SESSION 10
Radioisotopes Applications and Radiation Protection

Radioisotope Applications in the Petrochemical Industry : An Overview

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Radioactive isotopes particularly radiotracers and radioactive sealed sources have been used through out a broad spectrum of process industries for equipment and process troubleshooting, monitoring, control, inspection, optimization, and many others. However, their applications in multiphase flow systems need further development where these systems are opaque and not yet well understood and hence, further studies and investigations are needed. In multiphase flow systems two or more phases (gas, liquid, solid) are involved and interacted with each other in various forms. In petrochemical industry various types of multiphase flow systems are used such as multiphase reactors, blenders/mixers, separators, etc. Multiphase reactors can take various configurations and types based on the way the phases are contacted and interacted such as bubble column (gas-liquid system), slurry bubble column (gas-liquid-fine solid system), packed bed (gas-solid, liquid-solid, gas-liquid-solid systems), fluidized bed (gas-solid, liquid-solid, gas-liquid-solid systems), mechanically mixed equipment (gas-solid, liquid-solid, gas-liquid-solid systems), and many others. These systems are opaque and hence, only radioactive isotopes based techniques can probe and visualize them as light based technique cannot be applied. This is a challenging task due to the complex interaction among the phases and the opacity nature of these reactors and equipment.

Various radioisotopes based techniques have been developed for research in laboratory scale and pilot plant scale and for site applications in industrial processes. The following are some example of these techniques: radiotracer method for the measurement of the residence time distribution (RTD) and its utilization for trouble shooting and diagnostics; sealed sources for gamma ray and x ray transmission measurements; radioactive particle tracking techniques using single radioactive particle or multiple

radioactive particles and either collimated or non-collimated detectors; and positron emission particle tracking techniques. For all these techniques various mathematical models and reconstruction algorithms have been developed, evaluated and implemented for image reconstructions. Accordingly, implementing these techniques properly is not a trivial task. In this plenary lecture these techniques will be outlined and their application in petrochemical processes for both industrial on-site measurements and for laboratory and pilot plant scales research will be overviewed and discussed. Examples and results of these techniques used for various types of flow multiphase flow systems related to petrochemical processes will be as well summarized such as bubble column, slurry bubble column, gas-liquid packed bed, distillation column, structured bed, fluidized bed, circulating bed, mechanically mixing equipment, etc. In addition, the needed future work, research and development will be outlined.

Radiation-Based Technologies in Saudi Aramco

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Saudi Aramco (SA) is considered one of the largest users of radiation-based technologies in the region; these provide significant benefits in both industrial and medical applications. The company ensures that employees' exposure to ionizing radiation is kept as low as reasonably achievable by developing and implementing radiation protection standards and instructions which fully comply with national & international standards and current best practice.

Saudi Aramco has developed the industry's most integrated, comprehensive Manmade Ionizing Radiation Sources (MIRS) strategy to ensure all aspects of radiation protection are controlled and optimized. The objective of SA MIRS strategy is to promote the safe use of manmade ionizing radiation company-wide through technical guidance and consultation on radiation protection. The MIRS strategy aims to ensure progress by:

- Enhancing the control of MIRS
- Monitoring the compliance of MIRS users
- Enhancing radiation protection in the workplace
- Enhancing the radiation protection knowledge base

This presentation will provide an overview of the ionizing radiation–based technologies that are utilized in SA and highlight the key components of SA MIRS strategy.

Application of Radiation Sources in the Oil & Gas Industry and Shortages in their Services

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Oil and gas industry utilize many radiation sources in various applied radiation-based technologies. Those technologies provide significant benefit to the daily operations of the industry. Gamma emitter sources of Caesium-137 (^{137}Cs), Cobalt-60 (^{60}Co) and neutron source Americium-241/Berylium (^{241}Am-Be) are used in well logging. Barium-133 (^{133}Ba), ^{241}Am and ^{137}Cs sources are used in multiphase flow meters technology at platform of oil and gas production facilities. Gamma sources like ^{137}Cs and ^{241}am are used in transmitted level gauges for tanks in refineries while X-ray fluorescence (XRF) are used for sulfur gauges in laboratories. Cadimium-109 (^{109}Cd) and Iron-59 (^{59}Fe) are used in alloy analyzers in refineries and workshops. Neutron sources like Californium-252 (^{252}Cf) or ^{241}Am-Be are used in density gauges. Iridium-192 (^{192}Ir) and ^{60}Co are additional examples of routinely used radiation-based technologies in industrial radiography. Bismiuth-113 (^{113}Bi) and x-ray machines are used routinely in industrial security. To maximize benefits and minimize hazards associated with utilization of radiation-based technologies, national radiation protection standards are implemented. Utilize of radiation sources is controlled by international and national rules and regulations. The use of radiation sources needs regular services. There are shortages in the needed radiation sources' services within the kingdom. This paper will outline samples of radiation-based technologies used in the oil and gas industry and paying particular attention to shortages in the radiation services needed to the safe handling of the sources that need to be rectified in order to encourage the new radiation sources' users to utilize radiation-based technologies to the industry.