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PROCESS DESIGN SCOPE CRITERIA
PUREX MULTIPURPOSE DISSOLVERS

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PROCESS DESIGN SCOPE CRITERIA
PUREX MULTIPURPOSE DISSOLVERS

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Separations Process Design Engineering
Facilities Engineering Operation
Chemical Processing Department

October 15, 1963

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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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HW-79645

Page 3

PROCESS DESIGN SCOPE CRITERIA
PUREX MULTIPURPOSE DISSOLVERS

INTRODUCTION

An engineering study was recently performed by Separations Process Design Engineering to determine the feasibility of processing the total Chemical Processing Department production load in the Purex Plant. This document summarizes the results of the study and the basis for the scope design of the multipurpose dissolvers for the Purex Plant.

SUMMARY

The study indicates that it is feasible to process the total Chemical Processing Department production load, as defined in Reference 1, in the Purex Plant through the installation of annular dissolvers and supporting equipment. Annular type dissolvers are best suited for installation in the Purex Plant to obtain the high production capacity required in the utilization of only one processing plant for the total Chemical Processing Department load, to process safely 0.94% E-Metal, and to furnish the flexibility desired for future processing. With the installation of three annular, multipurpose dissolvers it will be possible to process all the natural metal, E-Metal, NPR fuels and PRTR fuels presently forecasted for the Chemical Processing Department, in the Purex Plant.

DISCUSSION

1. Production Capacity Requirements

As currently forecasted (Reference 1), the total production load of the Chemical Processing Department includes the processing of normal metal, E-Metal (0.95% U-235), NPR fuels and PRTR fuels. Future planning studies indicate a strong possibility that the Irradiation Processing Department will change some of the reactor loadings to include higher enriched fuels, up to 1.5% U-235, which must also be processed in the Chemical Processing Department.

Production capacity requirements are shown in Table I. Case 1 is the base case, Reference 1. The E-Metal production of Cases 3 and 4 are based on the predicted E-Metal production loads of Reference 2, and adjusted for equivalent plutonium production of Case 1. The total production requirements listed for Cases 2, 3, and 4 were arbitrarily chosen to provide a broad range of production for consideration in this study.

2. Dissolver Selection

To meet the production capacity requirements as predicted in References 1 and 2, and to provide the capability for processing safely higher enriched fuels, up to 1.5% U-235, annular dissolvers, similar to those which have been installed in the Redox Plant, are recommended for the Purex Plant Dissolver Cells, (A, B, and C).

DECLASSIFIED

HW-79645

Page 4

Annular dissolvers with a 12" wide annulus can be used for the dissolution of normal metal, E-Metal (0.94%), NPR fuels and PRTR fuels. To dissolve higher enriched fuels, above 0.95%, inserts will be added to the annulus to reduce the annular width.

Normal metal and 0.94% E-Metal can be dumped and dissolved in 12" annular dissolvers at a 4.0 CF processing rate. NPR metal can be charged either in canisters or by dumping, and PRTR fuel elements can be charged in canisters. Estimated capacity factors for dissolving the NPR fuels is 2.75 for charging by dumping, as shown in Table I, and 2.50 for canister charging. For future processing of higher enriched E-Metal a capacity factor of 4.0 is predicted for dumped fuels containing up to 1.5% U-235, in a 8" wide annulus. Canisterized E-Metal fuels, up to 2.0% U-235, would be processed at about 2.0 CF.

A summary of the estimated capacity of the annular dissolvers is shown in Table I.

3. Plant Operating Efficiency

Plant operating efficiencies are shown in Table I, for all production cases utilizing three annular, multipurpose dissolvers. Overall plant operating efficiencies of about 80% are required to process the forecasted production for the fiscal years of 1976-1968. Processing of higher enriched fuels, up to 1.5% U-235, require overall plant operating efficiencies of about 61%.

These data include plant clean-out time which will be required between the campaigns. One PRTR campaign per year will be performed. Due to the limitation of the NPR storage basin, of 500 ton storage capacity, three or four NPR campaigns per year will be necessary.

4. Nuclear Safety

A 12" wide annulus can be safely utilized to dissolve fuel elements containing up to 0.95% U-235, providing that adequate neutron absorbers are also installed. A 6" wide concrete (or masonite) ring with an exterior 30 mil. thick cadmium lining, installed inside and immediately adjacent the metal crib annulus, will provide the necessary neutron moderation. The concrete serves to slow down the neutrons for absorption by the cadmium.

To safely process higher enriched fuels, it will be necessary to reduce the annular width and also to install a neutron moderator at the outer periphery of the metal crib. This is achieved through the installation of inserts. A neutron absorbing steel appears very attractive for this use, since it can be utilized both for structural and neutron absorption purposes. At least two such steels are available, boron steel and gadolinium steel. Corrosion data for boron-containing steels do not appear favorable, mainly because of the high fluoride corrosion expected during the Zirtlex process used for decladding the zircaloy-jacketed NPR and PRTR fuels. Gadolinium steel corrosion data observed in the literature

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Page 5

appear more favorable. Hanford Laboratories has commenced a corrosion testing program for special gadolinium steel in the process solutions expected for our use. Lack of data on the welding and fabrication of gadolinium steels preclude use of these steels in the initial design of the new dissolvers. However, it appears necessary to use gadolinium or other neutron absorbing steels for the safe processing of higher enriched fuels along with the 12" wide annular crib.

5. Materials of Construction

Preliminary review of the zircalox corrosion data indicate that the most economical metal for use in the multipurpose dissolver is SS 304-L. The corrosive de-jacketing step is only about one-quarter of the overall NPR dissolution cycle or about 2% of annual on-stream time. A more resistant material, HAPC 20, is not commercially available at this time.

6. Problem Areas Requiring Additional Study and Development

Some of the problem areas which require additional development and study include: generation of gadolinium steel data, as mentioned above; techniques for dumping NPR fuels; zircalox technology; PRTR dissolution technology; and new canister designs required for processing of higher enriched fuels.

REFERENCES

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1. HW-70283, "Quarterly Forecast, July 1963 Through FY-1968," by D. McDonald, July 19, 1963.
2. Chemical Processing Department Operating Plan, 1962.

TABLE I

PUREX PRODUCTION CAPACITY

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Basis: New Dissolvers - annular type, with inserts for processing E-Metal above 1 per cent, dumping HPR Fuels (except Case 4).

Case 1. (Normally forecasted production)

	<u>FY</u>		<u>CF</u>	<u>Operating Days Rec'd</u>		<u>Annual % on Stream Time</u>	
	'67	'68		'67	'68	'67	'68
Normal	6250	6375	4.0	188	192	51.5	52.6
E-Metal	1540	1540	4.0	47	47	12.9	12.9
HPR	780	790	2.75	34	35	9.3	9.6
HPR-Nat'l	-	120	2.75	-	6	-	1.6
PRTR	(5)	(5)	-	1	1	0.3	0.3
Total Turn Around Time				<u>16</u>	<u>16</u>	<u>4.4</u>	<u>4.4</u>
Totals	8570	8825		286	297	78.4	81.4

Case 2. (Normal metal 50% of Case 1, E-Metal increased equivalent to normal).

Normal	3125	3188	4.0	94	96	25.8	26.3
E-Metal	3760	3804	4.0	113	115	31.0	31.5
HPR	780	790	2.75	34	35	9.3	9.6
HPR-Nat'l	-	120	2.75	-	6	-	1.6
PRTR	(5)	(5)	-	1	1	0.3	0.3
Total Turn Around Time				<u>16</u>	<u>16</u>	<u>4.4</u>	<u>4.4</u>
Totals	7665	7902		258	269	70.8	73.7

Case 3. (E-Metal production, predicted basis)

Normal	-	-	-	-	-	-	-
E-Metal	6150	6150	4.0	185	185	50.7	50.7
HPR	780	790	2.75	34	35	9.3	9.6
HPR-Nat'l	-	120	2.75	-	6	-	1.6
PRTR	(5)	(5)	-	1	1	0.3	0.3
Total Turn Around Time				<u>12</u>	<u>12</u>	<u>3.3</u>	<u>3.3</u>
Totals	6930	7060		232	239	63.6	65.5

DECLASSIFIEDNW-79645
Page 8Case 4. (E-Metal production, higher enrichments, predicted basis).

	FY		CF	Operating Days Req'd		Annual % on Stream Time	
	'67	'68		'67	'68	'67	'68
Normal	-	-	-	-	-	-	-
1.2% E-Metal	2020	2020	4.0	85	85	23.4	23.4
1.5% E-Metal	2425	2425	4.0	73	73	20.0	20.0
HPR	700	700	2.0	47	45	12.9	13.2
HPR-Nat'l	-	120	2.0	-	0	-	2.2
PRTR	(5)	(5)	-	1	1	0.3	0.3
Total Turn Around Time				15	16	4.4	4.4
Totals	6025	6155		222	231	61.0	63.5

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