RECYCLING AND DISPOSAL OF BY-PRODUCTS AND WASTES ORIGINATING FROM MELTING OF NORM-SCRAP

Dr. M. Hamm
Siempelkamp Nuklear- und Umwelttechnik GmbH Co. KG, Krefeld

1 ABSTRACT

Siempelkamp operates a melting-plant for chemically contaminated scrap. An additional contamination through naturally occurring radioactivity is presently accepted up to 500 Bq/g. The facility is licensed in accordance to BImSchG (Federal Law on protection against environmental pollution). During the past 4 years of operation app. 5.000 t of chemically or NORM contaminated scrap have successfully been processed. 1,300 t of this material was NORM-contaminated. After treatment, the iron is free of contamination. As a by-product the slag is taken off the melt, and is usually amounting to 5 to 9 % and can be processed for reuse as road construction material, whereas the resulting filter dust is often cross-contaminated, e g. by mercury, thus a safe disposal has to be ensured.

2 PROCESS

In 1998, the GERTA-plant for melting NORM and chemically contaminated scrap started operation. (GERTA: **G**rosstechnische **A**nlage zum **R**ezyklieren **t**oxischer **A**bfälle: large scale plant for recycling hazardous waste)
Based on the experience collected by melting slightly radioactively contaminated scrap over 10 years, Siempelkamp has developed this recycling process, the centre of which is a furnace with a capacity of 8 t.

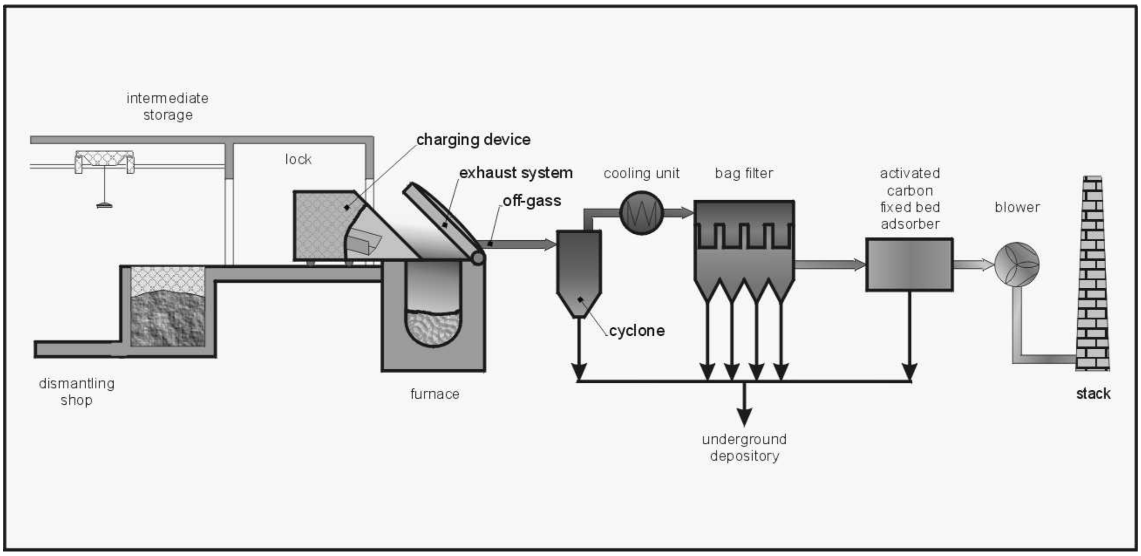

Fig. 1: Recycling Process in the GERTA-plant

All incoming material first has to pass through the dismantling area, located in the GERTA hall and separated from the furnace area by a gate. Various machines and cutting equipment are used to dismantle all material down to chargeable sizes. Vessels and all receptacles are opened, to enable the removal of residues of mercury. In case of any mercury evaporation, the air in this area is filtered by an exhaust system with a capacity of 40.000 m³/h.
For intermediate storage, until starting a melting campaign, three storage bunkers are available to store enough material for a two week melting campaign. These bunkers allow a separation of materials from different origins.
The scrap is then taken from the bunker and filled into the charging device, which automatically rolls through the gate to its end-position above the furnace. In this position, the charging device is closely connected to the furnace so that the off-gas can be extracted into the filter system.
The melting process in the 8 t-net-frequency-induction-furnace has to be started with a 3 t sump of liquid iron followed by a batch of 5 t of scrap. The furnace can be operated in the temperature range from 1,350°C up to 1,500°C. In the upper temperature range a special furnace lining is necessary.

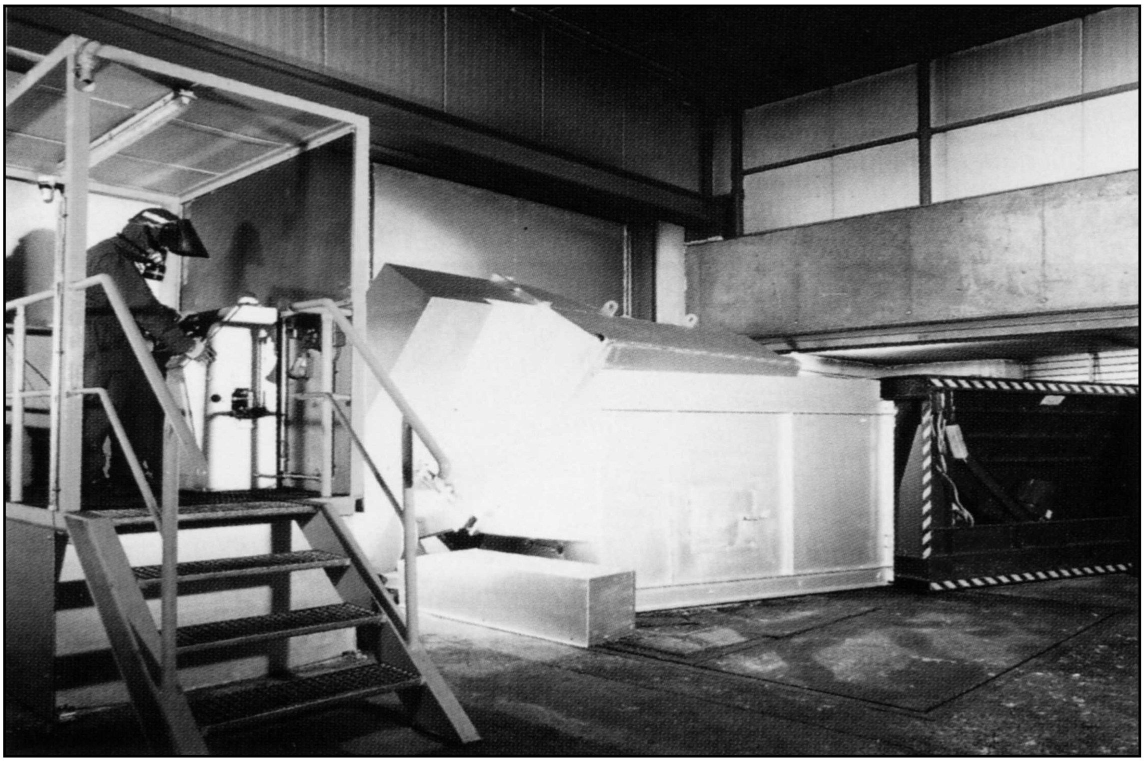

Fig. 2: Furnace

By the process impurities are transferred into the slag, swimming on the surface of the melt or they are evaporated and absorbed by the dust which is then extracted and filtered. As the majority of NORM-scrap is from the oil and gas industry and the radioactive impurities consist in a large amount of Radium and its decay products. After removal of the slag, the melt is cast into the ingot mould.
Mercury evaporates from the melt and passes through the exhaust cover to the filter plant, which consists of four steps, a cyclone, a cooler, a bag filter and a

fixed-bed-absorber. In the cyclone, coarse dust is separated, in the bag filter fine dust is separated. The fixed-bed-absorber with activated carbon is doped with sulphur and serves for the separation of mercury. In the cooler, the off-gas is cooled to lower temperatures to secure an optimum of efficiency for the bag filter.
This combination of filters prevents the mercury concentration in the chimney stack from exceeding 50 µg/Nm³, which is only ¼ of the permitted value.
As NORM-scrap is processed, radionuclides that vaporise, especially lead, condense and are absorbed by the dust and retained in the bag filter.

3 INCOMING MATERIALS

The specification for incoming steel scrap originates from restrictions based on foundry processing. Organics like plastics and rubber are limited to 5 wt-%. Mercury is limited to 1 wt-% of the steel mass.

Fig. 3: Incoming Material at Siempelkamp

At present, the radiological acceptance limit for scrap is 500 Bq/g total specific activity averaged over the whole steel mass. Cavities in the delivered scrap must be avoided for safety reasons. Lead is not accepted and the amount of aluminium and wolfram is restricted.

4.1 OUTPUT

4.1 Iron

At a melting temperature of approx. 1,400°C mercury is vaporising and being retained in the filter system and the NORM-radionuclides transferred into the slag. Thus the metal is free of contamination and can be used in the iron and steel industry.

4.2 Slag

The slag, approximately 4 % of the input, is free of toxic impurities and can be processed to road construction material. The total specific activity must not exceed 500 Bq/g according to the German radiation protection ordinance, and the activity of Ra-226 is restricted to 65 Bq/g. Finally the slag passes through a processing plant, thus producing road construction material.

4.3 Filter dust

Only 1 - 2 wt.-% of the input-material is dust retained in the bag filter and in the cyclone. Both kinds of dust are mixed with quick lime and then filled into storage drums.

The chemical contamination of the dust, in particular the content of mercury, prevents recycling.

Underground storage in rock salt mines provide a solution to dispose hazardous wastes, and is long approved as being safe for the environment. The Südwestdeutsche Salzwerke AG operate suitable mines near Heilbronn, their contractor UEV Umwelt, Entsorgung und Verwertung GmbH offers this environmental service.

Rock salt is mined in the Heilbronn area at a depth of 200 m, only the lower part of the 40 m salt seam is excavated. The size of the caverns is 15 m x 200 m with a height of 18 m. They are used for disposal since 1986. The waste drums are transported underground by forklifts and shaft cage-lifts, then trucks carry the materials to their final position. The cavern is being filled from the far end towards the entrance, and the drums are covered with anhydrite and clay originating from salt-refining. In this way the room is filled layer by layer. Finally the remaining hollow space will be filled with the remains from the salt-refining industry.

In order to deposit the dust resulting from the melting of NORM scrap, a radiological expertise must confirm that the dust complies with the acceptance criteria for underground disposal. Additionally the agreement between the city of Heilbronn, Baden-Württemberg and Südwestdeutsche Salzwerke AG has to be taken into consideration. It excludes materials that have to be transported under ADR-classification 1, 2, 3 and 7. ADR-classification 7 deals with the transportation of radioactive materials, and is valid for a total specific activity of > 70 Bq/g. This means that the total specific activity of the dust has to be less than this value.

As a second criterium, the filter dust must not be radioactive in the sense of the German Radiation Protection Ordinance. This criterium is fulfilled for NORM-materials, if the presently total specific activity is below 500 Bq/g.

According to the amendment to the German Radiation Protection Ordinance, the expertise must also confirm that there is no additional radioactive exposition to the public, as there could be external exposition, inhalation of the filter dust and ingestion of contaminated soil, ground- and surface water. Most paths of exposition can be excluded by hardening the dust with quicklime, then packing it into drums and finally covering the drums by salt. In the end, each cavern will be hermetically closed.

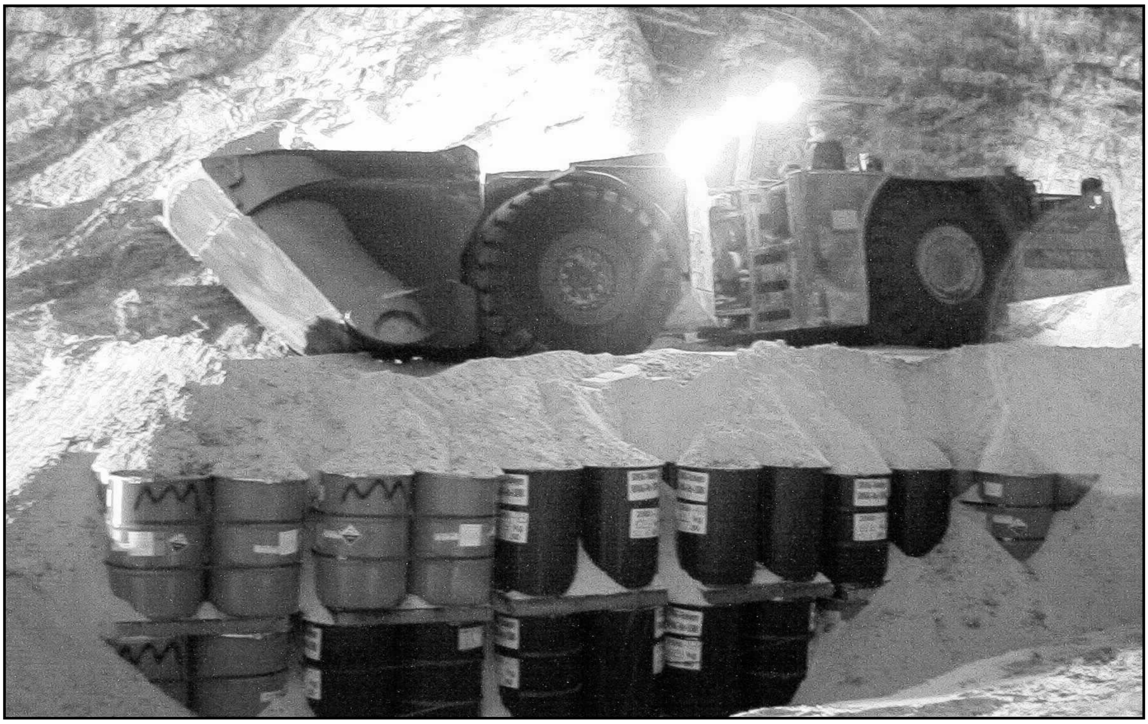

Fig. 4: Underground disposal in the salt cavern at Heilbronn.

Until the closure of the salt mine, only the air leaving the mine due to the air-conditioning could be a path of exposure to the public. Radon as a leading nuclide of naturally occurring radioactivity could diffuse from the drums and reach the surface-air. But this exposition is negligible compared to the natural radon emission of the mine.
The annual dose-rate for the workers handling these wastes will be far below 10 µSv/a and is therefore negligible, even so in the case of damaged packaging.
Siempelkamp also has to ensure that the waste is delivered in a dust-free condition. To meet this requirement, the air filter system had to be modified. Quicklime powder is blown into the system, the dust is retained in the bag filters and the heavier particles are retained in the cyclone, both are then collected in a mixer. Water is added to the dust, and after being thoroughly mixed the sludge is fed into a drum lined with a plastic-bag, where it hardens due to the hydrate amounting to app. 1% in the quicklime.
A sample is taken from each drum and is analysed by gamma-spectrometry. If the total activity is below 70 Bq/g (the limit for radioactive transport according to ADR) the waste is released for underground disposal at Heilbronn.
The licence for the disposal of filter dust at Heilbronn was issued to Siempelkamp in October 2000. Since then, 40 Mg of dust resulting from melting at Siempelkamp's GERTA-plant has been disposed at Heilbronn up to now.

5 REFERENCES

1. Quade, U., Kluth, T., NORM II 2nd international symposium, Proceedings, Nov. 10 – 13, 1998, p 95 – 101

2. Hamm, M., NORM II 2nd international symposium, Proceedings, Nov. 10-13, 1998, p 132 – 136

3. Good, B., Natural Radiation and NORM, Conference documentation, London, Sept. 30, 1999