated within the tank after process intensification. The flow was simulated using an Eulerian–Eulerian multi-fluid model where the RANS standard $k-\epsilon$ mixture model and a multiple reference frame approach were used to model turbulence and impeller rotation respectively. The simulated flowfield was found to be in agreement with the flow pattern of pitched blade axial-flow impellers that was used for mixing. The leaching tank exhibited good "off-bottom suspension" which reveals minimum deposition of gold ore particles on the bottom of the leaching tanks. Simulation results were consistent with experimental results obtained from a radioactive tracer investigation. CFD approach gave a better description of the flow structure and extent of mixing in a leaching tank. Hence it could be a preferred approach for flow system analysis where the cost of experimentation is high

B3

Safety

(Radioactivity, control)

&

Environment

(Wastewater treatment, air pollution control)

A-51 B3 Oral

EVALUATION OF HYDRODYNAMICS FROM THREE TERTIARY TREATMENT ARTIFICIAL WETLANDS BY APPLICATION OF FLUORESCENT TRACERS

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In Rhin-Meuse hydrological basin (North-East of France), local authorities have encouraged the setup of Free Water Surface Wetlands (FWSW) at the outlet of several small communities wastewater treatment plants. These systems are devoted to effluent polishing by providing potential pollutant mitigation. However, such systems are designed mainly empirically and resulting surfaces and shapes may not be optimal.

In the present study, the hydrodynamics of three FWSWs used for sewage tertiary treatment was assessed by means of multi-tracer experiment involving two fluorescent dyes: uranine (UR) and sulforhodamine B (SRB) [1]. Two FWSWs are parallel vegetated ditches whereas the third one is a pond. UR behaved conservatively during experiments carried out at night in the ditches wetlands. In the pond, sunlight caused photochemical decay during the 5 days experiment. SRB always exhibited a conservative behavior in the conditions of the experiments with very limited adsorption.

Residence Time Distribution analysis shows that the three investigated wetlands displayed very different hydrodynamic properties. Ditches behaved as Plug-Flow Reactors with dispersion whereas the pond underwent strong internal recirculation. The effective volume ratio was very low for all investigated wetlands. Sediment deposition as well as vegetation cover development may explain this result. Mean residence times were lower in the ditches (1 to 3h) than in the pond (mainly 20h). The influence of vegetation cover on hydrodynamic dispersion was evidenced. Finally, a systemic modeling approach was proposed to describe investigated wetlands, especially when a basic Tank-In-Series approach proves to be insufficient [2].

[1] J. Lange, T. Schuetz, C. Gregoire, D. Elsässer, R. Schulz, E. Passeport, and J. Tournebize, “Multi-tracer experiments to characterise contaminant mitigation capacities for different types of artificial wetlands,” *Int. J. Environ. Anal. Chem.*, vol. 91, no. 7–8, pp. 768–785, 2011.

[2] Y. Le Moullec, C. Gentric, O. Potier, and J. P. Leclerc, “Comparison of systemic, compartmental and CFD modelling approaches: Application to the simulation of a biological reactor of wastewater treatment,” *Chem. Eng. Sci.*, vol. 65, no. 1, pp. 343–350, 2010.

A-54 B3 Oral

²¹⁰Pb AND ¹³⁷Cs AS TRACERS FOR SEDIMENT GEOCHRONOLOGY AND RECONSTRUCTING OF HISTORICAL INPUT OF POLLUTANTS IN COASTAL ENVIRONMENTS: APPLICATION TO THE OUALIDIA LAGOON

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The aim of the present study was to assess historical input of radionuclide and heavy metal to the Oualidia lagoon sediment being an environmental matrix where human activities are archived.

A sediment core was collected in 2012 from Oualidia lagoon. Particle size distribution was performed using a grain size analyzer (Malvern, Mastersizer). Radionuclide activities were determined by alpha and gamma spectrometry and the heavy metal by neutron activation analysis.

Unsupported ²¹⁰Pb measurement in the different sections of the sediment core allowed determining the relationship age–depth, and the obtained ages were validated by using; ¹³⁷Cs. Results showed that there is no detectable anthropogenic input of naturally occurring radionuclide, except for ²¹⁰Pb which has its origin from atmospheric ²²²Rn.

Among the heavy metals analyzed, only Cu and Sr were present in concentrations above those found in non-contaminated similar ecosystems.

The lagoon, in particular the sampling site, is supplied with sediment particles basically by marine inputs.

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A-41 B3 oral

ENVIRONMENTAL IMPACT OF RADIOTRACER STUDIES: BIOTA DOSE ASSESSMENT

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The intentional release of short lived radioisotopes to trace transport and partitioning processes in the environment has been in decline in recent decades due to negative regulatory and public perceptions of the associated risks. Radiotracing is subject to significant regulatory requirements; in some jurisdictions one of these requirements is to demonstrate that radiation exposure to ecosystems is limited to ensure protection of populations of species.

Radiation exposures from radiotracer studies are localised, transient and infrequent by nature, making it difficult to apply guidelines and biota dose assessment tools that are designed for chronic and widespread exposure scenarios. We will discuss the limitations of available guidelines and dose assessment methodologies when applied to radiotracer studies. A range of case studies for biota dose assessment will be presented using a variety of available tools including the ERICA Assessment Tool, the methodology of Copplestone et al. (2001) and a dynamic dose assessment model (Vives I Batlle et al., 2008). These case studies demonstrate that steady state, spatial homogeneity and bioavailability assumptions inherent in available dose assessment tools may lead to an over-estimate of dose to biota from radiotracer studies, and that many radiotracer studies can be conducted with minimal dose to biota.

References:

Copplestone, D et al., *Impact Assessment of Ionising Radiation on Wildlife*, UK Environment Agency, R&D Publication 128 (2001).

Vives I Batlle, J et al., Dynamic model for the assessment of radiological exposure to marine biota, *J. Environ. Radioactiv.* 99(11), 1711-1730 (2008).

A-21 B3 Oral

SELECTIVE ADSORPTION STUDIES BY RADIOTRACER TECHNIQUE-APPLICATION OF SILICA SORBENTS FOR ^{134}Cs AND OTHER RADIONUCLIDES REMOVAL FROM THE SPENT FUEL STORAGE BASINS AND THE NUCLEAR REACTOR PRIMARY WATER CIRCUIT

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The total volume activity of water in the spent nuclear fuel basins reaches $8.5 \cdot 10^8 \text{ Bq l}^{-1}$. The most of the radioactivity results from the radiocesium content, but the other radionuclides (^{90}Sr , ^{54}Mn , ^{60}Co , ^{85}Kr etc.) are present in smaller amounts as well. Radiocesium is considered as serious threat to the humans as well as environment because of its long-life, high solubility and β -radiation emission. Radioactive cesium shows a tendency towards bioaccumulation in food chain of terrestrials as well as aquatic organisms. The objective of this study was the determination of adsorption kinetics of the ion exchangers based on silica matrix modified with metal hexacyanoferrate and/or aminoalcohol. Different radiotracers (^{134}Cs , ^{85}Sr , ^{60}Co) obtained in the neutron activation process were added to solutions of cesium, strontium and cobalt salts to study adsorption kinetics by radio tracer technique. Kinetics of radionuclides adsorption was studied with Instrumental Neutron Activation Analysis method. The research evaluates influence of different initial metal ions concentrations (10^{-6} - 10^{-3} M), influence of pH, temperature and presence of competitive ions (K^+ , Na^+ and Ca^{2+}) on the distribution coefficient of radionuclides. Distribution coefficient (K_d) for all examined ion exchangers is above 10^3 mL/g .

Acknowledgment: This work has been carried out under Strategic Project of The National Centre for Research and Development “Technologies Supporting Development of Safe Nuclear Power Engineering” Scientific Problem no. 8: Study of processes occurring under regular operation of water circulation systems in nuclear power plants with suggested actions aimed at upgrade of nuclear safety.”

A-10 B3 Oral

APPLICATION OF FACTOR CLUSTER ANALYSIS TO THE CHARACTERISATION OF ATMOSPHERIC AEROSOL SOURCES IN TETOUAN CITY (MOROCCO)

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The Mediterranean Basin, due to its vicinity with deserts and industrialized areas of continental Europe, is one of the areas heavily affected by aerosols. To gain a full understanding of origin of aerosol atmospheric at the basin, it is necessary to evaluate the influence of synoptic weather patterns and long-range transport episodes on the aerosol concentration levels. Air mass back trajectories arriving at the Tetouan city (North of Morocco) in 2011-2012 have been analysed by statistical methods. As a first step, cluster analysis was used to group 500 trajectories into 4 clusters depending on their direction, altitude and speed at 6h intervals over sampling period. As the second step, the effects of different air mass transport on aerosol and their composition levels at the studied site were evaluated. The study was focused on particulate matter concentrations (PM₁₀ and PM_{2.5}). The main transport patterns were identified at 1000 m: Mediterranean flows (35% of the total situations), Northerly flows over Europe (27%), Southwesterly (20%) and Northwesterly flows (18%). Four privileged PM sources were identified: mineral dust, road traffic, biomass burning and marine aerosol. By interpreting cluster results with wind direction data and back trajectory analysis further detailed information was obtained on potential source locations and possible links between air mass trajectory patterns and PM level variations.

DETERMINATION OF WATER VOLUME IN STEPPED CASCADES USING TRACER EXPERIMENTS

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Stepped cascades are recognized for their high potential of gas exchange between water and air. In the case of natural rivers, these structures enhance oxygen transfer to water by creating turbulence interface that entraining air into water and then contribute to self-purification by providing oxygen to microorganisms. The global aeration potential of these structures depends on oxygen transfer coefficient and interfacial area between air and water. If the global aeration potential can be estimated experimentally or by semi-empirical correlation, it is difficult to determine separately the transfer coefficient and the interfacial area as well as water volume over cascades because of the flow complexity. The aim of this work is thus to determine water volume as a function of flowrate and cascade geometrical parameters through tracer experiments.

Tracer experiments were realized in a large laboratory cascade with saline injections and conductivity detection upstream and downstream. Nine different cascades of 0.5 m maximum height equipped with 3 to 10 dimensionally variables steps were studied for a water flowrate ranging from 0.4 L/s to 2.5 L/s. Preliminary experiments with Rhodamine solution injections upstream cascade were conducted in order to properly select the injection point and the detection points that satisfied the basic hypothesis for proper RTD measurements. For studied cascades, calculated residence time was ranging from 0.7 s to 4.9 s. The low residence time values and the instabilities of the flow required numerous tracer experiments under the same operating conditions to ensure statistical reliability of the measurements. For a given cascade, residence time decreases with flowrate increasing. This decrease is more pronounced for low flowrates values with a sudden change in the slope of the curve which corresponds to the flow regime change. Water volume over stepped cascade varies with flowrate similarly to what was observed also for global aeration efficiency with three different behaviors. Tracer experiments were also modeled using simple compartmental approach. The variation of the model parameters with the operating conditions were studied and analyzed.

A-91 B3 Oral

AN OVERVIEW OF APPLICATION OF BAYESIAN CLASSIFIER APPROACH IN RADIOACTIVE TRACER TECHNOLOGY. CASE STUDY

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The usefulness of implementing a radioactive tracer techniques subjected to varied risk factors. Thus, the setup procedure for the application experimental techniques of radioactive tracer must be evaluated prior the decision action steps. One way of doing this, is to use Bay's theorem technique. As there is a possibility of classifying the implemented parameters into certain catogries depending on their certainty to effect *radioactive tracer technology*. In this paper, the radioactive tracer experimental parameters classified accoring to Bayesian theory. Using this theory, one can study the proposed technical systems to determine the probabilities of the effectiveness of any selected parameter among the others. The classification of the applied *experimental parameters* into suitable or unsuitable is proposed theoretically. Ten parameters used in this experimetal data were classified accordingly. The posterior is calculate from the prior and the likelihood previousy determinned by Bayes rule.

Key Words: Radiative tracer technology, Bayes classification theorem, Tracer application.

A-11 B3Poster

PHARMACEUTICALS INTO WATERS AND ASSOCIATED RISKS

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The presence of pharmaceuticals into waters and wastewaters is a very important issue today. The mixture of pollutants may affect biota as well as the human health. Among the Advanced Oxidative Processes there is the Electron Beam Technology which is one of the possibilities for degradation of such type of pollutants. Taking fluoxetine hydrochloride as an example, it was possible to remove > 90% in water solutions. The ecological risks of pharmaceuticals in waters and wastewater may be represented by concentration in different levels of living organisms such as crustacean, fish and snail. The average effective concentration (EC50%) at standard laboratory conditions are presented at Table 1.

Table 1 - Effective lethal concentrations of fluoxetine (FH) to distinct levels of aquatic organisms

Organismo-teste	CE50 (mg L ⁻¹)
<i>P. pandaliformis</i> (crustacean shrimp)	35.47 (48h)

<i>Vibrio fischeri</i> (luminescent bacteria)	1.15 ± 0.06 (15 min)
<i>Hyalella azteca</i> (amphipod)	0.59 ± 0.20 (96h)
<i>Daphnia similis</i> (microcrustacea)	1.28 ± 0.30 (48h)

The usual toxicity assays for environmental control before and after effluents discharges into environment apply mainly microcrustacea. On the other hand, as contaminants remain concentrated at sediments, the *Hyalella* assay is important and part of the job to be done when reservoirs and rivers are monitored for toxicity.

A-76 B3Poster

SOURCE IDENTIFICATION BY POSITIVE MATRIX FACTORIZATION OF AIRBORNE PARTICULATE MATTER SAMPLED IN KENITRA CITY (MOROCCO)

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Samples of fine and coarse fraction of airborne particulate matter were collected on weekly basis during the period from February 2007 to February 2008 in Kenitra City, Morocco. The samples were collected using a Gent stacked filter sampler in two fractions ($< 2.5 \mu\text{m}$, fine and $2.5\text{--}10 \mu\text{m}$ coarse). The samples were analyzed for their elemental composition by Total Reflection X-Ray Fluorescence (TXRF). The data set was then analyzed by the factor analysis method, Positive Matrix Factorization (PMF) in order to identify the possible sources of particulate matter and their contribution to the ambient particulate matter concentrations in Kenitra City. Four factors from PMF solutions were found for elemental composition of fine and coarse particulate matter at the Kenitra site. In the case of fine particles, metal smelting sources contribute about 52 % of the fine mass. The road dust contributes to about 22 % and the rest 26 % comprises emissions from motor vehicles and soil dust. In the case of coarse particles, soil dust contributes about 43 % and the two stroke engines about 42 % of the coarse mass; while road dust and motor vehicles apportioned to be about 10 and 4 %, respectively.

A-44 B3 Poster

RADIATION PROTECTION AND SAFETY ASPECTS AT THE APPLICATION OF SHORT-LIVED RADIOACTIVE ISOTOPES AT EXAMPLE OF RESIDENCE TIME MEASUREMENTS IN A HIGH PRESSURE PARTIAL OXIDATION (HP-POX) REACTOR WITH AR-41

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A HP-POX (high pressure partial oxidation) reactor is an apparatus for gasification of diverse chemical substances. It can be used for the treatment of gaseous, liquid and/or pasty input materials. The purpose of the chemical processes inside the reactor is the generation of synthesis gases. The specific feature of the reactor under investigation is the very high pressure. It works at pressures up to 100 bar.

The presentation deals with the radiation protection and safety aspects at the residence time measurements of the gaseous phase inside the reactor by means of the radioactive isotope Ar-41 of the noble gas argon. Because of the short half life period of this radioisotope (1.83 hours) the transport from the site of production (nuclear research reactor in Berlin, Geesthacht or Řež, near Prague) to the site of investigation (pilot scale HP-POX reactor in Freiberg) was carried out by helicopter.

In the presentation, the aspects of radiation protection and safety are considered not only during the measurement but also during the transportation process from the production to the investigation site, at the tracer input procedure and also after the measurement.

A-17 B3 Poster

HYDRODYNAMIC EVALUATION OF CONSTRUCTED WETLANDS USING NATURAL AND ARTIFICIAL SALT TRACER EXPERIMENTS

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The 1991 European Directive on wastewater collection and treatment still lacks full enforcement in France and in several other countries, mainly for small communities. For them, the treatment plants costs often exceed the available financial resources. Therefore, numerous small streams are, and will be for long, impacted by such pollution despite the commitment of authorities. Establishing a wetland between the exit of an existing wastewater treatment plants (WWTP) and the receiving surface water for WWTP effluent polishing has been recently recommended, for rural communities but also for treatment of storm water in urban areas. Besides reduction of classical pollution (carbon, nitrogen, phosphorus), removal of micropollutants is also expected (Conkle et al., 2012; Cohen et al., 2013; Ross et al., 2013). The wetlands are composed of one or several successive zones in which the hydrodynamic behavior is different depending on the geometry (deep stagnant zone, narrow natural channel with high local velocities...). Each zone will favor one or several a specific processes (oxygenation, adsorption of pollutants, biological degradation...). Design rules to build efficient low-cost and low-maintenance polishing wetlands are not well defined yet. In order to improve these design rules, an assessment of the efficiency related to the hydrodynamics of such existing systems should be made allowing to propose proper scale-up rules to maximize the abatements of the pollutants. Because of complex geometry of the constructed wetlands with free water surface, the evaluation of dimensions (surface, useful volume) and residence time by direct measurements is complex and imprecise. Moreover, it is an open system in which the infiltration and the evapotranspiration of water makes impossible to estimate properly the masse balance. The paper will report and discuss the methodology of tracer experiments in several constructed wetland (see figure 1 for example) using pulse injection of salt as an artificial tracer but also inlet effluent conductivity as a natural tracer as illustrated figure 2. The interpretation allowed us to establish a compartment model of the wetland with the aim to link this description with the abatement efficiency of the pollutants.

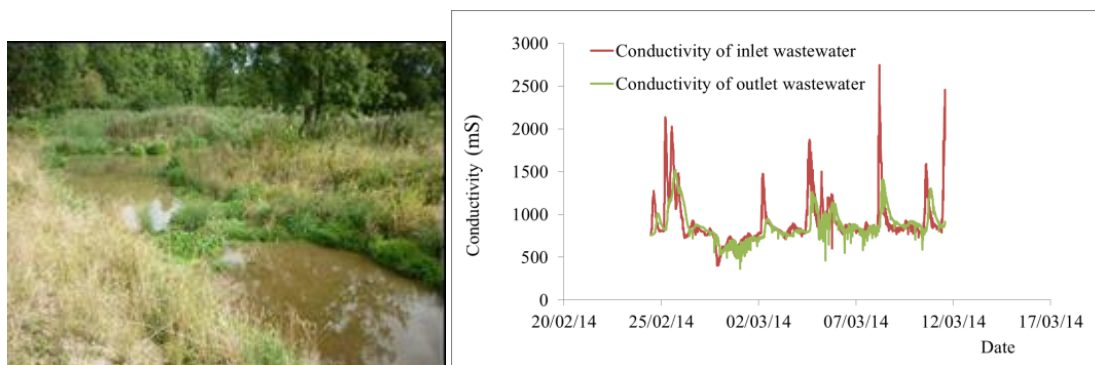


Figure 1: Typical constructed wetland. Figure 2: Example of natural tracer experiments.

Cohen, M.F., Hare, C., Kozłowski, J., McCormick, R.S, Chen, L., Schneider, L., Parish, M., Knight, Z., Nelson, T.A., Grewell, B.J. (2013) Wastewater polishing by a channelized macrophyte-dominated wetland and anaerobic digestion of the harvested phytomass, *Journal*

of Environmental Science and Health, Part A: Toxic/Hazardous Substances and Environmental Engineering, **48**(3), 319-330.

Conkle, J.L., Gan, J., Anderson, M.A. (2012) Degradation and sorption of commonly detected PPCPs in wetland sediments under aerobic and anaerobic conditions, *J Soils Sediments* **12**, 1164–1173.

Laurent J., Duclos N., Finaud-Guyot P., Wanko A. and Mosé R., Multi-traçage pour l'évaluation du fonctionnement hydrodynamique de zones humides artificielles à l'exutoire d'un bassin versant urbain, in *9ème Congrès International du GRUTTE*, Aix-en-Provence, France, 2012.

Ross, L., Queloz, P., Brovelli, A., Margot, J., Barry, D.A. (2013) Enhancement of micropollutant degradation at the outlet of small wastewater treatment plants. *PLoS ONE* **8**(3): e58864.

A-29 B3 Poster

RADIOLOGICAL BASELINE ESTABLISHMENT AROUND MOROCCAN TRIGA MARK II REACH'S SITE

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As for any installation presenting risks for its surrounding, CENM (Centre d'Etudes Nucléaires de Maâmora) that accommodates TRIGA Mark II Research Reactor and related laboratories is subjected to a statutory requirement stipulating that the CNESTEN (Centre National de l'Energie des Sciences et des Techniques Nucléaires) that is in charge the operating of CENM must define its own environmental monitoring program assuring that the nuclear installation is in appropriateness with its environment.

In this frame, since 1996 the team of USE (Unité Surveillance de l'Environnement) is conducting periodic work consisting in in-situ measurement of ambient gamma rays and collect of environmental samples and their preparation for adequate analysis form required for each radioactive measurement system. This first step of the environmental monitoring program allows establishing the radiological base line on the CENM's site.

This base line is necessary to inform on the present radiological state in order to detect any change of this state consequently to the operating of the reactor or the arrival of abnormal radioactive panache from any abroad source.

Keywords: Environment Monitoring, Radiological Base line, Triga Mark II Reactor's site.

Reference:

- IAEA - TRS 295, (1989), "Measurement of radionuclides in food and environment", A Guidebook.
- El Khoukhi T., M. Fidah and B. Oubelaid, (1995), "Cosmogenic ^7Be in grass of Maamora site", in Appl. Radiat. Isot., Vol. N° 6/7, p. 645
- Mitchell N. T., H. J. Dunster, A. W. Kenny and E. A. B. Birse, "Principles and practice of environmental monitoring in the United Kingdom", IAEA-SM-180/8, pp 47-58.
- Handge P. F. O. Hoffman, "The necessity for environmental surveillance in the evaluation of nuclear power plant sites", IAEA-SM-180/29, pp 65-83.

B4

Industrial column, pipe or vessel investigations using tomography or gamma scanning

A-9 B4 Oral

NEW RADIATION MEASURING DATALOGGER FOR THE COLUMN SCANNING CONTROL COLSCANCK1&NIBRAS

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The ColScanCK1 datalogger associated to the NibraS processing software for Column scanning is a new radiation measurement instrument. It was developed to scan and to plot density profiles, inside a distillation column, which illustrates the activity of the radiations able to cross the contents of the column.

This ColScanCK1 system is an autonomous data logger with very low power consumption, using only 4 batteries of 1.5V, supplied by solar power, and can be operated for more than 120 hours continuously; this presents an ecological and economic importance.

The major particularity of Nibras consists in its dual functionality: autonomous and software mode. In the first mode, it displays via LCD the counting rates indicating the existence and the intensity of radiation; while in the other mode, the system performs a real-time control in industrial plant particularly in oil distillation columns, due to its user-friendly software, NibraS.

Moreover, for the two operating processes, data recording is achieved automatically on an external storage key in addition to text file in software mode. This special software, NibraS, offers also the possibility to constantly print a preliminary report in pdf format of the scan state and a excel file to simplify the examination of the results.

This new radiation measurement datalogger provides essential data to optimize the performance of the columns, extend column run times, track the performance-deteriorating effects of fouling and solids deposition, and to identify maintenance requirements well in advance of scheduled turnarounds. This on-line knowledge can reduce repair downtime significantly.

Index Terms— Column scanning, petrochemical distillation column, data acquisition system (DAS), Labview®, USB communication.

A-30 B4 oral

COMPARATIVE STUDY OF RADIOTRACER AND SEALED SOURCE TECHNIQUES FOR DETECTING THE COKING IN DISTILLATION COLUMNS' PACKINGS

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This work discusses the results of a comparative study of two coking's diagnostic methods. The results correspond respectively to tests using two radioisotopes with gamma scanning technique and radiotracers.

The first approach was presented in a study in which the structural characteristics of a laboratory constructed distillation column (flow-rig) (41cm diameter) have been investigated using a ²⁴¹Am and tested using ^{99m}Tc. The Gamma scanning test consists in using the ²⁴¹Am as a gamma ray sealed source with the activity of 18,5GBq (500mCi), associated to a NaI(Tl) detector which were applied to locate the column trays and coking .

The second approach by radiotracers consists of an injection of an appropriate quantity of a specific radiotracer at the inlet of the process and studying its presence in the column. The tracing is achieved by the measurement of the tracer concentration along the distillation column using four installed detectors.

After comparison and assessment between the two methods we conclude that the second approach with radiotracers achieved better results and therefore was more effective than the first one(the gamma scanning technique) for the detection of coking.

Keywords: coking, Gamma scanning, radiotracer, Americium 241, Technetium-99m.

A-43 B4 Oral

NON-INVASIVE INSPECTION OF BLOCKAGE AND MATERIAL BUILD-UP IN PIPELINES USING A CLAMP-ON GAMMA-RAY TOMOGRAPHY SYSTEM

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The transportation of liquids and gases by pipelines is the most economical and efficient way. In process industries, in particular oil, gas and chemical industry, the precipitation of scale onto the inner walls of pipelines carrying raw or process materials poses a significant challenge as scale deposits such as sulfates, hydrates and carbonates may reduce the cross-section flow area and even lead to blockage of entire sections of the pipework. The deposition of scale in the pipework is a complex chemical process and may be caused by several different mechanisms as reported in many literatures. Therefore, undetected and untreated scale deposits in the pipework will eventually lead to costly production suspension and maintenance work. There exist several in-situ methods for scale detection and characterization. Some of these methods such as neutron moderation, electrochemical and natural radioactivity measurement techniques are already employed in different oilfield scale management programs. However, each of these techniques has its own advantages and disadvantages.

The attenuation of gamma-rays is highly correlated to the atomic number and density of materials. Theoretically, this means the non-destructive detection of blockage and material build-up in pipelines using gamma-ray transmission techniques is feasible. Realizing that a fast and reliable method is needed for field inspection, a portable clamp-on gamma-ray computed tomography system for non-destructive evaluation of blockages or material deposits in pipelines has been developed by the Malaysian Nuclear Agency. The system was designed and fabricated after successfully launched a transportable gamma-ray tomography system for BSR detection in oil palms plantations [Jaafar Abdullah et al, 2013]. Photographs of the system design are given in Fig. 1. The complete system is totally autonomous and is clamped on the pipe that allows it to be easily operated in the fields by one or two operators. The system provides rapid means of locating and measuring the thickness of deposits while the plant is on-line. It can be used to any pipes of size ranging from 4" to 30" in diameter, with or without insulation materials. This paper presents the basic concept of the system development and provides some results obtained from laboratory and field tests. Some of the results are given in Figures 2 to 4.

The portable system is composed of two major components, the scanner hardware and the system software. The hardware section contains four separate items, i.e. a radioactive source holder, a radiation detector holder, a pair of linear translation arms and a circular motion rig (O frame). The system software section contains three main programmes, which are used for the collection, conversion and reconstruction of the data.

Two stepper motors are used to control of the system. One motor moves the source and the detector synchronously in parallel motion whereas the other motor moves the O frame in an arc-like motion at a preset projection angle. During a scanning, the transmitted intensity of gamma-ray from the source gamma-ray is detected by a scintillation detector. The detector is coupled with a ratemeter or scaler, and finally connected to a lap-top computer for data acquisition and control. After completing a scanning process, all the data will be analysed and corrected before they can be further processed using a home-made image reconstruction algorithm to generate an image.



Figure 1: Portable clamp-on gamma-ray tomography system installed on a pipework

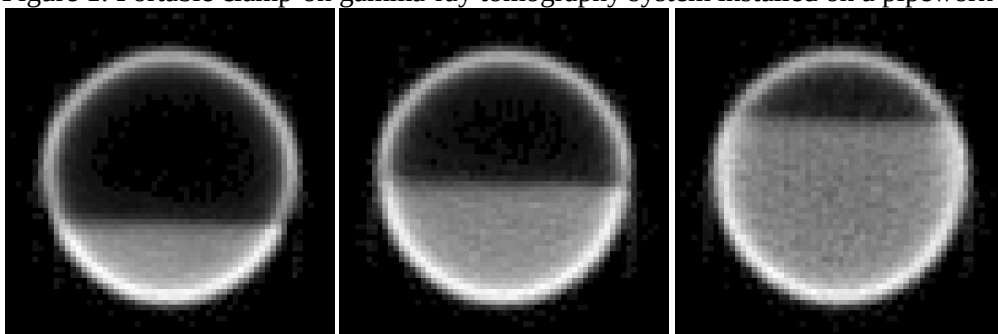


Figure 2: Image reconstruction of pipe with different thickness of loose deposit at the bottom section

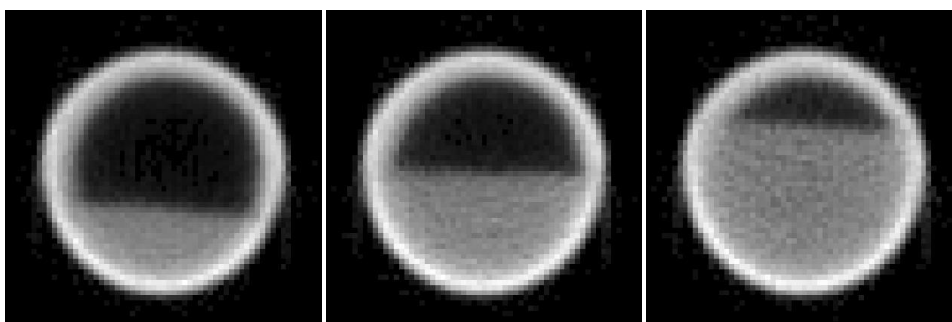


Figure 3: Image reconstruction of pipe with both hard coherent deposit on the circumference and loose deposit at the bottom section

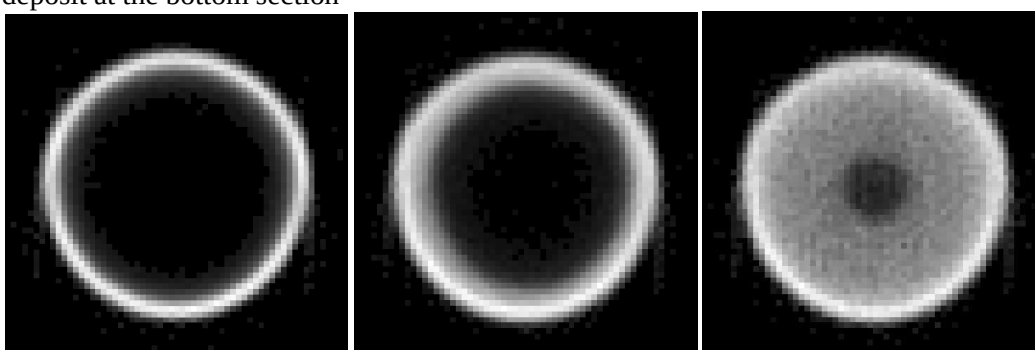


Figure 4: Image reconstruction of clean pipe, and pipe with hard coherent deposit of different thickness

REFERENCES

JAAFAR ABDULLAH, HEARIE HASSAN, MOHAMAD RABAIE SHARI, SALZALI MOHD, MAHADI MUSTAPHA, AIRWAN AFFENDI MAHMOOD, SHAHRIZAN JAMALUDDIN, MOHD ROSDI NGAH, NOOR HISHAM HAMID (2013), *GammaScorpion: mobile gamma-ray tomography system for early detection of basal stem rot in oil palm plantations*, Optical Engineering 52(3), 036502 (March 2013).

A-38B4 Poster

INDUSTRIAL PROCESS TROUBLESHOOTING WITH IMAGING TECHNIQUE IMPROVED BY GAMMA-RAY ABSORPTION SCANS

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Column gamma scan is one of the most common nuclear techniques on troubleshooting industrial process equipments like distillation columns and reactors. With a very simple concept, the technique is easy to implement, consisting basically on a sealed radioactive source that moves parallel to a NaI(Tl) detector resulting in one-dimensional density profile of the equipment. Searching for a competitive edge the industry has been long developing solutions to achieve better results. On the last decades, significant development has been done with the advent of new hardware, electronics, portable computers and software. Continuous scanning and wireless detection systems are examples of successful field solutions, while new software's aid on reporting and data presentations. However, the type and quality of the results itself has not dramatically changed since its beginning. A scan profile is simple to understand, although the process to build it can be very complex as it requires a specific blend of knowledge and abilities. Process engineering, chemical engineering, internal hydraulic project, nuclear engineering and field abilities are pre requisites for of any scan specialist. Correct data gathering, interpretation and reporting are abilities often difficult to match or requires a long time of training. The industry faces a similar difficult on the customer side, as it is always necessary to train end users to understand a report and how to use its best. This scientific work describes our effort on developing a new approach on the gamma column scan test using image reconstruction techniques that would result on a two-dimensional graphic image rather than a XY plot. Direct and easier to understand, a report with graphic images would be accessible to a wider audience, not limited to the customers experienced with gamma scan interpretation. The innovating technology resulted on a patent register at National Institute of Industrial Property and recently received the 2013 Petrobras Technology Award, Brazil's biggest oil company, for Master Degree projects on refining and petrochemical area.

A-3 B4 Poster

COKING PHENOMENON DETECTION IN GASEOUS PHASE USING GAMMA SCANNING TECHNIQUE

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Gamma Scanning Technique was applied to investigate Furfural solvent production unit which have experienced a serious problem of pressure drop at the thermally insulated gaseous line connecting the output column head to other production units.

A coking phenomenon responsible for the malfunctioning was clearly identified and localized by the gamma-scanning technique: a real success story.

A-6 B4 Poster

GAMMA COLUMN SCANNING TECHNOLOGY IN THE PHILIPPINES

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Gamma column scanning technology is an established technique for inspection, analysis and diagnosis of industrial columns for process optimization, solving operational malfunctions and management of resources. The Philippine Nuclear Research Institute (PNRI) recognizes the significance of this technology and has implemented activities to make gamma column scanning locally available to benefit the Philippine industries. Manpower development efforts were implemented through participation in International Atomic Energy Agency-Regional Cooperative Agreement (IAEA-RCA) projects while a complementing locally funded project ensured the provision of infrastructure requirements to be able to conduct gamma scanning in the field. Problems and issues encountered and lessons learned in the efforts to make the technology locally available are presented and discussed.

A-34 B4 poster

DETERMINATION OF FLOW PATTERNS ACROSS A 90° HORIZONTAL BEND DURING TWO-PHASE FLOW OPERATION BY GAMMA COMPUTER TOMOGRAPHY

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Gamma Computer Tomography (CT) is an imaging procedure in which transmission property of gamma rays is used to exploit density distribution of materials in an object. This procedure is carried out by obtaining several radiographic projections of the object followed by image reconstruction in two or three dimensions using various image reconstruction algorithms. This technique has been widely accepted worldwide in medical and materials diagnostics since inception. It has also emerged as a valuable technique for diagnosing industrial multiphase flow systems in the recent past. Two-phase flow regimes in straight pipes are well established and reported in literature but little attention has been paid to define these flow regimes across bends. This paper presents an experimental investigation of flow patterns developed across a 90° horizontal bend during two phase air-water flow using the gamma CT technique. The 90° horizontal bend was scanned at various cross-sections using the first generation gamma CT system GORBIT. Stratified flow patterns with major portion of void at the upper section of bend have been observed on the inlet and outlet of bend on the studied operating parameters. However, the void has been noticed to move towards the inner curvature of bend at the central location.

Keywords: Gamma CT, two-phase flow regimes, bends

A-24 B4 Poster

Preventive Diagnosis of Alcohol Distillation Towers Using Gamma Scanning Techniques

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This paper displays the results achieved during the diagnosis of the distillation towers operation state in distillery Jesus Rabi. A method using Gamma Scanning Techniques was applied. It was appreciated a malfunction of some trays which spread to lower ones. Nevertheless, the tower seemed to operate correctly according to the product quality parameters.

A-25 B4 Poster

SCREENING BLOCKAGE OF THE PETROCHEMICAL GAS PIPELINE BY USING GAMMA SCANNING TECHNIQUE

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The Petrochemical gaseous pipeline encountered difficulty operation at the designed high pressure of 80 bars during the commissioning tests. Blockage caused by debris at several locations such as valves, bending and elbows was suspected. Gamma Scanning was carried out along the long pipeline to indicate the blockage locations. The identified locations were consequently confirmed by Radiography and visual inspection. After cutting and re-fabricated, the pipeline could perform according to the design. This paper presents detail of the scanning results and interpretations.

A-26 B4 Poster

GAMMA SCANNING OF INDUSTRIAL PROCESS VESSELS IN THAILAND

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Gamma Scanning Technique was applied to investigate the performance of process vessels in several petroleum and petrochemical industries in Thailand. Based on the radiation transmission principle, the measured information reflects not only the internal structures of the process vessels but also the process condition when the process system is operating.

In averaged, a hundred process vessels were inspected annually during the last three years. These include various kinds of complexity process vessels such as distillation columns of different internal design (e.g. HIFI Tray, Ribbon Tray, and packed bed), process pipelines, chemical reactors etc. Important key parameters enhancing the quality of the scanning information and results and interpretations of some case studies are presented and discussed in this paper.

A-89 B4 Poster

SEALED SOURCES SCANNING TECHNOLOGY FOR TROUBLESHOOTING AND PROGNOSTIC MAINTENANCE OF A PETROLEUM FRACTIONATING COLUMN

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Sealed source scanning technology was used to investigate a fractionator column in a petrochemical refinery in Sudan. The scan aimed at detecting a suspicious malfunction present in the main RFCC fractionator distillation column. The problem was determined and predictions were made regarding the causes.

Results of previous prognostic maintenance scans on the same fractionator column were used to compare the results obtained in this troubleshooting scan. The comparison revealed the same symptoms in spite of the maintenance that took place on the three past overhauls.

A total vision of the four scans results led to deduce that the design is responsible of the abnormal behavior. Adjustment of the operating parameters to suit the design was recommendation made to the plant engineers.

The paper shows and discusses the scan results.

B5

Stable isotope tracers and radio tracer in water resources research, hydrology, sedimentology and agriculture.

A-62 B5 Oral

APPLICATION OF WATER TRACER EXPERIMENTS TO CHARACTERIZE THE DYNAMICS OF RAIN WATER INFILTRATION PROCESSES IN THE VADOSE ZONE OF IRON ORE CAVES

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Application of water tracer experiments to characterize the dynamics of rain water infiltration processes in the vadose zone of iron ore caves enables the determination of a minimum area required to keep its physical integrity, considering the interests of mining activity and speleological patrimony preservation. A series of experiments were performed in the North region of Brazil South of Pará State, and region of Quadrilátero Ferrífero, near from Belo Horizonte city, Minas Gerais state. Accordingly Brazilian laws, natural caves have to be protected and it has been the subject of great importance both in the mining and environmental perspective. Currently the presence of caves is one of the main restrictions to the full exploitation of mineral resources, since a significant portion of the ore bodies has been preserved due not only to the caves as its radius of protection established in a 250 meters around its surface projection. This value mentioned of 250 meters to the environment protection is an arbitrary estimate that, in accordance with the above resolution needs to be adjusted based on specific studies for each cave. There is no technical justification for the use of 250 meters as value-based environment protection zone. The infiltration of water coming from rain is important for the preservation of the water activity of the cave, resulting in the continuing process of speleothems genesis and maintenance of high relative humidity, typical of the underground atmosphere. Water can seep in at least two ways: vertically from the rain that falls above the cave and laterally through the water that runs (*through flow*) in discontinuities above the cave. The relative influence of each of these factors depends on lithology of the cave, the layers of rock and fracturing and depth of the cave to the surface. The deeper the cave, the greater the chances of having a lateral dispersion of the flow from the point of entry (input). During rainfall periods different dye tracers have been injected from distinct distances from the cave surface projection allowing the recognition of what would be the distances that rain water contributes to a given cave, considering the apparatus of detection installed in the interior of that caves.

A-33 B5 Oral

X-RAY BASED SEDIMENT PROFILER FOR PREPARING AND EVALUATING DREDGING WORKS

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There is a continuous inflow of sediments in ports and access channels and therefore maintenance dredging is necessary. To determine when and how much there needs to be dredged the underwater sediment and mud layers must be monitored and analysed. This paper presents an innovative vertical profiling technique measuring the depth, thickness and density of the underwater sediment layer. The instrument uses X-ray to measure the sediment density. The data is used for two important aspects.

First in the preparation of dredging works where the data is used to determine ton dry matter of the dredged material. In combination with acoustic methods like multibeam echo sounders it is used to visualize the sediment layers under a multibeam surface.

Another important aspect of soft sediment is the navigability. Ships can navigate through loose mud layers if the physical characteristics of the mud stay below a critical limit. Today the measured physical characteristic in many ports is density. The proposed measurement technique allows visualization of density and enables ports to evaluate nautical depth criteria.

A-61 B5 Oral

A STUDY ABOUT THE RADIOACTIVE DISEQUILIBRIUM OF THE URANIUM AND THORIUM SERIES IN SOIL SAMPLES OF THE STATE OF MINAS GERAIS – BRAZIL

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One of the most important aspects of the study of the environmental radioactivity is the assessment of natural radionuclides distribution, which will lead to the evaluation of problems related with soil degradation. The objective of the present work was to verify the ratio between the activity concentrations for $^{226}\text{Ra}/^{238}\text{U}$, $^{210}\text{Pb}/^{238}\text{U}$ and $^{228}\text{Ra}/^{232}\text{Th}$ in order to assess the level of secular equilibrium between the ^{238}U and ^{232}Th series and to identify possible processes leading to changes in the concentrations of natural radionuclides that may have occurred during soil weathering. Specific activities of ^{238}U , ^{226}Ra , ^{210}Pb , ^{232}Th and ^{228}Ra have been measured in 110 soil samples collected in depths ranging from 0 to 20 cm, the portion equivalent to horizon A for most soil types. In this soil portion, which is usually soft and severely altered, directly exposed to atmospheric action, most of bacterial life is developed, as well as intensive leaching of the soluble compounds. The collection of samples has been randomly distributed, inserted into the surveyed unity, taking into account the dominating preserved vegetation or minimally impacted areas like, for instance, native pasture. The study area covers the whole state of Minas Gerais, which detains very peculiar characteristics related to lithology, geneses and morphology of its soils, which present a dominant influence of trace elements and radionuclides in their pedogeochemistry. All over the state of Minas Gerais several volcanic manifestations can be observed as a result of intensive geotectonic processes in the rock formations, allowing for the migration of radioactive minerals to the ground surface. About 70% of all soils in the state correspond to very weathered ones, like latosols, claysoils and nitosols, apart those soils in which weathering is limited by the material of origin, like quartzarenic neosols. It was possible to verify that, from the results of the ratio between the activity concentrations for $^{226}\text{Ra}/^{238}\text{U}$, $^{210}\text{Pb}/^{238}\text{U}$ and $^{228}\text{Ra}/^{232}\text{Th}$, the elements in the natural series of Uranium are not in radioactive equilibrium. In this case, for daughters ^{226}Ra and ^{210}Pb , results yielded were 0.65 and 0.82, respectively. For the ^{232}Th series, the ratio $^{228}\text{Ra}/^{232}\text{Th}$ was 1.19, showing a close equilibrium between these elements. This radioactive disequilibrium may be mainly attributed to the characteristic geochemical behavior of each one of these radionuclides.

A-7 B5 Oral

EVALUATION OF SEDIMENTOLOGICAL ISSUES, USING TRACER TECHNIQUES, REGARDING A BOTTOM DISCHARGE IN THE PACIENCIA SMALL HYDRO POWER PLANT – BRAZIL

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The Paciencia small hydroelectric power plant (SHP) located in the Paraibuna River and near the city of Juiz de Fora, Minas Gerais State - Brazil, was the scenario of many sedimentological and biological studies performed in 2011-2012. These surveys were carried out in the scope of a project supported by CEMIG - electric utility responsible for the operation of the plant. The objective of this work is to present the results of some studies, in particular those related to the river and reservoir sediment characteristics and its correlation with the bottom discharge. The presence of the dam created a backwater region extending 1.6Km upstream. Bathymetric surveys and sediment sampling were performed in this region, just before and just after a bottom discharge, as well as sediment sampling was done also downstream the dam. The sediment was subjected to particle size analysis and the fine fraction to chemical characterization (heavy metals and pollutants content). Interesting results were obtained when comparing the situation just before and just after the bottom discharge. Special attention was paid to fine sediment which is the main carrier of heavy metal, pollutants and nutrients in the aquatic environment. The transport of fine sediment in suspension was quantitatively studied by labeling it with the radioactive tracer technetium 99m (^{99m}Tc), broadly used in nuclear medicine. Two campaigns were performed: in normal operation of the SHP and during bottom discharge. Both occurred in dry season, the most critical. Applying a mathematical model, calibrated with the results of the tracer experiments, it was possible to simulate the propagation of the suspended sediment concentration originating from bottom discharge, downstream the measured stretch (10Km), and verify that the concentration decreased to a value of about 18% of the initial value of the bottom discharge, 34Km downstream the dam. The sedimentological results were considered together with the biological studies using the macrozoobenthic community, found in biomonitoring network stations, for the set-up of a basic methodology for bottom discharges of SHP.

A-78 B5 Oral

INVESTIGATION OF SEDIMENT TRANSPORT MECHANISMS IN THE GULF OF DURRES (ALBANIA) USING RADIOTRACERS AND NATURAL RADIOACTIVITY OF SEDIMENTS

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Radiotracers were applied to study the sediment transport in the gulf of Durres in the framework of the maintenance of Durres harbour. Based on conventional data it could be assumed only that the sediment transport is probably developed in suspension or by saltation of cohesive sediment apparently in the direction of the harbour. First, the natural radioactivity of sediments was applied as “complementary tracer” because it could provide interesting information on sediment dynamics. Radiometric measurement of gamma natural radiation is a simple and fast technique for lithological mapping of the sea bottom that could provide useful information about the origin and transport of sediments.

Natural radiometric survey of the sediments of sea bottom provided some qualitative sediment transport features:

- There was not any visible granulometric selection of sea bottom sediments in the gulf of Durres.
- There was an indication of sediment transport trend from south to the north of the gulf under the influence of waves coming from the south sector.
- There was evidence of silting process, in particular in the first part of the navigation channel near the harbour.

Quantitative results about sediment transport can be obtained applying tracer techniques only. Among various tracers we preferred radiotracer as most competitive for online measurement.

The radiotracer study had the following objectives:

- to clarify the mechanism of sediment transport in the gulf of Durres, and to obtain quantitative results regarding the sediment transport in the gulf of Durres.
- to find the sediment transport direction and sediment transport quantity in the vicinity of the access channel of Durres port,
- to determine the sediment quantity deposited every year in the channel.

The radiotracer selected was Ir-192 (activity 1 Ci), which has a half life of 74 days. The characteristics of this radioisotope make it an ideal tracer in sediment transport of sands when the study lasts several months. Iridium was incorporated in an activable glass with density of 2.65 with granulometry of 40 - 100 μm (250 g for each point). Four points where radiotracer was released has been selected around the access channel in order to cover all potential movements of sediment to/from channel.

The main conclusions of study were:

The rough estimation of silting up of the access channel was of 100 000 m^3 in a year, out of this 2/3 are for the first part of the channel from harbour to its half, and 1/3 is the open sea half part. The silting up of the access channel is estimated of 1 500 000 m^3 in 10 years.

The dredging material can be discharged in the NW part of the port of Durres, after 10 m depth; there is very small risk that the dredged material will return to the access channel. The dredging process is permanent, but the silting up is not extraordinary in comparison of other similar ports, it is a normal process in normal rate.

The mapping of natural radioactivity before the radiotracer test helps to design better the radiotracer test, and in addition provide complementary data for the origin and the trend of sediment transport. The complex sediment transport study in Durres gulf showed that the qualitative results of natural radioactivity were confirmed by radiotracer tests and both they contributed to clarify sediment transport situation in the gulf of Durres.

A-27 B5Oral

FLOW MEASUREMENTS IN GREAT RIVERS, SOUTHERN CHILE, USING FLUORESCENT TRACER

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Southern Chile is a place that has many rivers product of the lot of rain falling during most of the year and the melting of the Andes Mountains, this allows the construction of hydroelectric plants to power electric energy to the country. However, to make an assessment of the environmental impact caused by intervening watercourses is required to measure the flow of the river at various points along the way to determine if the construction of the hydroelectric plant on the river is able to maintain a water flow that allows the sustainability and biodiversity of the ecosystem. In the austral region of Chile flow rate are evaluated in high and medium rivers flow, both are in inaccessible area where cannot be made mechanical measurement equipment. By foregoing is that the water flow measurements are made using the techniques of fluorescent tracer dilution and used Rhodamine WT. For measurements at high flow, the method of injection punctual is selected, due to the operating conditions of the site under study; flow rates around 100 m³/sec, few accesses for installation of measuring it is necessary the injection of the tracer from a helicopter. The tracer is injected into the river upstream of site at a distance conducive a long good mix. The passage of the tracer is registered on the site of measurement by deriving water from the river. In river with medium flow, continuous injection method is selected due to the operating conditions of the site, flow rate less than 10 m³/sec and easier access to the riverbanks. It is possible to install measurement stations and injection at constant flow in appropriate places.

The values obtained for the river with high flow varied between 70 and 150 m³/sec and for medium river flow between 1 and 10 m³/sec.

These values allow decisions to implement the projects under study of hydroelectric power station.

A-28 B5 Poster

THE MOROCCAN ENVIRONMENTAL SIGNATURE OF THE FUKUSHIMA ACCIDENT

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USE is the Environmental Monitoring Unit in charge of executing radiological environmental monitoring program around CENM (Centre d'Etudes Nucléaires de Maâmora)'s site accomodating TRIGA II Research Reactor operated by CNESTEN (Centre National de l'Energie des Sciences et des TEchniques Nucléaires). This Unit works on the objective of protecting human health from the adverse effects resulting from any contamination. So it executes an environmental monitoring programme and delivers reports intended to the regulatory authorities concerning the radiological state of the CENM's environment. In parallel, as technical tool to the Moroccan government, USE is called to intervene at national scale in case of emergency. It was the case in 1998 after Spanish Algeciras ¹³⁷Cs emission accident, in 2001 with suspected radioactive release from the British Tireless Submarine and recently the environmental survey campaign executed after the Fukushima accident [1].

The present work aims to summarize the tasks carried out and describes the evolution of the situation on moroccan environment on the short term after Fukushima accident.

During this campaign, traces of ¹³¹I were detected that was consistent with the Fukushima nuclear accident but regarding the activities detected these did not constitute a health hazard compared to the elevated levels of iodine in Fukushuima prefecture that was three times the normal level where the Japenese Health Ministry on March 21, 2011 advised people not to drink tap water [2].

USE started radioactivity measurement programme on 21/3/2011 to determine the impact of Fukushima nuclear accident on Moroccan territory. Measurements using High Purity Germanium gamma spectrometry were conducted on aerosol, vegetation, surface and rain water, milk and soil samples collected on CENM's site. ¹³¹I was detected in many matrices mainly in the aerosols.

Key words: Environmental monitoring, Gamma Spectrometry, Fukushima accident, ¹³¹I.

References:

- [1] K. Shimomura, "Flashback to the accident", pp 26-27, Eurosafe Tribune, June 2012
- [2] (<http://fr.slideshare.net/Nubiagroup/japan-maximum-nuclear-alert-march-30>):

A-56 B5 Poster

USE OF ENVIRONMENTAL RADIONUCLIDE ^7Be TO EVALUATE SOIL PRACTISES IN SEHOUL CATCHMENTS, MOROCCO

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Sehoul region, close to Rabat city, might be the more favourable agricultural lands in terms of climatic conditions. Unfortunately it suffers from marginal lands, important soil degradation, very high land vulnerability and a high poverty. This can be due to the natural parameters (climate change, natural catastrophe etc..) but also to the soil practices followed by the farmers. Reliable information's are needed to assess the extent of this problem and maximize conservation measures to be adopted to ensure sustainable agricultural development in this region.

Use of radionuclide ^7Be as sediment tracer is an excellent and innovator tool, possesses many advantages compared to the traditional methods (experimental plots, modelling...). This technique allows studying soil erosion associated with individual events or short periods and informing about the effectiveness of soil conservation practices used. ^7Be is a natural radionuclide, with a short half life of 53 days, derived from the bombardment of the atmosphere by cosmic rays.

The aim of this study is to evaluate the soil erosion by ^7Be measurements for 2009, 2010 and 2011 for three agricultural fields where three practices were followed by the farmers; cereal/cereal rotation, leguminous/cereal rotation and vine monoculture.

The results show that vine monoculture gives less erosion compared to the two other techniques (cereal/cereal rotation and leguminous/cereal rotation) even if the precipitation amount was different for the three years. Vine Monoculture can be proposed as an interesting practice to mitigate land degradation

A-42 B5Poster

^{99m}Tc VS RHODAMINE WT FOR TRACING COASTAL HYDRODYNAMICS

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Rhodamine WT is a tracer commonly used to quantitatively and visibly trace currents and contaminant plumes. Radioactive tracer ^{99m}Tc can also be used for these applications. Both of these tracers were injected simultaneously in a study of currents in a nearshore area of Darwin Harbour, Australia. Five subsurface drifters were released at one minute intervals during the tracer releases as an additional method of determining dispersive processes. Aerial photography was used to observe the Rhodamine WT plume. These methodologies provided data on dispersion and advection for calibration of a 2D hydrodynamic model of the harbour, which was in turn used to design the extension of a sewage outfall.

Using this case study we contrast and compare the independent analysis of the two tracer methods. Some differences in the initial tracer plume are expected due to different deployment methods. Differences in detection systems may lead to time lags between datasets. The methods used to quantify tracer concentration will also be discussed. Once these technical aspects are accounted for it should be possible to directly compare the behaviour of the two tracers and their suitability for determining dispersion. Logistical aspects relating to tracer availability, detection systems, human safety, environmental impact and cost will also be addressed. Unexpected regulatory obstacles existed for Rhodamine WT – a tracer specifically designed for surface water and ^{99m}Tc was the favoured tracer out of the two for regulators in the Northern Territory of Australia on the basis of environmental impact.

A-45 B5 Poster

EXPLORATION OF THE DEPOSIT OF THE POWER STATION INGA CANAL USING A NUCLEONIC GAUGEJDT3

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Load suspended in the canal of the hydroelectric power station of Inga includes mainly sand, silt and clay whose settling properties depend on hydrodynamic conditions. The JDT3 application for turbidity studies and top determination of deposits in the Canal, in March-April 1988, allowed to define and precise two sedimentation areas: "Sand sedimentation area and mud (clay + silt) sedimentation area". Furthermore, bathymetrical map of explored areas as a reference tool for next determination of deposits evolution in the canal has been established. This can be used to create, after many experiments, a simulation model of this evolution.

A-52 B5Poster

USE OF ENVIRONMENTAL ISOTOPES TO TRACK MOROCCO'S WATER RESOURCES

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The sustainability of groundwater resources for drinking water supplies, agriculture, and industry is a prime concern in countries dominated by arid and semi-arid climates such as Morocco. The growing demand for groundwater coupled with impacts from land use and climate change make sustainability an even more important water management goal. In order to make sound decisions about water use and protection of water quality, water managers and policy makers must have a sound understanding of such factors as the location and amount of groundwater recharge and groundwater ages. Isotope methods can be essential for understanding how groundwater systems work in large dry land basins and yield critical insights that standard hydrological or geochemical methods cannot provide. Stable isotopes of the water molecule along with tritium and carbon-14 are effective tracers of the hydrological cycle and have proven to be effective in helping Morocco better understand its water resources and manage them more efficiently.

For many years the Morocco Ministry of Energy, Water and Environment, and the Morocco National Centre of Nuclear Energy, Sciences, and Technology (CNESTEN) have worked together to characterize groundwater basins in Morocco using isotope and nuclear methods. Many different groundwater investigation projects have been conducted, and this work demonstrates how environmental isotopes can be used as a national and international resource for sustainable groundwater management, and should help promote increased utilization of isotope methods in other countries.

A-12 B5 Poster

APPLICATION OF NEUTRON ACTIVATION ANALYSIS FOR METALLIC POLLUTION STUDY IN SEBOU RIVER (MOROCCO)

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The aim of this work was the study of the heavy metals pollution and the distribution of trace elements in sediment samples of the Sebou river (Morocco). For that, 11 sampling points have been chosen taking into account the diverse lithology of the Sebou basin and the anthropogenic contributions. Sediments samples have been analyzed by neutron activation analysis recently installed around the Moroccan Triga Mark II research reactor in the nuclear study center of Maamoura. Two types of irradiation have been carried out in order to determine both elements of short and long periods. Acquisition of irradiated samples spectra has been carried out by Maestro software. Fitting and the determination of element concentrations of each sample has been done using the K0-IAEA program. Results of sediment samples showed contamination in some elements such as Cr, Mn, As, Ti, Sb, Zn, V, Co and Fe. This contamination is probably due to the chemical composition of the soils crossed by the river as it can be also from the anthropogenic discharges of wastewater coming from rural settlements, including leaching uncontrolled garbage or water irrigation of surrounding agricultural land rich in fertilizer.

We also noted the effect of accumulation of some heavy metals in the estuary of the Sebou river such as As, Co and Sb. Finally, the comparison of our results with previous studies on Sebou river and other Moroccan rivers gives an idea about the temporal evolution of heavy metal contamination.

Keywords: neutron activation analysis, Triga Mark II reactor, K0-IAEA, traces elements, heavy metals, sediments, Sebou river.

A-13 B5Poster

APPLICATION OF NEUTRON ACTIVATION ANALYSIS FOR THE GEOCHEMICAL STUDY OF EL HACHEF RIVER (REGION OF TANGIER - MOROCCO)

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Neutron activation analysis recently installed around the Moroccan Triga Mark II research reactor in the nuclear study center of Maamoura has been used for geochemical study of water and sediment samples of El Hachef river in the region of Tangier.

To analyze a range of elements as wide as possible, collected samples were analyzed using neutrons of Triga Mark II research reactor accessible from facilities of neutron activation analysis laboratory. Pneumatic transfer system and rotary specimen rack systems were respectively used for the determination of elements of short and long periods.

From sediment analysis, we deduce a very important geochemical heritage and geochemical homogeneity of the environment of El Hachef river basin (comparison between sediments and the chemical composition of the upper continental crust).

The study of water chemistry has confirmed the difference in the behavior between the so-called soluble elements and other insoluble elements such as rare earth elements. The concentrations of these elements in the dissolved phase are more related to the internal chemistry of the river and the existence of a colloidal phase. This is particularly highlighted during the very low water where concentrations of organic matter can be significant.

Keywords: neutron activation analysis, Triga Mark II reactor, traces elements, heavy metals, water, sediments, El Hachef river.

A-40 B5Poster

CONTRIBUTION OF HYDROCHEMICAL AND ISOTOPE TOOLS TO THE VULNERABILITY OF THE COASTAL AQUIFER OF THE MITIDJA PLAIN (NORTH EAST OF ALGIERS)

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The exploitation of water resources in the coastal zone and in particular in the North-Eastern part of the Mitidja plain has known an increase due to the demographic and economic development of the last decades. The Mitidja plain is the main reservoir for the North East region of Algiers and contributes to the water needs of the population.

The quality of groundwater in the main aquifer of the Mitidja plain is threatened by contamination of deeper parts of the aquifer by salt water, close to the sea. These resources are often exploited to the limit of their availability; they record considerable piezometric decreases and a degradation of their quality by salinisation or contamination.

Thus, the use of conventional methods complemented by environmental isotope techniques allow us to characterize the aquifer water resources and to identify the mechanisms that take place in order to detect a progress from the sea front.

The main objective of the study is to combine conventional methods and isotope techniques to understand the mechanisms of salt water contamination of groundwater in the Mitidja East region specifically in the Northern part of the aquifer, in the recharge zone near the sea.

This study was carried out within the framework of a Technical Co-operation project supported by IAEA (ALG/7/005) and the investigation was performed by a research team from the Algiers Nuclear Research Centre in collaboration with engineers from the National Agency of Hydraulic Resources.

The results obtained until now have allowed us to better understand the mechanisms of the evolution of salted water intrusion. For this purpose, several profiles of temperature and conductivity were carried out on a large number of public wells and piezometers to locate and characterize saltwater intrusion. The mineralization of waters is between 500 mg/l and 2 g/l.

The results of chemical analyses of water are calcium bicarbonate type, for the less mineralized, with relatively high levels in calcium and sulphate when the mineralization is increasing (probable presence of evaporites in the aquifer) and a trend towards sodium chloride facies for the highest.

The isotopic analyses have been the subject of an interpretation for the analysis of the evolution of the salted water intrusion. In fact, treated on a diagram $^{18}\text{O}/^2\text{H}$ they show for many points a mixing with sea water. The diagram shows clearly a straight line of mixing fresh water/sea water, but also a more complex combination between mixing and effect of evaporation.

A-81 B5 Poster

Uranine in groundwater as a tracer to assess flow velocities: two test cases in Lithuania

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Tracers are used widely to determine the direction and velocity of ground-water movement (Worthington, 2007). For more than a century, dye tracers have provided clues about the hydrological cycle as well as flow and transport processes in subsurface (Flury et al. 2003). Fluorescent dyes are often chosen for tracer studies because of low toxicity, availability, low cost, water solubility and stability, and ease of detection (Field et al. 1995). Sodium fluorescein ($C_{20}H_{10}Na_2O_5$; Acid Yellow 73; CAS number 518-47-8) also known as uranine, is used frequently for aquifer tracer studies.

Two network systems has been designed at nuclear objects site in Lithuania, where the first system defines the first semi-confined intertill aquifer with depth of 10-19 m and the second system is installed in the unconfined aquifer with depth of 4.5-9 m. The injection masses of uranine amounted to 500 mg and 50 mg respectively. The concentration of uranine was measured with the computer-controlled Aminco Bowman luminescence spectrometer (totally 960 samples). The test results with tracer in groundwater show the flow and transport mechanism in this area. The results were compared with other countries test results also.

A-31 B5 Poster

ESTIMATION OF SOIL EROSION AND DESERTIFICATION BY RADIOACTIVE NUCLIDES IN UVURKHANGAI PROVINCE OF MONGOLIA

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The accumulation of ¹³⁷Cs was determined in soil samples, which were collected from Uvurkhangai province in Mongolia, using HP-Ge gamma-spectrometer. It was determined the soil erosion by accumulation of ¹³⁷Cs using MODIS satellite information.

Key words: Soil radioactivity, specific radioactivity, soil erosion

A-84 B5 Poster

RADIOCAESIUM-137 AS TRACER IN SOIL EROSION INVESTIGATIONS AT THE WATERSHED SCALE

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Soil erosion poses the greatest threat to agriculture and food security, especially in arid and semi-arid lands. The factors behind vary according to the affected areas. Many studies have been conducted to assess soil erosion phenomenon. Nuclear techniques through the use of radioactive tracer ¹³⁷Cs showed the goal potential for determining the soil redistribution as a valuable tool to complement the classical techniques.

¹³⁷Cs is an artificial radionuclide from atomic testing of 50s and 60s. The impact of this radionuclide is strongly adsorbed by fine soil particles and thus constitutes a tracer movement. The importance of soil movement is based on the comparison of the ¹³⁷Cs inventories for a sampling point with a reference inventory where neither erosion nor deposition of soil occurred. Generally, in a place where soil erosion occurs, the ¹³⁷Cs inventory is smaller than the reference inventory. However, to obtain quantitative estimation of soil erosion one of the models should be used to convert ¹³⁷Cs data into erosion rate, for undisturbed areas (diffusion model) and for agricultural areas (mass balance model).

The study area is "My Bouchta" watershed (7 664 ha), located in Rif mountains. As such, it encompasses a complex fragmented and varied landscape. Thus, to optimize the sampling, we produced a map of homogeneous units using a GIS tool, by combining three agro-environmental parameters "land use, soil type and slope gradient". 18 units, representing 96 % of the watershed, were considered to study the long-term erosion rates (50 years).

The results show that the majority of the eroded soil (98%) is located mainly on cultivated lands, these lands have an important mean erosion rate around 27.6 (t/ha/year), while sites scrub and forest have significantly lower rates of erosion, with average rates of 3.7 and 0.9 (t/ha/year) respectively. The overall soil erosion calculated by weighting the production area of each unit is estimated at 23 (t/ha/year), and annual losses across the watershed is 150 435 (t/year). The siltation of the future dam rate is estimated, in the absence of any anti-erosion management, 12.3 (t/ha/year), with an average coefficient of delivery 56 %. The quantity of sediments that reach the outlet is 54 872 (m³/year).

The study of radionuclide ¹³⁷Cs gave a quick and accurate estimate of the rate of soil erosion and allowed to take into account the temporal and spatial variations across the watershed.

Keywords: Erosion, Siltation, Tracer, Radionuclide, ¹³⁷Cs, Watershed.

A-85 B5 Poster

USE OF FALLOUT BERYLLIUM-7 TO ASSESS THE EFFECTIVENESS OF NO-TILL MANAGEMENT IN CONTROLLING SOIL EROSION

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Conservation agriculture (CA) promotes practices to achieve acceptable profits from high and sustained crop production levels while, at the same time, conserving resources and protecting the environment. The process of no-till is one that follows the principle of CA, with doing minimal mechanical soil disturbance crop residue accumulate near the soil surface, where it will be most effective in reducing wind and water erosion, improving infiltration and reducing evaporation. The objective of this work was to use beryllium-7 in the model of simplified mass balance to determine the effectiveness of no-till management in controlling soil erosion in the rainfed agricultural system of the North of Morocco.

The methodology allows to differentiate the soil redistribution and the process of erosion under two treatments: no-till (NT) and conventional till (CT), during the season of cultivation of wheat. Both treatments were conduct in two study sites: The first site is located in Larache region and the second in Tetouan region. The transect sample approach is purposed for each treatment and a reference site has been identified next to each study site. The samples were analyzed by gamma ray spectrometry.

Monitoring of the spatial distribution of ⁷Be activity after a heavy rainfall provide a basis for investigating sediment mobilised by soil erosion. Penetration depth into the soil is shallow 11 (mm), since its short half-time (53 d) means that there will be limited time for downward migration and diffusion. The calculated relaxation mass constant (h_0) is 3.16 (kg/m²). For Tetouan region, the field leads with a conventional till gave a soil loss of -18 (t/ha), while no-till practice has reduced soil loss to -11 (t/ha). In contrast, for Larache region, soil loss were recorded as -10 (t/ha) in the field leads with no-till, while there is a significant sedimentation of 13 (t/ha) in the field leads with conventional till.

The possibility of this technique to determine the soil redistribution in a short period has been constantly increased its relevance in efficient farming practices and environmental impact assessments.

Keywords: Soil erosion, Tracer, ⁷Be, Conservation agriculture, No-till, Conventional till.

Special session devoted to:

- the creation of an International society and
- the evolution of the next tracer conferences

P. Brisset and J-P Leclerc

A-16

DEVELOPMENT OF A TRAINING AND CERTIFICATION SCHEME IN THE FIELD OF INDUSTRIAL APPLICATIONS OF NONDESTRUCTIVE DIAGNOSTICS TECHNOLOGIES

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The International Atomic Energy Agency (IAEA) has been playing a major role in facilitating the transfer of the radiotracer and sealed sources technologies to developing Member States. The major techniques have been implemented through IAEA Technical Co-operation projects and adopted by many Member States. The expertise and knowledge gained should be preserved. The sustainability of technology and knowledge preservation calls for creation of young specialists and for continuing good practices.

As a part of its involvement in human resource development, the IAEA is aware of the important need to prepare standard syllabi and training course materials for education of specialists in different fields of nuclear technologies. Training course materials on the radiotracer and sealed sources methods for industrial and environmental applications have been developed for the cultivation of radiation technologies specialists and for continuing technical education of practitioners worldwide. The wide interest in radiotracer technology has created the need for high-level professional education and training in this field, which are generally not covered by traditional University courses.

There are lack of technical knowledge, experience and qualified manpower in general, limitations due to lack of equipment, non-availability of radioisotopes, strict regulations not technically related with real radiological safety impact, etc. The society for radiotracer and sealed source is requested to solve the problems through various cooperative activities.

Training is provided by IAEA through fellowships, expert missions for group training and regional training courses. But it appears clearly that a complementary training system is necessary to develop the activities and to ensure its sustainability among Member States. This system would be based on the example of the system used in NDT. This requires the development of a training system under a Quality Management System (QMS). Obviously such QMS in general would be developed in each MS institute for management, laboratory practices, etc... but this general organization is out the scope of the meeting.

First of all we have to recognize that Nondestructive Diagnostics Evaluation Technologies represent less workers, less services than NDT. Thus even if the objective is to create a training and certification system on the model of the NDT one, it is not possible to comply with all requirements existing for NDT. The scheme to be established would be lighter than in NDT, more supple and adapted to the needs of the NDE technologies and directly at the international level because there are not enough people in each country to justify the establishment of such scheme at a national level.

Globally the scheme would be:

- The International Society for Nondestructive Diagnostics Evaluation (ISNDE – provisional name and acronym) being recognized as the independent certification body. ISNDE would be created during the Tracer 7 International conference on tracers and tracing methods. This means ISNDE would act as a third party certification body but not under ISO 17024. ISNDE would manage a certification between peers system. ISNDE would be also a scientific society.
- ISNDE would prepare with the help of IAEA and based on its documents:

- a syllabus for the methods recognized of practical interest
- recommended practices, protocols covering the main techniques
- a question bank for examination
- A training and examination center would be established (in a first step) in IAEA laboratories in Seibersdorf – Austria (or in another convenient place).

