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DECONTAMINATION-MELTING OF URANIUM-CONTAMINATED METAL

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ABSTRACT

Studsvik RadWaste AB (SRW) has since the mid-1980ies handled radioactive metal in form of scrap and larger components through segmentation and melting. When necessary, pre-treatment through decontamination (chemical and/or mechanical) has also been applied.

Recently, SRW has successful carried out decontamination melting on uranium contaminated stainless steel with the aim to free-release and recycle this material.

This paper describes the experience from the treatment and indicate how this can be used as a new service offered by SRW.

BACKGROUND

Since start in the mid-80ies SRW has been melting roughly 5000 tons of scrap metal from the Swedish sites and from sites abroad. For the melting process two induction furnaces are used.

Material for melting has been received from Germany and several other European countries. Scrap metal delivered in containers or as larger components like steam generators, turbines and heat exchangers have been treated. The treatment consists of decontamination and segmentation before melting for free-release and recycling.

For decontamination SRW has developed its own one-step, room-temperature, non-chelate containing method – based on the use of ozone - which have been patented in several countries including Europe, Japan and the USA.

The melting process is not only relevant for the expected volume reduction but also for the homogenisation of activity in order to allow for a careful determination of the correct activity level.

A third effect, which is obtained through melting, is decontamination due to the fact that some nuclides are caught in filters, like Cs-137. It is under this aspect the value of decontamination melting of uranium–contaminated scrap metal has to be considered.

THE MELTING FACILITY

A new melting facility is under construction during 1999 to establish a new workshop ready by the new millennium. In the facility for treatment and scrap melting there are two induction furnaces in carrousel geometry to provide maximum efficiency. Each furnace has a capacity for steel of approximately 3.5 tons – resulting in 10-15 ingots per 8 hours working day, see figure 1 below.

Figure 1 Pouring the melt into a mould

During the night shift preparatory work is done as concerns sorting and cutting to prepare for the next days melting work. The new workshop will therefor have abundant space for pre-treatment using various mechanical methods, for different types of segmentation methods and for laboratory work in connection with chemical decontamination. It is the laboratory that will provide the background for the new service comprising "melt-decontamination" of uranium-contaminated metals.

PRINCIPLE

The principle of decontamination of uranium-contaminated material during melting is to get the uranium to transfer into the slag. This is achieved by using additives. Depending on the material and the level of activity the procedure may be carried out in one step or as a repetitive procedure – even a couple of times to obtain a resulting level of activity for free-release.

As concerns Co-60, which usually is the main nuclide (the "key nuclide") with a half-life of 5 years, free-release levels can be obtained during decay storage. On a case by case basis SRW can obtain a permit to store the resulting ingots for decay for up to 20 years. In these 20 years the key nuclide, Co-60, can decay for approximately 4 half-lives, resulting in a decrease of the residual activity by a factor of 16.

For uranium the half-life is much longer and therefore reaching free-release levels by waiting for the necessary decay-period is not relevant. It is therefore mandatory to reach free-release levels for the material within the process of melting.

TREATED AMOUNTS

SRW has successfully treated more than 200 tons of ferritic scrap metal using special additives for the developed decontamination method. The obtained levels for free-release were in most cases much lower than the limit value set by the authorities.

Two different campaigns have been performed. In these campaigns we have treated material of different initial activities, between 1 and 45 Bq/g as mean values and with peak values as high as 100 Bq/g. For the lower level categories we have achieved decontamination below the requested levels with one melting routine. For the higher level-categories, the melting routine had to be repeated. The repetition is quite time consuming and the next step is to optimise the process.

The Studsvik approach for the melt decontamination service is

- decontamination of uranium contaminated scrap during melting
- measurement to prove the residual activity content
- minimise waste volume
- free release of this material

The measurement of such low levels is a problem by its self. These measurements are conducted in an independent measurement laboratory at Studsvik. The activity is measured as U-235 and takes at least 8 hours and measuring times as long as 24 hours has been used.

REGULATIONS FOR FREE RELEASE

Clearance can be given either on the basis of the Swedish Radiation Protection Institute's regulations or with special permission. In the case of clearance in accordance with regulations, the activity content (total activity) may not exceed 0.5 Bq/g of which no more than 0.1 Bq/g may consist of alpha-emitting nuclides. This clearance procedure results in the unrestricted reuse of the material.

Studsvik's procedure for clearance in the case of material with a radioactivity content of a maximum of 1 Bq/g (total activity including not more than 0.1 Bq/g α-activity) means, in cases where the activity content exceeds 0.5 Bq/g, that special permission must be granted by the regulatory authority. This level was considered to be appropriate since the melted metal, in the form of ingots, was sent to steelworks where it was re-melted. During re-melting, the Studsvik ingots were mixed with other scrap metal originating from non-nuclear activities.

Studsvik has a permit to store the ingots if clearance can be given within 20 years. In cases where ingots cannot be given clearance within 20 years, the ingots are returned to the owner. The secondary waste is always returned to the owner.

RESULTS

Two campaigns of stainless steel has been melted and decontaminated during the melting. The total amount of material melted is 236 tonnes.

The first campaign was 112 tonnes. After the initial melting 59 tonnes were subject to re-melting for decontamination. Since the material has been measured for activity once it was easy to calculate a decontamination factor (DF). The DF for these ingots was between 5 and 75 have been obtained depending on the initial activity. Of this first 59 tonnes of scrap metal 51 tonnes could be free released (i.e. 86 %), generating 2.3 tons of slag (i.e. 4 %). From the total of 112 tonnes melted in the end 102 tonnes could be free-released (i.e. 91 %), generating 3.9 tonnes of slag (i.e. 3 %).

The residual activities after decontamination melting of 0.015 to 0.085 Bq/g have been obtained, which is – compared to the limitation level of 0.1 Bq/g – a successful and very satisfying result.

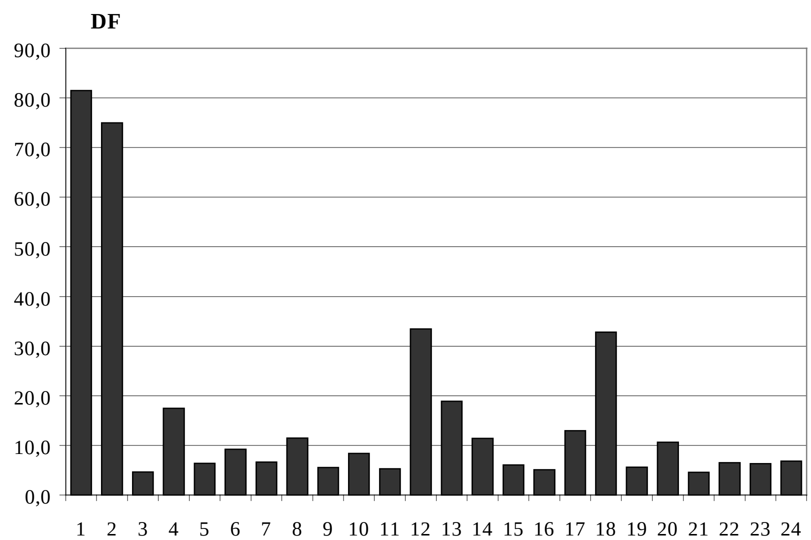

Figure 2 DF from the first melting campaign

The second campaign 114 tonnes of scrap was melted. The material could be divided into three fractions

Table 1. The second campaign

Activity level (Bq/g)	Weight (tonnes)	DF mean value
1 – 2	52	26
10 - 20	42	227
40 – 45	30	348

The campaign resulted in 124 tonnes of ingots, of which 117 tonnes are free releasable and 7 tonnes of slag (i.e. 5.5%). The ingots, which are not free releasable directly will be re-melted including treatment with the decontamination process.

FUTURE

In the new melting facility other new decontamination methods will be implemented. A new mechanical decontamination equipment, i.e. a blasting machine, will be installed. The next treatment process to be introduced into the facility after that will be a chemical decontamination equipment.

In this new facility there will also be a hall for development of new processes to further improve the performances and to test new treatments of the incoming scrap.

One of the first steps in the new development hall is to investigate the best method of pre-treatment of the incoming material. The aim of this further development is to optimise the secondary waste of the process even further than today.

CONCLUSION

Studsvik RadWaste AB has developed a process to decontaminate stainless steel melts from uranium contamination. The decontamination during the melting process has proven to be a success. Of the 236 tonnes treated scrap 218 tonnes are directly free releasable. The rest can be decontaminated again to reach the limit of free release.