

RADIOACTIVE WASTE TREATMENT OF OIL AND GAS INDUSTRY

Alifia Darmayanti¹, Yohannes Sardjono², Sri Yuniarti³

^{1,3}*Faculty of Environmental Engineering, Institute Technology of Yogyakarta, Indonesia Jl. Janti Km. 4 Gedongkuning, Bantul, Yogyakarta*

²*Indonesian Nuclear Energy Agency (BATAN) Jalan Babarsari No. 21 Kotak Pos 6101 ykbb Yogyakarta, 55281, Indonesia*

Abstract The increase of energy needs leads to the increase of oil and gas industry in Indonesia. Along with this, a good understanding about the application of radioactive materials, the treatment of radioactive waste and its disposal is needed. It is important because nowadays the radiation-based technologies are widely used by oil and gas industry, and a good understanding of the mentioned points will enable us to provide better and improved treatment as we strive to achieve clean technology. The uses of radioactive materials in the oil and gas industry are in exploration, producing, refineries, inspection of facilities, laboratories, and industrial security. The treatment of radioactive waste from oil and gas industry are divided into aqueous waste treatment, organic liquid waste treatment, and solid waste treatment.

Keywords Oil and Gas Industry, Treatment, Aqueous Waste, Organic Liquid Waste, Solid Waste

INTRODUCTION

The increase of energy needs leads to the increase of oil and gas industry in Indonesia. Along with this, a good understanding about the application of radioactive materials, the treatment of radioactive waste and its disposal is needed.

It is important because nowadays the radiation-based technologies are widely used by the oil and gas industry, and a good understanding of the mentioned points will enable us to provide better and improved treatment as we strive to achieve clean technology.

The oil and gas industry includes the processes of exploration, extraction, refining, transporting (often by oil tankers and pipelines), and marketing of petroleum products. The oil and gas industry waste, especially radioactive waste, is a critical factor when considering the industry's environmental impact and development of clean technology.

The knowledge and practical example of radioactive waste treatment in the oil and gas industry allows us to expand and improve the treatment better in the future.

USE OF RADIOACTIVE MATERIALS IN OIL AND GAS INDUSTRY

Before understanding the radioactive wastes from oil and gas industry along with their management, the application of radioactive materials in the process will be explained briefly.

Application in exploration

Radioactive sources routinely used in oil & gas well logging operations are:

- Caesium-137 (¹³⁷Cs), gamma source.
- Cobalt-60 (⁶⁰Co), gamma source.
- Americium-241/Beryllium (²⁴¹Am-Be), neutron source.

Applications in producing

- a. Multiphase flow meters (MPFMs)

MPFMs measure the phase fraction from an oil well. The operation principle is placing a gamma source on one side of a pipe and a detector on the other. The gamma source used in this kind of measurement is either ^{133}Ba , ^{241}Am or ^{137}Cs .

b. Radioactive Tracers

A small amount of liquid radioactive materials are injected into the selected oil and gas field wells to trace the fluid flow. The radioactive materials used in this process are the materials with relatively short half-lives, like ^{198}Au , ^{131}I , and ^{124}Sb .

Application in inspection of facilities

- Industrial Radiography

In industrial radiography, radiation (gamma or x-ray) is used for the quality assurance of welds during construction. It is important because of the need to detect the lifetime operations and corrosion of the facility or pipeline.

- Alloy Analyzers

The alloy analyzer uses x-ray to help the detection process of metal equipment in the industry. It is for fulfilling quality assurance.

- Density/Moisture Gauges

These gauges take measurements of moisture content, compaction and density of soil, and construction materials. Moisture gauges contain a gamma radioactive source such as ^{137}Cs and neutron source such as (^{252}Cf) or $^{241}\text{Am-Be}$.

Application in Refineries

Refineries use radiation sources in

applications such as transmission level gauges and sulfur analyzers.

Application in Laboratories

Oil industry laboratories use several radiation-based techniques for various purposes such as:

- X-ray Fluorescence (elemental analysis),
- X-ray Diffraction, and
- CT Scanners.

Application in Industrial Security

Industrial security uses x-ray equipment to inspect the packages in order to gain information from the content of the package. The content information is then displayed on a screen.

CLASSIFICATION OF RADIOACTIVE WASTE

According to IAEA, the classification of radioactive waste falls into 6 categories as follows.

1. Exempt waste (EW)

Waste that does not need regulatory control for radiation protection purposes.

2. Very short lived waste (VSLW)

Waste that can be stored for decay over a limited period of time.

3. Very low level waste (VLLW)

Waste that has low level activity and is suitable for disposal in near surface landfill type facilities with limited regulatory control.

4. Low level waste (LLW)

Waste that contains short-lived radionuclides at higher level of activity, and/or long-lived radionuclides, but at relatively low activity.

5. Intermediate level waste (ILW)

Waste that contains long-lived radionuclides which lead to the requirement of greater containment and isolation. But, ILW does not need provision, or only limited provision, for heat dissipation during its storage and disposal.

6. High level waste (HLW)

Waste with high activity that leads to heat generation caused by the radioactive decay process. The disposal is in deep stable geological formations usually several hundred metres or more below the earth's surface.

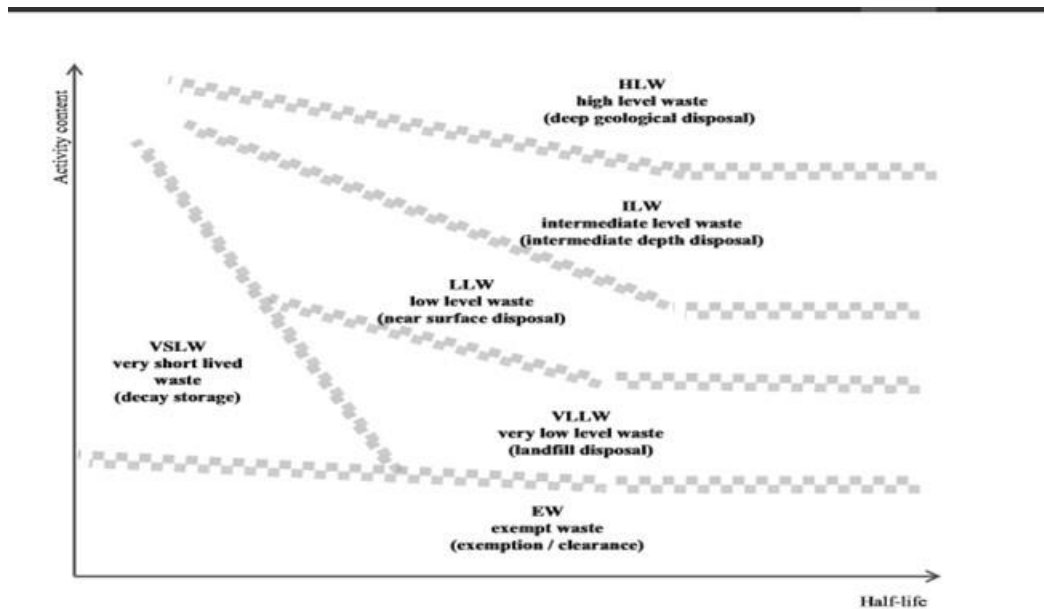


FIG. 1. Conceptual illustration of the waste classification scheme.

NORM in oil and gas industry are presented in following table:

TABLE II. NORM IN OIL AND GAS PRODUCTION

Type	Radionuclides	Characteristics	Occurrence
Ra scales	Ra-226, Ra-228, Ra-224 and their progeny	Hard deposits of Ca, Sr, Ba sulphates and carbonates	Wet parts of production installations Well completions
Ra sludge	Ra-226, Ra-228, Ra-224 and their progeny	Sand, clay, paraffins, heavy metals	Separators, skimmer tanks
Pb deposits	Pb-210 and its progeny	Stable lead deposits	Wet parts of gas production installations Well completions
Pb films	Pb-210 and its progeny	Very thin films	Oil and gas treatment and transport
Po films	Po-210	Very thin films	Condensates treatment facilities
Condensates	Po-210	Unsupported	Gas production
Natural gas	Rn-222, Pb-210, Po-210	Noble gas Plated on surfaces	Consumers domain Gas treatment and transport systems
Produced water	Ra-226, Ra-228, Ra-224 and/or Pb-210	More or less saline, large volumes in oil production	Each production facility

Source: IAEA SAFETY REPORTS SERIES No. 34. 2003. Radiation Protection and Management of

Radioactive Waste in The Oil and Gas Industry.

TREATMENT OF RADIOACTIVE WASTE BASED ON ITS FORM

Treatment of aqueous waste

According to IAEA 2001, the common processes in treating aqueous radioactive waste are ion exchange, chemical precipitation, and evaporation.

Both D-D and DT CNGs have advantages and disadvantages. These challenges triggered scientists and engineers to develop the technology. The latest are shown below.

Chemical precipitation

For radioactive waste effluent containing large amounts of particulates or high concentrations of inactive salts, precipitation might be used for treatment. The operational cost is low, and allows the treatment of large volumes of aqueous waste.

Ion exchange

Ion exchange means replacing the cations or anions between a liquid solution and the solids containing ionizable polar group, for example resin beads. In its application for aqueous radioactive waste, the radioactive content on the waste effluent is transferred into the resin beads, in other words, into the solid volume which is smaller than the effluent volume.

Evaporation

The process is commonly used for the treatment of high, intermediate and low level waste effluents; in particular for the treatment of small volumes of highly active effluents. It is effective for concentrating salts, heavy metals, and various hazardous materials from the effluent.

Treatment of radioactive organic liquid

Radioactive organic liquid waste, may also contain biochemical hazards aside from radionuclides. The objective of the treatment is to reduce the volume of radioactive waste which requires storage, transport, conditioning and land disposal, eliminating the organic components to enhance compatibility of the treated waste with secondary conditioning processes.

Incineration

Incineration is used for reduction of solid and liquid radioactive waste volume, downscaling land requirements for disposal.

The disadvantages of radioactive waste treatment with incineration are that an off-gas filtering system is required to control radioactive discharges, thickening and dewatering waste pretreatment may be required, and it is not economical for small solid waste plants.

Distillation

Distillation is a process of reducing the volume of radioactive waste. The process is simple, known, and cost effective if the valuable solvent is recycled or reused. The active residue could be either immobilized or destroyed by incineration.

Treatment of solid waste

According to IAEA 2001, in the handling, storing, and disposing of radioactive solid waste, treatments aimed at reducing the volume of waste are needed.

Decontamination

Decontamination is the removal of contamination from areas or surfaces of facilities or equipment by washing, heating, chemical process, etc. The purposes of decontamination are to reduce the volume of equipment and materials requiring storage and disposal and to remove contamination from components or systems. Decontamination processes may be divided into chemical, electrochemical and mechanical processes.

Compaction

The purpose of compaction is to reduce the volume of the solid waste and to concentrate the radionuclides.

Cutting

The main purpose of this process is to reduce the size of solid waste, which will be useful for the incineration process or packaging process for disposal.

Crushing

Glass, concrete, ceramics, and other friable solids need size reduction to ease the incineration process. Hence, the crushing process is used.

Shredding

The purpose of the shredding process is to reduce the void space. The air trapped between the folds of bulk waste is removed in this treatment step.

Incineration

This is the treatment of wastes by combusting them, and the success of the process is affected by size reduction, mixing, and blending of the waste.

TREATMENT OF RADIOACTIVE WASTE FROM OIL AND GAS INDUSTRY

According to IAEA 2001, the radioactive waste treatment is to minimize the volume of waste which requires management. The radiological and physicochemical properties of waste directly affect the selection of the treatment process. The following figure shows the treatment of NORM waste from the oil and gas industry.

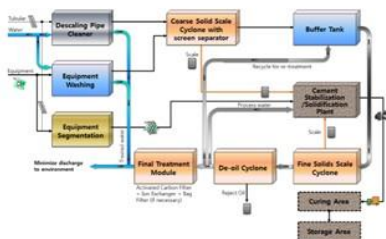


Figure 2. NORM waste treatment system Concept

A. Descaling Cleaner

Descaling Process will operate two descaling lines, one using an automated jetting, designed specifically for the decontamination of tubular and the other jetting unit for manually cleaning other items such as valves, flanges and pumps.

B. Separating Processes by multi-steps of cyclones

Scale will be washed away with process water from tubular or contaminated equipment in Descaling Cleaner.

C. Final Treatment Module

The principal target of the final water treatment module is to treat the influents for reuse in the NORM descaling process. And the recycling of water in multi-steps of cyclones and a series of filtering creates an efficient treatment because of the repeated process.

D. Solidification/stabilization plant

The solidification or stabilization plant is to immobilize radioactive waste with cement. All radioactive wastes will be finally solidified in condition with integrity. Scale solids from the cyclone will be directly transferred to the solidification or stabilization plant for its immobilization.

DISPOSAL OF RADIOACTIVE WASTE FROM OIL AND GAS INDUSTRY

Radioactive waste should be managed in a way that takes into consideration the impact on the health of future generations and do not exceed levels which are accepted today.

Activity	Half-life		
		Very short-lived Half-life < 100 days	Short-lived Half-life < 31 years
Very low level	Stored to allow radioactive decay, then disposed of adopting conventional solutions	Surface disposal facility	
Low level		Surface disposal facility	Shallow disposal facility
Intermediate level			
High level		Reversible deep geological disposal facility	

Source : French National Radioactive Waste Management Agency. June 3, 2014.

CONCLUSION

Radioactive materials are extensively used in industrial research and activities in medical, agricultural and environmental applications, and in various other areas. In the oil and gas industry, the radioactive materials are used in exploration, producing, refineries, etc.

The treatment of radioactive waste is divided into liquid waste treatment, organic liquid waste treatment, and solid waste treatment. The liquid waste treatments are ion exchange, chemical precipitation, and evaporation. The organic liquid waste treatments are incineration and distillation. And the solid waste treatments are decontamination, compaction, crushing, cutting, shredding, and incineration.

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