Present Status and future trends of Industrial Radioisotope Application in Sudan

Salih A. S.*[1]
Sudan Atomic Energy Commission, Department of radiation Utilization
Po Box 3001 Khartoum – Sudan

Abstract

Radioisotopes continue to play an important role in better management of natural resources, industrial growth and environmental preservation . The success of radioisotope applications is due primarily to the ability, conferred by the unique properties of radioactive materials, to collect data, where conventional methods fail or become uneconomical. These are prompt, on-line, in-situ and do not disturb the main industrial process in any way. In Sudan, the application of these nuclear techniques has considerable economic and environmental impact. This paper casts light on the present application of radioisotopes and future trends in the country.

[1] Correspondence author: justsalih@hotmail.com

Introduction

- Modern industry uses radioisotopes in a variety of ways to improve productivity and, in some cases, to gain information that cannot be obtained in any other way.

- Radioisotopes application in industrial sector is a new technology in Sudan; it was transferred through the technical cooperation between International Atomic Energy Agency (IAEA) and Sudan government represented in Sudan Atomic Energy Commission (SAEC).

- The industrial sector in Sudan is expanding rapidly. Due to oil producing activities several refineries are being constructed. In addition petrochemical plants are planned, new bridges and new airports are also planned, a car assembly factory is operating, power stations and sugar factories are established, so radioisotopes technology is very important.

Radioisotopes technology in industry

1. Sealed Sources.

To move to a greater degree of industrial plant production sophistication, industrial processes require more reliable and efficient techniques for investigation process problems. Several very specific sealed source technologies are applied all over the world, radioisotope technologies have proved it self as a sensitive tool for investigation and solving plant and process problems, which in turn results in considerable economic benefits.

Sealed sources technology is playing an increasing role in assisting industry to satisfy a critical need for efficiency. Although the technology is not applicable across a broad spectrum, the petrochemical\chemical plants and oil fields are identified as appropriate targets for sealed sources applications. The above-mentioned industries are widespread internationally and can benefit economically from this technology.

Since the technology become available in the nineteenth century, it has scored a number of important successes for industrial companies worldwide. Gamma ray scan in petrochemical and chemical process plants are used effectively to identify process anomalies as well as integrity of column's internals. It can also be used to measure and quantify deposits and blockages in pipelines.

A wide range of investigations aimed at optimizing of process design and control can also be undertaken. The biggest advantage over conventional methods is based on the fact that investigation can be carried out while a plant is on-line, with no disruption to operating processes. Expensive downtime is avoided and the convenience of direct measurements leads to saving process investigation costs.

- **Sealed Source Applications**

  - **Radiometry (Gamma Scanning)**
  - **Radiography**
  - **Tomography**
  - **Nucleonic Control Systems**
  - **Radiation Processing**
  - **Blockage location in buried pipelines**

2. **Radiotracer.**

Radiotracers have been widely used throughout industry to optimize processes, solve problems, improve product quality, save energy and reduce pollution. Their technical, economic and environmental benefits have been well demonstrated and recognized by the industrial and environmental sectors.

Relevant target areas for radiotracer applications are defined. Though the technology is applicable across a broad industrial spectrum, the petroleum and petrochemical industries, mineral processing and wastewater treatment 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.

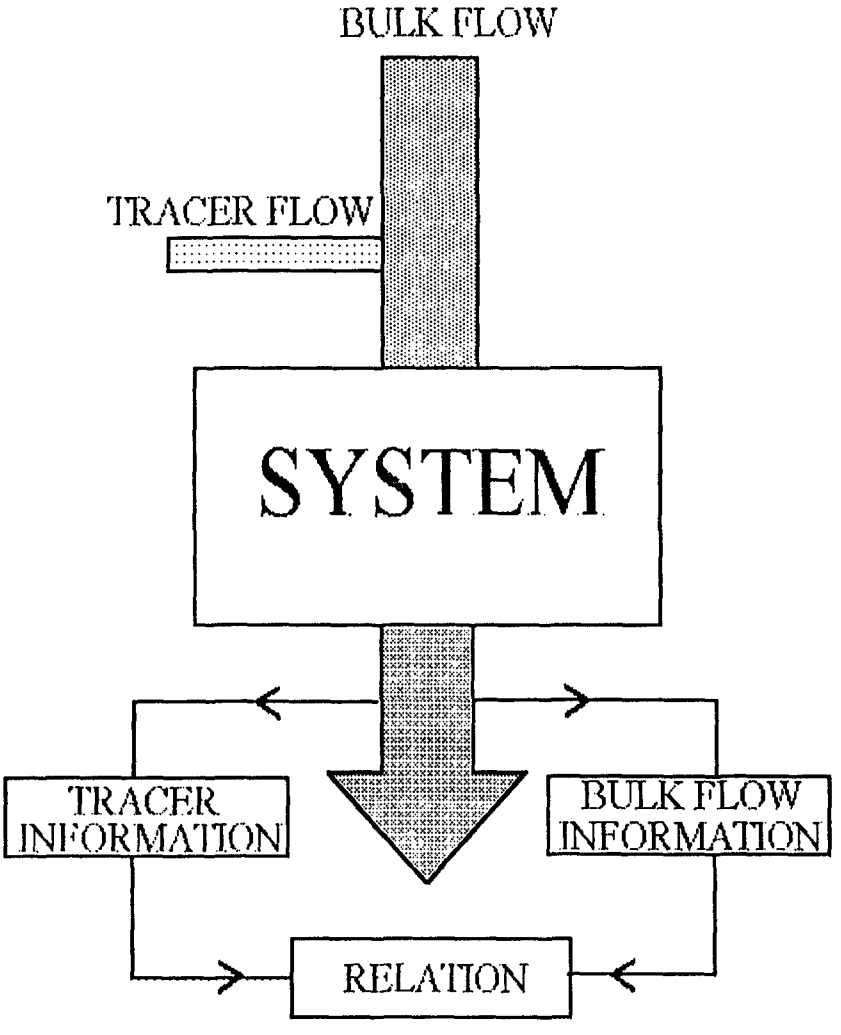
For conducting radiotracer investigation, various requirements need to be met before starting the actual test. The most important of all the requirements is the "Radiotracer itself. It is of fundamental importance that the radiotracer compound should behave in the same way as the material to be investigated. Therefore, the selection of an appropriate tracer is crucial to success of a tracer study. For reliable and meaningful results, an industrial radiotracer must meet the basic requirements like identical behaviour with the traced substance, suitable half-life and energy of radiation, physical and chemical stability, easy and unambiguous detection. It is often difficult to meet all the requirements of an ideal tracer and certain compromises have to be made. Even if a radiotracer meets the required criteria, it may not be available to small tracer groups in developing countries.

- **Radiotracer Applications**

  - **Leak detection in buried pipelines & industrial systems**
  - **Seepage location in dams and water bodies**
  - **Material/Mercury inventory**
  - **Flow rate measurement**

- Mixing/blending time measurement
- Residence time distribution measurement
- Sediment transport ports and harbors
- Effluent dispersion in coastal water
- Effective management of oil fields
- Wear/Corrosion rate measurements

GENERAL PRINCIPLE OF TRACER TECHNIQUE



PROPERTIES OF AN IDEAL TRACER

1. Should have similar physical and chemical characteristics to that of the material being traced.
2. .Should have at least one distinguishable property.
3. Should not react with the process material (in case of physical tracing).
4. Should not be adsorbed/absorbed in the system.
5. Should be stable at the conditions prevailing in the system.
6. Addition of the tracer should not disturb the flow

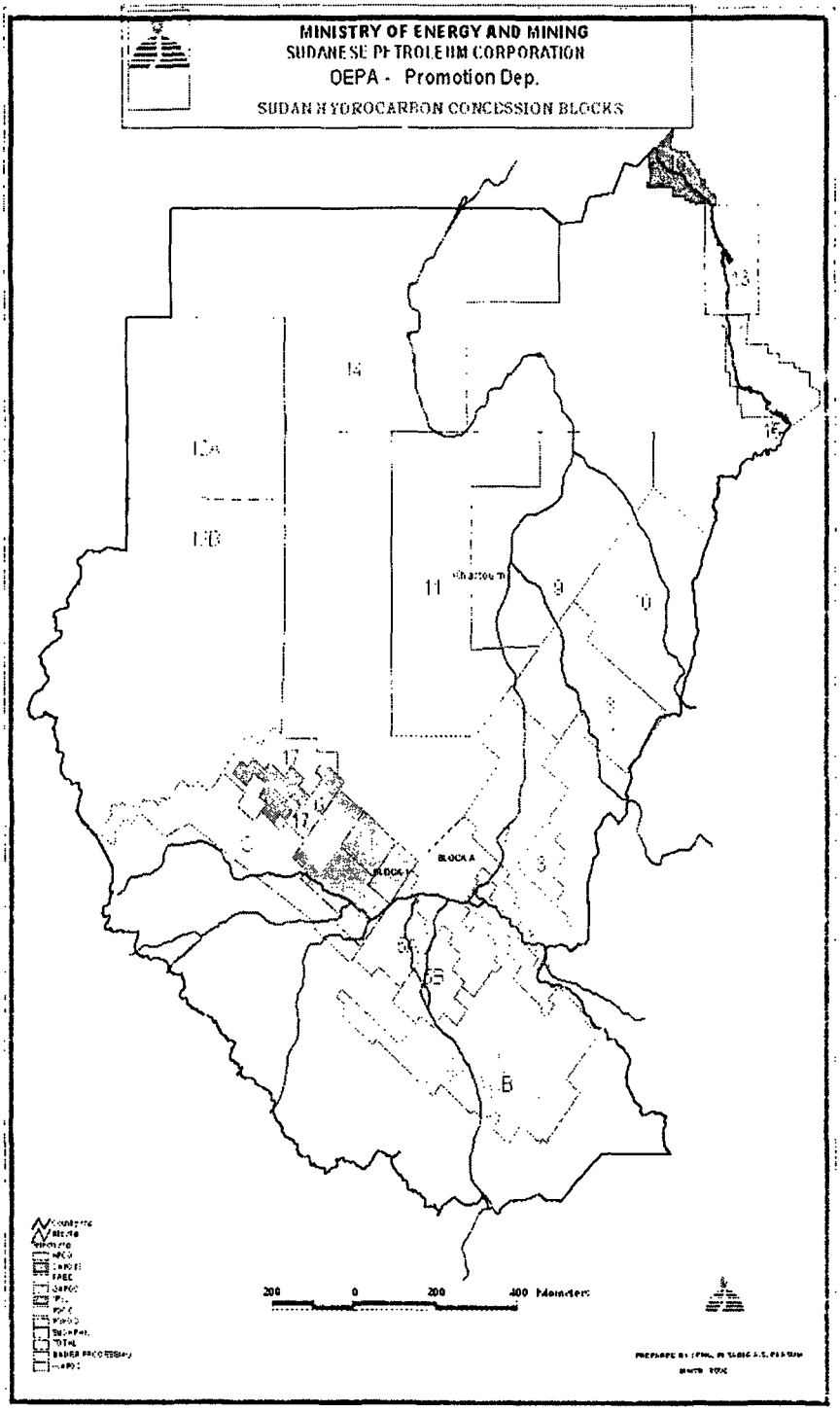
Advantages of Radiotracers

- High detection sensitivity
- *"In situ"* detection
- Physico-chemical compatibility
- Availability in wide range
- Results are obtained immediately and repeat tests can be carried
- Limited memory effects

Industries in Sudan
History

- The first petroleum projects in Sudan were a construction of Port-Sudan refinery in 1964. and a construction of import pipeline from Port Sudan to khartoum(8 inch 812 km), pump stations on the line and terminal stations with storage facilities in1974.

- Petroleum industry in Sudan started to evolve since 1999 where massive money was put to develop oil fields in heglieg.
- Cross-country pipeline(28 Inch1600 km) was constructed.
- Khartoum refinery was established at 2000 with 50000 barrel per day, upgraded to 90000 last year.
- The first Radioisotopes application executed by Sudanese was Gamma radiation scan investigations using sealed sources technology (co60) on a fractionator's column at a petrochemical refinery in order to obtain very important data to optimize the performance of process distillation columns.
- Since then, awareness of employing Sudanese nationals in such works was raised and the share of work became good to the extent that adequate qualified people were at short.



Oil Concession Blocks

Block 1,2 & 4
- EPSA: 1997
- Area: 48913 Km²
- Production Start: 1999 with 150,000 B/D now reached 300,000 B/D

Block 6
- EPSA: 1995
- Area: 38468 Km²
- Production Start: 2003 with 40,000 B/D

Block 5A
- EPSA: 1997
- Area: 29885 Km²
- Production Will Start on 2006 with 40,000 B/D

Block 5B
- EPSA: 2001
- Area: 20199 Km²

Block C
- EPSA: 2003
- Area: 65000 Km²

Block A
- EPSA: 2004
- Area: 125480 Km²

Block B
- EPSA: 1980 renewed at 2004

- Area: 118586 Km²

Block 3 & 7

- EPSA: 2000
- Area: 72419 Km²
- Production Start in 2006 with 170.000 B/D

Block 8

- EPSA: 2003
- Area: 65856 Km²

Block 10

Free

Block 9 & 11

- EPSA: 2003/2004
- Area: 245214 Km²
- Exploration Stage

Block 12A

- EPSA: 2006
- Area: 136000 Km²

Block 13

Under processing

Block 14

- EPSA: 2006
- Area: 263000 Km²

Block 15

EPSA: Aug 2005

Area: 25000 Km²

Block 16

- Under processing

Block 17

Under processing

Pipelines

Heglig-Bashair Pipeline

- Length: 1610 Km
- Diameter: 28 in
- Capacity: 450,000 bbl/day

Alfulla-Khartoum Pipeline

- Length: 720 Km
- Diameter: 24 in
- Capacity: 200,000 bbl/day

AdarYale-Bashair Pipeline

- Length: 1400 Km
- Diameter: 32 in

- Capacity: 500,000 bbl/day

Khartoum - Port Alkhair Export Pipeline

- Length: 815 Km
- Diameter: 8 in
- Established: 1978

Alroyan Port Alkhair Export Pipeline

- Length: 741 Km
- Diameter: 12 in
- Capacity: 800,000 MT/A

Refineries

Khartoum Refinery

- Established: 1999
- Capacity: 50,000 bbl/day
- Crude: Nile Blend
- Expansion Project: Jan 2006
- Expanded Capacity: 40,000 bbl/day
- Crude: Fula Blend

Al'Obaid Refinery

- Established: 1996
- Capacity: 15,000 bbl/day
- Crude: Nile Blend
- Expansion Project:
- Expanded Capacity: 30,000 bbl/day
- Crude: Nile Blend

Abu Gabra Refinery

- Established: 1992
- Capacity: 2,000 bbl/day
- Crude: Abu Gabra

Portsudan Refinery

Old Refinery

- Established: 1964
- Capacity: 25,000 bbl/day
- Crude: Arabic Light

New Refinery

- Strat up: 2009
- Capacity: 100,000 bbl/day
- Cost: 1.1 Billion USD
- Crude: Nile Blend

Specific Investment Projects

Downstream:

- Product Pipelines Khartoum- Medani- Gadarif- Ethiopia
- Rabak Refinery
- Distribution of LPG for home uses to all parts of Sudan.
- Petrochemicals Industries

Future Projects:

Projects related to Natural Gas discovered in Block 15 and possibly Block 13 such as: LPG & LNG Plants, Power Plant, Fertilizer & Petrochemicals

The following projects are expected to be executed in this year and in the next years:

Mala satelite development project, which includes a construction of 20 flow lines,3 OGMs,3 trunk lines.

Khartoum-Wadmadni pipeline(185 km).

ORC upgrading (new storage facilities & custody meter).

Baleela CPF extension (Block 6).

Neem CO2 .

Pump stations on 12" pipeline(5 stations 2011).

KRC to new airport pipeline(100 km).

Produced water bio-remediation (Block1,2&4).

3 FPFs at Block 3 & 7.

Block 9 facilities.

Radioisotopes technology in Sudan

In Sudan there are many activities has been carried, by means of Radioisotopes technology Such as:

- Gamma radiation scan investigations using sealed sources technology (co^{60}) on a fractionator's column at a petrochemical refinery in order to obtain very important data to optimize the performance of process distillation columns or vessels, terminate or extend process columns' production run times, identify maintenance requirements (material, labour) well in advance of scheduled turn around.

(From the scan results obtained during the time of the scan it is concluded that all the trays were in position. Malfunction and anomalies were present on tray 32 and on tray 30. Weeping was also present which is an indication of partially damaged or fouling present on the trays).

- gamma radiation scan using sealed sources technology (co^{60}) as a radioisotopes on an absorber stripper column Petroleum Refinery in order to obtain a real hydraulic behaviour performance (internal inspection) of a distillation column and to familiarized the end-user as well as the application group concerning the benefits associated with gamma ray scanning.

(From the results obtained it is concluded that no observable malfunctions and anomalies were measured in this potion of the column during the time of the scan).

- Residence Time Distribution (RTD) of a chemical reactor or vessel using radiotracer technology (^{82}Br).
- Leak detection in heat exchanger using radiotracer technology (^{82}Br).
- Flaw Rate Measurement using radiotracer technology (^{82}Br).

At the manpower side there are 8 persons have been trained in the radioisotopes application in industry under IAEA RAF/8040 and M.Sc Degree in Radioisotope Investigations on a Petrochemical Refinery.

Conclusion

Sudan has fairly advanced infrastructure/facilities and good expertise for applications of Radioisotopes in industry. The radioisotopes technology is well developed and services have been routinely provided to Sudan industry for troubleshooting, process diagnosis and optimization on commercial basis. It is generally realized that the level of application of radioisotopes technology in Sudan industry is presently confined to only a few well informed industries and there is need for a much wider application of these techniques to help in the optimum utilization of industrial infrastructure. The level of application, though growing, is still not commensurate with the level of technology development for a country of Sudan's size and growing economy.

Due to increasing awareness the industrial organization are becoming more and more interested to utilize these nuclear techniques for QA & QC of their industrial products and thus a great economic benefit is being envisaged.

References

1. A.E.Hills "practical guidebook for radioisotope-based technology in industry", second edition.

2. International atomic Energy Agency "Radioisotope applications for troubleshooting and optimizing industrial process" . IAEA/RCA in India, March 2002.
3. Mohammed Siddig Hassan "Radioisotope Investigations on a Petrochemical Refinery". Sudan Academy of Science. December 200
4. Hamid S Hamid " National Project Management Meeting & National Workshop on the Establishment of Qualification and Certification Scheme for NDT Personnel in Sudan - 3rd - 04th March 2007 KHARTOUM - SUDAN " - Sudanese Petroleum Pipeline Company (SPPC).
5. Sayed Abu Elhassan " National Project Management Meeting & National Workshop on the Establishment of Qualification and Certification Scheme for NDT Personnel in Sudan - 3rd - 04th March 2007 KHARTOUM - SUDAN " - Ministry of Energy And Mining.