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PROJECT C-361
ENGINEERS' FLOW SKETCH AND PROCESS DESCRIPTION
METAL CONVERSION FACILITIES FOR COMMENT ISSUE

The attached Engineers Flow-Sketches and Process Description for the contemplated Metal Conversion Facilities are being transmitted for your information and comment.

We would like to arrange a Comment Meeting for Thursday, May 10, 1950.

JM Frame:CG Bragg:khs

J. M. Frame
Project Engineer
Design & Construction Divisions

By:

C. G. Bragg

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A. Introduction

The Metal Conversion Process described herein is designed to handle the combined output of decontaminated uranium from both the Redox and T.B.P. processes. Thus the design rate is 13-1/8 short tons per day. The bulk of the equipment is to be installed in the presently unused 224-U Building. The feed storage tanks, the gas absorber and gas cooler will be outside but adjacent to this building.

B. Process Description

1. General

The process has been divided into two steps.

- 1) Acid Recovery & Uranyl Nitrate Concentration.
- 2) Uranyl Nitrate Conversion.

The major items of equipment and flows thru the plant are shown on the attached Engineers' Flow Sketches, numbered SK-2-50005, and SK-2-50006.

2. Acid Recovery & Uranyl Nitrate Concentration

The products of this system are concentrated uranyl nitrate, 60% nitric acid, 40% nitric acid, and water. Since it will take about three years to exhaust the uranium bearing material now stored underground, after which time the plant will run at a reduced rate, this section of the plant has been split into two parallel and identical systems. The flow from the feed storage tanks and thru either half of the acid recovery and uranyl nitrate concentration system may be described as follows:

Feed from Redox and TBP, composed of uranyl nitrate in dilute nitric acid, is received alternately in either of two 60,000 gallon working capacity, vertical cylindrical storage tanks. This is equivalent to a total storage of two days feed. These tanks are equipped with side-entering agitators and steam heating coils and are provided with recording instruments for temperature, specific gravity, and liquid level.

After required mixing and sampling, uranium-containing liquor is fed to the evaporator by horizontal centrifugal pumps. Liquor flow is regulated by a flow controller.

The evaporator affects concentration of uranyl nitrate by continuously boiling out water and nitric acid. Concentrated uranyl nitrate overflows from the evaporator system to a heated storage tank. The evaporator system consists of a vertical tube evaporator heated by steam on the shell side, a centrifugal separator to de-entrain liquid in the overhead from the evaporator and circulating lines between these vessels. Control of evaporator operation is by a temperature sensing element in the liquid return line from the

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separator to the evaporator which resets a flow controller regulating steam to the evaporator shell. Vapors of water and nitric acid flow overhead from the separator to the nitric acid fractionator, where the nitric acid is concentrated to sixty weight per cent for re-use.

Uranyl nitrate bottoms are held in an agitated heated storage tank under temperature control. A submerged pump circulates uranyl nitrate thru a loop header to the decomposition pots (see (3) following).

The nitric acid fractionator is a conventional bubble tray tower which produces 60% nitric acid as a bottom product. Overhead water vapor is condensed and part is returned to the tower as reflux. The excess condensate goes to cribbing. Control of bottoms product quality is maintained thru a specific gravity recorder resetting a flow controller regulating steam to the tower reboiler. Top tower temperature is recorded.

Bottoms product from the fractionator flows to a 600 gallon working capacity cooking tank equipped with agitator and water coils. Record of specific gravity and temperature is provided, and flow out of the tank is by level controlled submerged pump.

Condensate required for reflux is pumped to the tower by a submerged pump in the condensate tank. Level control maintains this tank full and by-passes excess condensate directly to cribbing. The condensate tank has a working capacity of about 600 gallons.

Hot gases from the uranyl nitrate decomposition pots (see (3) following), consisting of water, nitric acid, air and oxides of nitrogen, are cooled in the gas cooler and partially converted to dilute nitric acid. Cooled uncondensed gases from the cooler flow to the nitric acid absorber. The gas cooler is equipped with a flow controller on the cooling water and a flow recorder to measure the uncondensed gases.

The absorber is a bubble tray tower, with cooling coils on each tray to remove the heat of formation of dilute nitric acid. Water for this absorption is fed into the top of the tower, the rate of water feed being regulated by a specific gravity recorder in the absorber. The remaining oxides of nitrogen are converted to nitric acid here.

Dilute acid condensed in the gas cooler and dilute acid bottoms from the absorber are combined into one stream and pass downward thru a small packed stripping tower where they are stripped with air to remove traces of dissolved NO. The stripping air is returned to the bottom of the absorber. The quantity of stripping air is regulated by a flow controller.

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Bottoms from the stripping tower flow into the 40% nitric acid tank which is equipped with an agitator and a submerged pump, and has a working volume of 600 gallons. Nitric acid is pumped out under level control. Record of specific gravity and temperature is provided.

3. Uranyl Nitrate Conversion

This step of the Process involves the thermal decomposition of uranyl nitrate to the tri-oxide, and the subsequent handling and packaging of the product. Proper ventilation of the area where these operations take place must be provided. The majority of problems in this step are of a mechanical nature.

Uranyl nitrate pumped from the storage tank is circulated continuously through a loop with individual take-offs to each decomposition pot, and is drawn off to the individual pots as required.

Eighteen pots are provided, each pot being about 30" inside diameter by 30" deep overall. This size will allow adequate freeboard for a charge having a net UO_3 content of about 600 pounds. Based on a 600 pound yield per batch and with a time cycle as described below, sixteen of the eighteen pots will be in operation, and the remaining two pots will be available for spares. Each pot is provided with an electric furnace, rated capacity 50 KW. Regulation of the decomposition of uranyl nitrate will be secured by variation of temperature with time.

One operation cycle for a pot is as follows:

<u>Operation</u>	<u>Time</u>
Load	10 min.
Heat Up	2 hr. - 40 min.
Decompose	3 hr. - 0 min.
Final Heat	20 min.
Cooling	40 min.
Unload	10 min.
	<hr/>
	7 hr. - 0 min.

Calculation of the foregoing time cycle is based on reports of G. E. observers at Mallinckrodt.

Decomposition pots are provided with anchor type agitators, turning at about 40 RPM. These agitators clear the pot wall by about 1/8", in order to aid in transfer of heat to the salt. The agitator is powered with a 7½ HP drive, since just prior to complete conversion to UO_3 the mixture goes through a "plastic" stage where its consistency is that of a heavy dough.

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Gases evolved by the decomposition of UNH are drawn to the gas cooler, and treated as described in part (2) above.

The handling of uranium tri-oxide powder is discussed briefly below. It will be treated more fully in design instruction letters now in preparation, as it is primarily a mechanical problem.

UO₃ powder product is unloaded with a vacuum type pneumatic conveyor after shutting off the gas line to the gas cooler. The complete system is composed of unloading lines with flexible hose connections to each pot, a combination cyclone separator and product receiver, a "sock-type" bag dust collector and a centrifugal exhaust. The product receiver is emptied by a rotary valve since it is under a negative pressure of about 5 psi. The unloading system is designed to unload a maximum of four pots simultaneously. The discharge of the exhaust passes through the ventilation system dust collector as a final clean-up (see below).

In order to minimize dusting which will take place during unloading handling, and packaging of UO₃ powder, a separate ventilation system has been provided for the pot room and loading facilities. The system will produce an air velocity of 400 FPM across the pots during unloading, and is also used to produce a slight negative pressure in all material hoppers and lines. The ventilation system consists of the required ductwork, a combination cyclone separator and dust hopper, a continuously cleaned tube type bag house (Hersey patent), and an exhaust fan. The discharge of the exhaust fan is through the existing large stack to atmosphere. The dust hopper discharges through a rotary valve.

Instrumentation of the pneumatic unloading and dust collecting systems consists of draft gauges, material level indicators and smoke detectors to signal the presence of ruptured bags.

UO₃ collected in the product receiver and in the dust hopper is fed out by rotary valves and drops by gravity through a crusher which reduces the particle size to 100% through 80 mesh. The UO₃ is now ready for packaging and a weight actuated packaging system is shown on the flow sheet. Final make-up of this system awaits information from the AEC as to the size and nature of containers desired.

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