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AUTHOR

S. J. Beard and W. C. Schmidt

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PUREX PLANT TEST OF THE CESIUM PHOSPHOTUNGSTATE PROCESS

By

S. J. Beard and W. C. Schmidt

Purex Process Engineering
Research and Engineering
CHEMICAL PROCESSING DEPARTMENT

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INTRODUCTION

The Chemical Processing Department's Waste Management Program includes removing greater than 95 per cent of the cesium-137 and strontium-90 prior to solidification and final storage as a salt cake. One of the processes developed for removing cesium from high level acid waste (IWW) is precipitation of cesium as cesium phosphotungstate. This process has been demonstrated in the laboratory on a liter scale with full level Purex IWW.

The purpose of this test was to demonstrate on a plant scale the flowsheet developed in the laboratory by H. H. Van Tuyl.

SUMMARY

Approximately 98 per cent of the cesium in Purex IWW was removed by a single phosphotungstate precipitation. Decontamination factors from the other isotopes could not be determined due to cross-contamination between feed and product streams. Chemical costs for this process were approximately $22.00 per ton of uranium processed to produce the IWW.

DISCUSSION

The process for removal of cesium from acidic Purex waste is composed of five steps. These steps include precentrifugation, precipitation, centrifugation, cake wash, and cake removal. Figure 1 is a chemical flowsheet neglecting the precentrifugation step.

Precentrifugation of the Purex IWW is necessary to obtain good decontamination factors from the other fission products. Purex IWW is 0.4-0.8 M sulfate ion and with the acidity reduced to 1-2 M by denitration with sugar, gross quantities of the fission products except cesium are precipitated. Without precentrifugation, these precipitants would follow the cesium throughout the process.

After the IWW has been precentrifuged and the precipitated fission products have been removed from the bowl, the solution is sampled for fission product content. The cesium is precipitated by the addition of .017 M phosphotungstic acid to the centrifuged solution. The phosphotungstic acid is added to a final concentration of 0.0024 M and digested for one hour at ~ 25° C.

The precipitated cesium was separated from the supernatant liquor by centrifugation. The solution was transferred at ~ 25° C at a rate of ~ 10 gpm to a centrifuge which develops a centrifugal force of 1500 G. The bowl hold-up time at this rate is estimated at 9 minutes.

The precipitated cesium cake which is now held in the centrifuge bowl is washed with 1 M nitric acid to provide additional decontamination from the other fission products. The cake is washed by slurrying with four separate shots of 1 M nitric acid. The nitric acid is introduced to the cake and the interior of the centrifuge bowl via high pressure sprays. The wash solution and the supernatant solution are combined in the waste tank and sampled.

The precipitated cesium in the centrifuge bowl is removed by dissolving with 1 M sodium hydroxide. The cake is dissolved by slurrying with six separate shots of 1 M sodium hydroxide which is introduced to the centrifuge bowl via high pressure sprays. Due to the size of the product tank, dilution water was added to provide sufficient volume in the tank to obtain good agitation and a representative sample. In a properly designed plant, this dilution water could be eliminated. The product tank is sampled to provide process control for the recovery of cesium and decontamination from the other fission products. In this test, the sampler on the product tank was found to be inoperable. An acid flush of the feed tank was made and the product solution was moved to this tank. The cesium product was sampled in the feed tank, but cross-contamination from the feed sample prevents calculating true fission product decontamination factors. See Table I for a material balance of this process test run.

The chemical cost of this process is $22.00 per ton of uranium processed to product the IWW. Ninety-seven per cent of the total cost is contributed by the phosphotungstic acid. See Table II for a breakdown of the chemical costs.

TABLE I

CESIUM PHOSPHOTUNGSTATE RUN
MATERIAL BALANCE

	Cesium	Per Cent Of Feed
Feed	100	
Waste		1.5
Product	___	92
Material Balance	100	93.5

No material balance on fission products other than cesium was made due to the malfunction of sampler equipment.

TABLE II

CHEMICAL COSTS

CESIUM PHOSPHOTUNGSTATE PROCESS

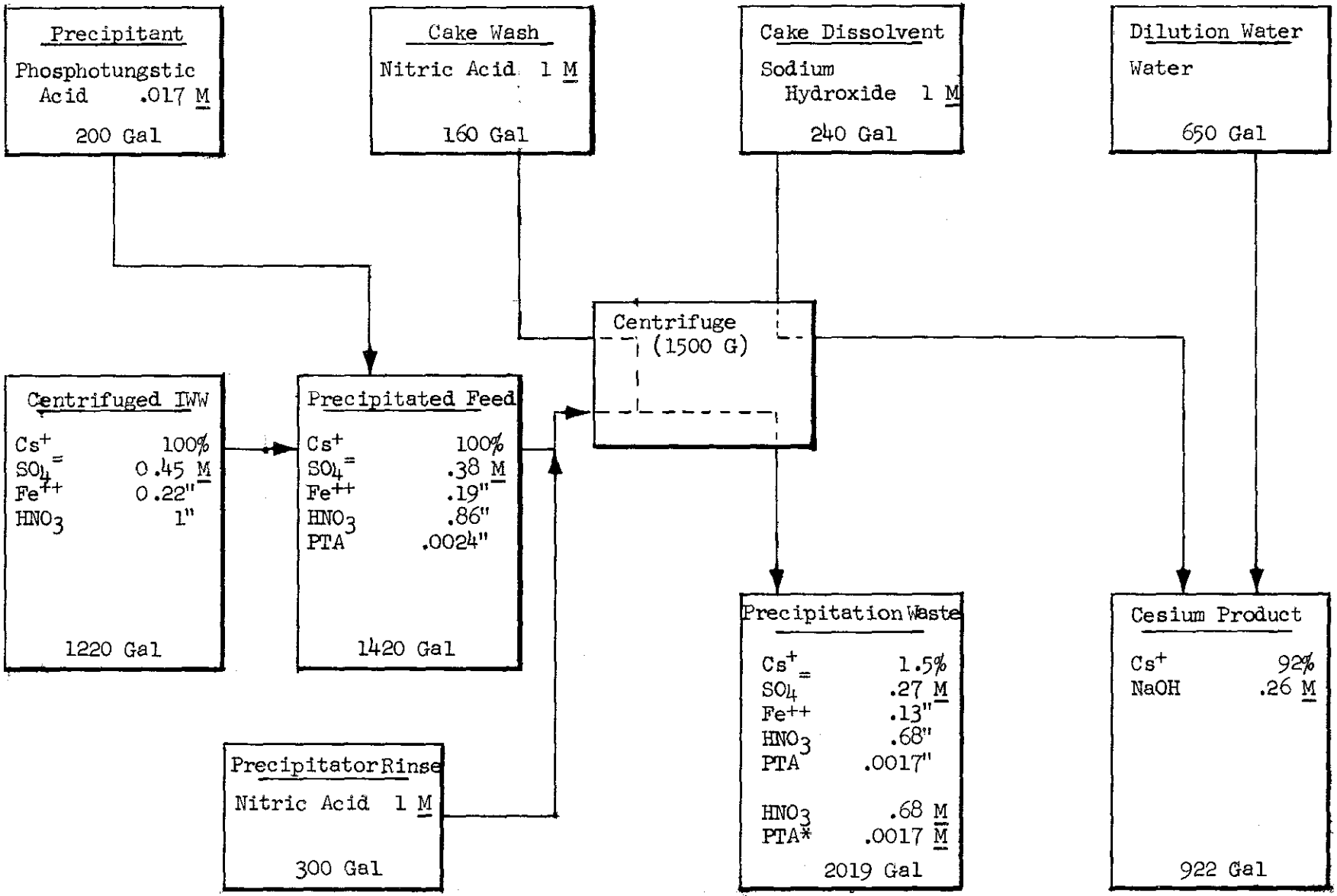
Amount	Total Lbs	$ Per Lb	Total $	Remarks
200 gal at .017 M	82	4.65	382.00	
460 gal at 1 M	242	.0264	~ 6.00	
240 gal at 1 M	72	.0287	~ 2.00	
460 gal at 1 M	138	.0287	~ 4.00	Needed to neutralize 1 M nitric acid in process
			394.00	

$$\text{Cost Per Ton U} = \frac{\$394.00}{17.7} = \sim \$22.00$$

The IWW used in this test was 70 gal/ton of U.

FIGURE 1

CESIUM PHOSPHOTUNGSTATE FLOWSHEET



*Neglects the phosphotungstate ion associated with the cesium in the product tank.