

Product Control of Waste Products with New Coating Materials - 9301

H. Krumbach, H.-J. Steinmetz, R. Odoj
Research-Center Jülich GmbH (FZJ)
D-52425 Jülich, Germany

W. Wartenberg
nuclitec GmbH
D-38110 Braunschweig, Germany

H. Grunau
Eisenwerk Bassum m.b.H
D-27211 Bassum, Germany

ABSTRACT

In Germany, with the shaft KONRAD a repository for low radioactive waste will be available at the earliest in the year 2013. The previously conditioned radioactive waste has to be suitable for a longer-term interim storage. They have to be treated in a way that they are chemically stable and that their integrity is guaranteed for a long time. That's why the waste product or the container is covered/ coated for special waste such as hygroscopic waste or waste that includes aluminium.

The Product Control Group for radioactive waste (PKS) has to proof the suitability of the so-treated waste for the repository KONRAD on behalf of the Federal Office for Radiation Protection (BfS). This has to be done before the delivering. In this context the PKS also assesses the suitability of new coating materials for low radioactive waste products or containers and their correct technical application. The characteristics and the technical application of polyurethane coatings as well as the control of the so-coated waste for the disposal in the shaft KONRAD are described in this poster.

The Poster shows the development stages of the coating and the filling. There are also shown the boundary conditions and the investigations of the Product Control Group for the use of the new coating material for radioactive waste.

INTRODUCTION

After a long legal dispute one decided in 2007 that the former iron ore mine KONRAD (Salzgitter, German Federal State of Lower Saxony) can be expanded and used as a repository for low level radioactive waste. The technical requirements for the storage of radioactive waste are expected to be realized as of 2013.

By the time radioactive waste has to be conditioned and interim stored according to the final conditions requirements for disposal radioactive waste - „Anforderungen an endzulagernde radioaktive Abfälle – Schachanlage Konrad“ [1] (Stand: Dezember 1995).

The waste products or waste packages must be chemically stable and technically in perfect condition until the date of the disposal. Regarding different wastes such as ash, concentrates (hygroscopic waste) or waste with aluminium, the integrity of the packaging shall be ensured by a special anti-corrosion coating. Before the application of such a coating their suitability has to be examined by experts and released by the Federal Office for Radiation Protection.

Because there is currently only a technical application for polyurethane coating it is also only part of the assessment by the product inspection for radioactive waste.

In the context of two research projects, the possibilities for the coating or backfill of waste products were inspected.

In this context the Institute of Materials Engineering at the University of Dortmund accomplishes long-term studies of polyurethane (PU) coated samples [2].

The second research project at the Institute for Energy Research 6 (IEF-6) of the Research Center Juelich, deals with the implementation of silicon plastics as coating or filling materials [3].

A major focus of those investigations was to ascertain the suitability of both materials in terms of corrosion-protection.

The using of silicon plastics as coating or backfill is mainly based on theoretical considerations and laboratory tests. These investigations show that silicon plastics can be used for the filling of containers with radioactive waste and are not suitable for the coating of radioactive waste products.

The Product Control Group has to conduct studies in order to assess the suitability of various coating materials. Those investigations prove, whether these new coating materials are in line with the disposal conditions requirements for radioactive waste „Anforderungen an endzulagernde radioaktive Abfälle - Schachanlage Konrad [1] (Stand: Dezember 1995)“.

POLYURETHAN COATING

The coating with polyurethane is the most developed process in the industrial application.

A polyurethane coating is used as corrosion protection for the walls at the dock "Benser - Siel" in a long time test. There, the materials demonstrated the effectiveness as a corrosion protection for more than 20 years. The investigations by the Department of Materials Technology at the University of Dortmund also assess the suitability as a long-term corrosion protection.

In nuclear technology polyurethane was initially used as corrosion protection for KONRAD containers.

Besides using it as a serious corrosion protection for KONRAD – containers (Fig. 8), the polyurethane coating is also used for waste products.

The coating of waste products can be used for corrosion protection as well and on the other hand; the material properties of polyurethane can be used as a further protective effect for the waste products.

The coating with polyurethane avoids the penetration of oxygen in hygroscopic waste other chemical reactions in the waste products can be blocked also. The basic property such as fire behaviour and thermal properties of polyurethane were examined in the approval of the coating material as a coating for disposal containers.

The PKS evaluation covers the technical suitability for coating material for waste products (water permeability, impact strength). Several techniques are used for the application of polyurethane. The common techniques for the coating of KONRAD – containers and barrels are spray proceedings, while the coating of super compacted waste is made by cast proceedings.

Suitability as a coating material for radioactive waste products

To study the suitability of a polyurethane coating various tests with a polyurethane coating were arranged. The coating of the samples was enforced at the ironworks Bassum. The following tests were accomplished at first:

- coating of corroded underground
- test of the water permeability of polyurethane.

In order to test the coating of a corroded underground, a corroded (rusty) inactive empty 200-liter barrel (Fig. 7) has been coated with polyurethane. A 200-liter barrel was filled with inactive concrete (Fig. 6) to study the permeability of polyurethane. By adjusting the 200-liter barrel in a bigger seized water-filled barrel it was possible to control, if the water passes through the coating.

The barrel was over pressured in order to accelerate the test. During the rest of the tests for the polyurethane coating the test series were extended by the following points:

- coating of non-metallic Underground
- Coating uneven bodies

The grip of polyurethane on a non-metallic substrate was tested as an extension of the coating Ytong stones experiments. Polyurethane should not only be used for the after treatment of barrels, but also to prevent the moisture absorption in pellets. For this reason has been the test extended again. For this purpose inactive pellets were coated.

The intention of this experiment was to show that even a wrinkled body can be coated with polyurethane and that rather a bridging of deep wrinkles on the surface of the pellets is possible.

Spray coating method

The following figures 1 and 2 shows the principle process of a drum coating with polyurethane. The waste drum was coated by a spray coating method with polyurethane. As shown in the figures (Fig. 1-3), the test items were also coated with polyurethane



Fig. 1: Coating with Polyurethane



Fig. 2: Finishing of work



Fig. 3: Polyurethane coated barrel

To control the quality of the coating a visually flawless, completely and evenly applied coating is necessary. Also the compliance of the prescribed thickness is important. The measuring instrument shown in figure 4 (Fig. 4) is used for checking the thickness of the coating.



Fig. 4: Coat thickness measuring



Fig. 5: Hammer scale on dummy

After finishing the coating with polyurethane, the coating is so cured, that it resists to a simple hammer test. After several hardly hammer scales the coating bursts of from the test item (Fig. 5).



Fig. 6: Inactive drum



Fig. 7: Corroded drum



Fig. 8: Empty container

In the first step of the tests, the containers and drums, which are shown in the figures (Fig. 6-8) above, were coated with polyurethane by the ironworks Bassum company. There was no specific treatment before starting the coating of the containers. The specimen should be coated with their usual surface, because the surface of the old waste packages also should not be treated before coating. The effort and the cost should be minimized thus by the reconditioning

In the further progress two standards Ytong stones (Fig. 9) and the dummy pellets (Fig. 10) were used as a sample for testing.

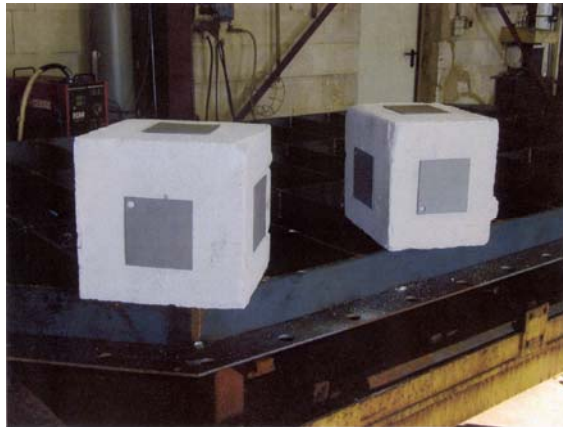


Fig. 9: Ytong stones with metal plate



Fig. 10: Sample pellet

There were three points of interest, at first is there a possibility to fix polyurethane at corroded undergrounds, at second is polyurethane able to pass a permeable water test (Fig. 12) and at last is there an opportunity to fix polyurethane at non-metallic undergrounds (Fig. 11). For this test two Ytong stones (with the dimension of 250 mm x 250 mm x 200 mm) were coated with polyurethane.

To repeat the failed experiment of the water permeable test, the company ironworks Bassum expanded their not metallic substrate test with the controlling of the permeability of water through polyurethane.

The two with polyurethane coated Ytong stones were weighted (Fig. 11) and placed in a drum (Fig. 12). The drum has been also filled with water and charged with an overpressure of 0.2 bar.



Fig. 11: Coated Ytong Stones



Fig. 12: Ytong Stone in the drum

After 14 days the Ytong stones had been taken out of the drum and weighted again (Fig. 13). Before the test started the first Ytong stone had a weight of 8220 g. At the end of the test the weight didn't change. After the test the weight of the second stone was 10 g higher than before.



Fig. 13: Coated and weighted Ytong stones

If water gets through the polyurethane coating of the test items, both test items should be heavier. Due to the fact that only one of the test items had a higher weight, the coatings had to be controlled more exactly. No bumps or pores could be detected on the coated Ytong stones. Therefore the water has no opportunity to pass through this polyurethane coating. The test items are coated permanently.

It seems that the higher weight of 10 g is a mistake caused by the first measurement. At the end of all tests two dummy pellets were coated with polyurethane to proof this treatment. One Pellet has been coated completely with polyurethane.

The second pellet has been coated to the half and sawed off afterwards (Fig. 14). On the sawed pellet the thickness of the polyurethane coating can be seen. Unevenness (crinkles) on the pellet has been covered with polyurethane. The coating is permanent and its adherence is good. The test to coat unevenness / crinkles bodies was effectually.



Fig. 14. pellet half coated with polyurethane

Cast proceeding

The practice showed that the coating of pellets with spray technique is difficult to handle. As a consequence the method has been developed and improved. During the treatment with polyurethane coating for pellets, which included aluminium, cast proceeding (Fig. 15-18) were used.

The coating was necessary to stop the reaction between aluminium, metal and concrete. For the cast proceeding the pellet was put in a form (Fig. 15), which has a smaller diameter at the underside as the pellet. Then a border for the filling of the upside of the pellet was created. In the second step the upside was filled with polyurethane (Fig. 16). The coated pellet is immune for environmental conditions and it can be handled with a vacuum gripper (Fig. 18).

As part of the product control, this process is suitable for the protection of objectives in accordance with the disposal requirements for radioactive waste „Anforderungen an endzulagernde radioaktive Abfälle - Schachtanlage Konrad [1] (Stand: Dezember 1995)“.



Fig. 15: pellet in a cast form



Fig. 16: grouting of a pellet

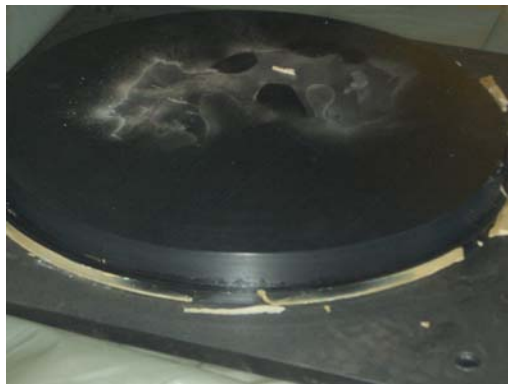


Fig. 17: bottom form



Fig. 18: coated pellet

CONCLUSION

The PKS's own assessments concerning the acceptability for reposition of new coating materials have shown that the polyurethane coating of radioactive waste products is adequate.

Polysiloxane which has been investigated alternatively at the beginning is not suitable as a coating. Because this material is permeable to air it has only got a limited protective function.

The coating of radioactive waste products or containers with polyurethane can be used in cast proceeding as well as spraying procedures. For drums and containers the spray technique turned out to be advantageous. For super compacted waste (pellets) the cast proceeding has got considerable advantages.

The suitability of polyurethane as corrosion protection has been demonstrated by studies at the University of Dortmund and in practice by the coating of a port basin.

For reasons of economy the polyurethane coating is used only for problem waste.

The coating meets the demands of the final repository for radioactive waste "Schachanlage KONRAD".

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