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THE CHEMICAL TREATMENT OF RADIUM HILL CONCENTRATES

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GENERAL INTRODUCTION

The deposits of a uranium bearing ore at Radiun Hill have been known for some 50 years. Since their discovery, the field has been exploited twive commercially for the recovery of radium and other products. However, both ventures were unsuccessfully on account of treatment difficulties and the limited market for radium and other products.

With the presence of rutile and ilmenite in the ore, research chemists also considered the possibility of recovering titania, but to ate this has not been successful commercially.

Within the last five years due to the spectacular interest in uanium and its potential sources for production of industrial power, the Radium Hill deposits have been reviewed to determine the feasibility of recovering uranium economically.

Several methods have been considered including the traditional methods of sodium carbonate fusion and sulphuric acid leaching, followed by the chemical precipitation methods to obtain a uranium phosphate.

More recently the Division of Industrial Chemistry CSIRO have investigated the possibility of nitric acid leaching followed by novel met ods of extracting the uranium from the nitric acid solutions. These processed have all been abandoned in favor of a sulphuric acid leaching procedure, followed by a process of ion exchange.

The benefit of the experience of American and British scientists have enabled this process to be quickly assessed in relation to Radium Hill concentrate, culminating in the erection of a chemical pilot plant to study on a large scale the technical and economic problems associated with this method of extraction the uranium.

Illustration 1 shows the building housing the pilot plant and labor atories

PROCESS DEVELOPMENT

The economic extraction of uranium from Radium Hill ores or concentrates has presented many uniques and difficult problems. The concentrates obtained from the mined ore are relatively rich in uranium, which is contained in the mineral davidite. Because of the mineral association in the ore body, the extraction of the uranium presents a special problem. Tests have shown that it is essential to leach the uranium using hot strong acid solutions, whereas the uranium bearing ores which hav e been exploited comercially elsewhere are all amenable to simple cold leaching processes.

This has necessitated a careful study of precise leaching conditions in order to make the extraction of uranium economic as the cost of plant for hot acid leaching is naturally high.

In this work the co-operation of C.S.I.R.O. Division of Industrial Chemistry the Chemical Research Laboratories of the Ministry of Supply of Great Britain and the American Atomic Energy Commission has enabled the devlopment of the process whic isnow under test in the Department's chemical pilot plant at Thebarton. This work is now in progress and is directed towards the design and erection of a full scale chemical treat-ment plant at Port Pirie which is to go into operation in 1954.

Sulphuric acid leaching is the bases of the uranium recovery and in the large scale operations a considerable amount ofthis raw material is needed.

LEACHING OF THE CONCENTRATE:

The concentrate received into the chemical treatment plant has been previously treated at Radium Hill to free it from undesirable materials, incldìng acid consuming minerals.

The concentrates is leached with strong sulphuric acid in stainless steel tanks. The charge is stirred for some hours during which time live steam is used to maintain the charge at boiling point.

Batch leaching methods are used and illustration No . 2 shows portion of the digestor used. It will be seen that the concentrated sulphuric acid is fed direct to the digestor by means of a pipe. Above the digestor is seen the motor and reduction gear driving the anchor type stirrer fitted to the digestor,

Illustration No 2 Digestors and limesslurry tank

During the leaching process most of the uranium is taken into solution, together with iron, titanium aluminium, sodium potassium and magnesium any calcium leached is precipitated as sulphate. After leaching the pulp is discharged into water for cooling and adjustment of the composition of the leach liquor.

RECOVERY OF URANIUM

The diluted pulp is agitated using air and the acidity reduced by the addition of limes. The conditioned pulp is pumped to a thickener for seperation of solids and liquid, the overflow running into a holding tank, the underflow being pumped bu diaphragm pump to a rotary vacuum filter.

The filter cake is washed with water and the residues discharged to waste. The filtrate is mixed with the overflow from the thickener after further adjustment. The liquor containing the uranium is passed to the subsequent treatment stage which includes an ion exchange process. The resulting uranium rich liquors from this process are delivered in to tank where ammonia is added to precipitate the ammoniun uranate which is subsequently filtered on pan filters dreid packed and stored.

EQUIPMENT USED IN THE PROCESS

The necessity of using strong acid at boiling point as the leaching liquor and the resulting liquors being acidic, present many corrosion problems in the plant. All the equipment used in the plant is constructed of acid resisting material and use is made of stainless steel, rubber lined tanks polyethylnene and other plastics to protect both internal and external surfaces.

The floor is protected against acid and the whole pilot plant area is suitably painted to protect against acid liquors and fumes.

Illustration No 3. General Arrangement of Pilot Plant
Showing the digestors, thickener and vacuum drum filter in the foreground

ANALYTICAL CONTROL

A control laboratory adjoins the plant and chemists work on a shift basis, seven dyas per week to do such analytical work as is required to keep the plant continuously in operation. Othe: assa s are undertaken by the Department's Analytical Section.

HEALTH REGULATIONS

It will be appreciated that with large quantities of u anium present both in the solid form and in solution and with the possibility of the presence of radium in the fine concentrate: and in the spent ore as finely dispersed radium sulphates every care must be taken to safeguard the health of employees.

A rigid procedure for changing of clothes of personnel engaged in work, washing before meals and showering at the finish of work, is in operation at the plant. In addition regular medical checks of personnel are undertaken to safeguard operative's health. To ensure that the radiation level is at a minimum the plant is monitored to check the radiation level in the area.

CONCLUSION

This plant is beign operated on a pilot scale to check the process with a view to using the information and data obtained for the erection of a chemical treatment plant at Port Pitie. To date the pilot plant has been successful in its operation and has shown some of the difficultues which can be anticipated in the large scale operation of such a process. Modifications to the flowsheet are already under way but it is anticipated that adequate information will be available for the operation of a large scale plant in 1954.