

REDUCTION OF WASTE DISCHARGE BY UNDERGROUND DISPOSAL OF PROCESS RESIDUE LIFE ENV/UK/000603

Potash in the European Union

The European Union is a major producer, consumer and exporter of potash (potassium chloride) more than 90% of which is used in fertiliser production. Other uses include specialist chemical manufacture, glass making and pharmaceuticals. Potash is produced in five EU member states – France, Germany, Italy, Spain and the United Kingdom and employs around 10,000 people across the EU.

Waste disposal in potash production

The production of potash involves the separation of the valuable product from largely inert waste materials. These waste materials typically comprise a coarse soluble component, mostly sodium chloride or other salts, and a fine-grained insoluble clay. Traditionally, these wastes have been disposed of either by discharge into coastal waters and rivers or by storage in surface disposal facilities. In an attempt to reduce the requirement for discharge of waste material into the environment and the necessity of extensive surface disposal facilities, the industry is evaluating alternative waste disposal strategies.

The Boulby Mine

Cleveland Potash Limited (CPL) currently supplies some 55% of the United Kingdom's potash consumption from its Boulby Mine, which has been operating since 1973. The mine is located within a National Park on the north-east coast of England. Workings extend down to 1500m below ground level and as far as 7km underneath the North Sea.

Given the sensitivity of the location, surface waste disposal is not a favoured option and the mine currently disposes of all its waste into the North Sea. Environmental concerns arising from the impact of the clay component of the discharges, together with plans to increase the scale of production at the mine, have focussed attention on alternative options for waste disposal.



Boulby Mine, Cleveland, United Kingdom

Alternative waste disposal strategies

Alternatives to the surface disposal of wastes or discharges to coastal waters and rivers have been evaluated at mining operations worldwide. The practice of returning some or all of the waste produced into worked-out underground voids (“back-filling”) has been adopted at many sites. Until recently, a combination of the physical characteristics of potash wastes (high water content, low strength and long consolidation times) and the nature of the underground environment (very low humidity and high temperature) has prevented this practice being applied in potash mines. In particular, there has been real concern within the industry that the introduction of liquid wastes into the very low humidity underground environment could result in deterioration in the structural stability of the workings with serious implications for health and safety.



Worked out area of mine suitable for waste disposal

The project objectives

Initial laboratory research work commissioned by Cleveland Potash Limited in 1996 identified measures that have the potential to overcome the practical constraints to backfilling in potash mines. From November 1998, the development of this laboratory-based research work into a demonstration project with the construction and operation, firstly, of a pilot-plant and, secondly, of a full-scale demonstration plant has been funded through the LIFE ENVIRONMENT Programme. The key objectives of the project are :

- To develop a specification for a mixture of the fine clay component of the waste with some of the coarse soluble salt waste and cementitious additives to produce a waste product with defined and consistent density/flow characteristics, high water retention and high compressive strength suitable for underground disposal.
- To develop and demonstrate the technology necessary for the transport of the waste under gravity and subsequent placement in worked-out areas of the mine over a distance of up to 11km from the plant site.
- To evaluate the potential for the use of the waste product as structural support within the underground workings, a practice that would allow the mining of pillars of potash minerals currently required to be left in situ to maintain the integrity of the workings thus ensuring a more efficient utilisation of the resource.

Laboratory testwork

During testwork performed at The University of Nottingham's School of Chemical, Environmental and Mining Engineering, more than 80 potential combinations of soluble and insoluble waste materials were tested with nine binding agents to evaluate their suitability for the long-term stabilisation of a placed waste slurry. Of particular interest were early development of strength following binder addition, the retention of water present in the waste and overall solidification times. In particular, many mixtures were found to release “free” water during consolidation, a characteristic that would prohibit use as backfill. However, one mixture comprising a 3.3:1 ratio of coarse soluble salt to insoluble clay combined with a controlled quantity of cementitious binding agent and mixed with seawater to achieve a constant relative density of 1.6 did meet all the test criteria.



Underground salt road along which waste will be transported in a pipeline

The pilot scale test programme

A pilot scale waste plant was built both to confirm the engineering criteria necessary for the production of the optimum waste mixture and to test the infrastructure necessary for the transport of the waste mixture and its placement underground. The pilot plant, designed by ECS Engineering Consultants with input from Cleveland Potash Limited, was constructed in late 1999 and comprised :

- Waste collection systems
- Pipeline transfer systems
- Mixing tanks
- Header tank and pipe network for gravity flow testing.



Pilot plant in operation

In addition to confirming on a larger scale the findings of the laboratory testwork, the pilot plant enabled potential operational issues such as changes to waste characteristics during pumping and possible solidification of waste within the pipeline system to be evaluated and overcome.

The full-scale demonstration plant

Design of the full-scale demonstration plant commenced in the summer of 2000. At the same time, the operational criteria for waste disposal underground were developed and the identification and quantification of areas suitable for such disposal were undertaken. Exercises to simulate the effects of underground waste disposal on the low humidity mine atmosphere were also performed.

The need to clarify the status of the proposed backfilling operation in relation to anticipated developments in the EU policy and regulations regarding waste disposal delayed construction of the demonstration plant. The decision to proceed with the backfilling of wastes was only made following discussions with representatives of the European Commission and the UK Government.

Construction of a full scale demonstration plant with the capability to dispose of 155,000m³ per annum of slurry containing the insoluble waste material was completed in early 2003. After an extensive phase of commissioning and operating trials, CPL began routing waste disposal operations underground in May 2003.



Waste mixing trials using the pilot plant

Further information

Further information regarding the Reduction of Waste Discharge by Underground Disposal of Process Residue LIFE ENV/UK/000603 can be obtained from :

Matt Wilkins
Cleveland Potash Limited,
Boulby Mine, Loftus, Saltburn, Cleveland TS13 4UZ,
United Kingdom
or at matt.wilkins@clevelandpotash.co.uk

Mark Dodds-Smith
Mineral Industry Research Organisation,
1 City Square, Leeds, LS1 2ES,
United Kingdom
or at mark.dodds-smith@miro.co.uk

