

MINIMIZING WASTE FROM THE OIL INDUSTRY: SCALE TREATMENT AND SCRAP RECYCLING

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ABSTRACT

Naturally occurring radioactive material is technologically concentrated in the piping in systems in the oil and gas industry, especially in the offshore facilities. The activity, mainly Ra-226, in the scales in the systems are often at levels classified as low level radioactive waste (LSA) in the industry. When the components and pipes are descaled for maintenance or recycling purposes, usually by high-pressure water jetting, the LSA scales arising constitute a significant quantity of radioactive waste for disposal.

A new process is under development for the treatment of scales, where the radioactive solids are separated from the inactive. This would result in a much smaller fraction to be deposited as radioactive waste. The radioactive part recovered from the scales will be reduced to a stable non-metallic salt and because the volume is significantly smaller than the original material, will minimise the cost for disposal.

The pipes, that have been cleaned by high pressure water jetting can either be reused or free released by scrapping and melting for recycling.

INTRODUCTION

Studsvik RadWaste AB is a part of the Studsvik group and situated in Nyköping, Sweden.

Since the 1970-ties low level organic burnable waste, originating in NPPs, hospitals and from fuel producers, has been incinerated by Studsvik RadWaste AB. Since the 1980-ties Studsvik RadWaste has also worked with melting of metals (steel, aluminium, copper and brass) from the nuclear industry and fuel products in order to recycle the metals for unconditional release. Studsvik RadWaste AB also works with intermediate level waste, both generated at the Studsvik site during the early days and waste produced today.

Project management for D&D project is also within the range of Studsvik RadWaste. In a large on-going project one of the old laboratories in Studsvik is decontaminated and measured in order to lift the radioactive classification for the building awaiting the final decommissioning of that building.

Recently there has been more and more questions regarding radioactive material from the non-nuclear industry which has also been attracting attention from the media. The main issue for Studsvik RadWaste has been handling of metals in form of piping and other components.

BACKGROUND

There are several industries apart from the nuclear industry where radioactive waste is or can be a problem. Example of such industries is the oil & gas industry, phosphogypsum/phosphate industry and mining. In these industries the radioactivity has its origin in the bedrock. This kind of contamination is usually referred to as TENORM (Technically Enhanced Naturally Occuring Radioactive Materials).

In this paper the oil and gas industry in the northern part of the North Sea will be in focus.

SCALE

The oil and gas TENORM-contamination arises in the piping, pumps, valves and tanks used in the drilling and oil-extraction processes due to so-called scale which is mainly a precipitation containing radioactivity. The radioactivity in the scale is dominated by radium and its daughter nuclides. The origin of the radioactivity is of course the natural occurrence of uranium and thorium in the bedrock.

Scale formed in the oil and gas industry is, according to the literature [see for example 1], mainly barium sulphate. Barium sulphate is a substance more or less famous for its very low solubility product. Since radium is a chemical analogue to barium, radium will naturally accumulate in the scale matrix of barium sulphate, which will then become radioactive and in need of treatment/ handling according to the local regulations.

Scale is often removed from piping with high-pressure water-jetting. This results in a slurry of scale, water and some oil which can be radioactive or not. The piping from which the scale is removed are often slightly contaminated as well, due to cracks and corrosion on the pipe-walls.

In other parts of the North Sea the radium is not the main contamination. In parts where gas is extracted Po-210 and Pb-210 is the most important contaminant due to the decay of radon in the gas. This is a separate problem and is not considered in the current proposed procedure.

SITUATION IN THE NORTH SEA

As a Swedish company it was most natural to look close to Sweden to understand this new industry, and the first oil-rich area was the North Sea, which also has special regulations.

Around the world in the oil and gas industry there are waste containing radioactive substances such as Ra 226, Pb 210 and others. Whether these are labelled radioactive waste is a question of legislation, which also controls the handling of such waste. In the North Sea the OSPAR convention [2] regulates what can or cannot be released into the sea. The headline of the OSPAR convention is "A convention for the protection of the marine environment of the north-east Atlantic".

The Convention has been signed by all Contracting Parties to the Oslo Convention and to the Paris Convention (Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Netherlands, Norway, Portugal, Spain, Sweden, and the United Kingdom of Great Britain and Northern Ireland), Luxembourg, Switzerland and the Commission of the European Communities.

The OSPAR convention has several annexes. Annex I and annex III are the annexes most relevant for the oil and gas industry. Annex III is denoted "Annex III- on the prevention and elimination of pollution from offshore sources". Annex III, Article 3 says that:

- Any dumping of wastes or other matter from offshore installations is prohibited.
- This prohibition does not relate to discharges or emissions from offshore sources.

Where "Dumping" means

- any deliberate disposal in the maritime area of wastes or other matter
 1. from vessels or aircraft;
 2. from offshore installations;
- any deliberate disposal in the maritime area of
 3. vessels or aircraft;
 4. offshore installations and offshore pipelines

This means that for the North Sea that the disposal of scale into the sea is not an acceptable way of disposing of large volumes of radioactive material.

There are also other forces [see for example 3] working to totally stop any discharges of radioactive material to the North Sea, although the main object is the releases from reprocessing plants.

The handling of waste from the oil and gas industry varies very much around the world. To serve as examples Norway and UK/Scotland has been chosen [4].

Table I. Comparison of UK and Norwegian handling of NORM waste from the oil/gas industry.

	Clearance limits (Bq/g)	Waste handling Off-shore	Waste handling On-shore
Norway	Ra-226 10	grinding < 1 mm	Intermediate storage at oil-sites, according to regulations from NRPA, awaiting final storage
	Ra-228 10	discharge at sea	
	Pb-210 10		
UK	Pb 0.74	grinding < 1 mm (>98% of total weight)	Two ways: 1 release into the sea 2 collection into 200 l drums, solidified with concrete or plaster
	Po 0.37		
	Ra 0.37		
	Th 2.59		
	U 11.1		

HANDLING OF SCALE – A NEW APPROACH

Based on the experience from waste treatment for the nuclear industry and with the same approach, development of a method for treatment of radioactive material from the oil and gas industry was started. The aim was to minimise the final waste volume and to produce a waste, which will not chemically or biologically degrade over long time and maybe produce chelates, as in a final storage, or being contained in a non-solid matrix.

The aim is supported by the intention that the majority of other materials, for example steel from piping, after treatment which no longer are classified as radioactive shall be recycled.

There is also the intent of the method to meet environmental demands as they are agreed upon today and also to meet demands that might be more restrictive in the future.

In the oil and gas industry today there are radioactive material identified on several of the large oilfields [5-8 and references therein]. Depending on the regulations and legislation the handling of the occurring TENORM material are very different from site to site.

From the above given prerequisites a process which can handle both the scale and scrapped steel piping was designed.

The procedure is divided into two parts, one for the metal and one for the scale. Descaled and scrapped piping can be melted in order to simplify the clearance procedure if the authorities or the industry demand it.

The scale is treated in a separate procedure in which the radioactive components are separated from the non-radioactive components. This means that the amount of radioactive waste that need handling and disposal is minimised, and therefor also the costs. The procedure also ensures that the waste is dry, not biodegradable or contains any chelates, which is essential for the repository, especially if the repository is in contact with water

The process is yet in it's development stage but so far a volume reduction factor of at least 20 is reasonable. This means that the amount of waste after treatment is only 5 % of the original volume.

HANDLING AND RELEASE FROM REGULATORY CONTROL OF DESCALED METALS

Studsvik RadWaste is today treating low-level scrap metals from the nuclear industry. The aim for the treatment is to release the metals from regulatory control and to recycle the metals outside the nuclear industry. Studsvik RadWaste has a permit to store material for 20 years awaiting decay of the radioactivity.

At Studsvik all scrapped metal are melted in one of the induction furnaces. The induction homogenises the melt and one sample is representing the whole batch, 3.5 tonnes of steel. This makes proving the activity content for clearance of the metal very easy.

Since uranium cannot be stored for decay and since the are metals contaminated with uranium that can be re-used Studsvik RadWaste AB has, in the last few years, developed a method for decontamination of steel from uranium during the melt process. This method can be used for TENORM contaminated material as well.

With these experiences a handling and clearance of material from the oil and gas industry can be done according to regulations.

Melting of these materials in an induction furnace has the advantage that any radioactivity left in the metal is homogeneously distributed.

How this material will be released from regulatory control is under implementation in many countries today and the outcome is to be seen.

CONCLUSION

The oil and gas industry in the North Sea is today not processing their scale in order to decrease the volume. If this is forced upon them or not is to be seen in the future. However, continuing to dispose of radioactivity into the North Sea is not an acceptable long-term solution.

Sulphate scale from the oil and gas industry can be processed in order to minimise the waste volume, the total radioactivity content will however not decrease.

Metal scrap from the oil and gas industry with residual radioactivity can be melted, in order to prove the activity content to the authorities. It is also likely the metal will be further decontaminated from the heavy elements as well as from lead and polonium during the melting process. It has been shown that it is possible and feasible to decontaminate steel from uranium.

All of this taken together will be of benefit for the oil and gas industry when decommissioning of oil rigs will take place, in some area in the near future and in other areas later.

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