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RECUPLEX DISSOLVER CRITICAL MASS

AUTHOR

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November 14, 1957

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RECUPLEX DISSOLVER CRITICAL MASS

Recent overcharging difficulties in the dissolvers has led to a review of the critical mass basis for the Recuplex dissolvers. Recommendations are made to establish a more accurate charge-in value (over the present accountability value plus rough check with the neutron counter).

Summary:

1. The estimated minimum critical mass limit for Recuplex dissolvers (D-1 and D-2) is 1450 grams Pu based on 100% water tamping, and that all the Pu must uniformly precipitate and be in suspension throughout the solution. If this does not take place, the estimated minimum critical concentration is 8 g/L (operational limit in Recuplex is 1.95 g/L). [redacted]

2. Normally 300 liters of solution are necessary before all Pu is dissolved or the minimum critical mass limit is 2400 grams providing the Pu does not precipitate.

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3. Precipitation of Pu can occur in two ways, one, by adding caustic to the dissolvers, a remote possibility, and secondly, by formation of a Pu polymer. A polymer can form in an acid deficient system; however, in the Recuplex dissolvers, if the system were acid deficient, the Pu would remain at the bottom of the dissolver safely undissolved. In both cases, the precipitation must occur uniformly and be in suspension throughout the dissolver. Once the precipitate reaches the bottom of the dissolver a higher critical mass limit is again in order.

4. As an example, an incident is cited wherein 1320 grams of Pu in solution was found to be in one dissolver charge. A subsequent clean-out of the dissolver netted 250 grams more, or a total of 1570 grams. With regard to critical mass danger, only the 1320 grams which were in solution should be considered, and since no precipitation occurred, the minimum critical mass limit was 2400 grams.

Recommendations:

1. It is recommended that the 1450 gram critical mass limit and the 700 gram operational limit be maintained.

2. The present neutron check constitutes only a rough check since it counts boxes. The geometry for counting boxes is poor and varies considerably, depending upon the distribution of Pu throughout the cartons. It is recommended that each carton be counted individually.

3. Pure Pu emits only spontaneous neutrons. Pu existing as compounds, such as PuO_2 and PuF_4 causes secondary neutron emissions (reaction of an alpha particle with light elements such as oxygen and fluorine) besides the spontaneous neutrons. The instrument settings used to date have registered the spontaneous emissions and almost all the α,n neutron emissions. (The α,n emissions were greater than 80% of the total.) The result has been a tremendous safety factor for powders and an untrustworthy safety factor for pure Pu. A study was made and it was found that at a gain of 64-7/8, 2100 volts, and a discriminator setting of 100 plus, about 3/4 of the lower energy α,n neutrons are screened out. It is recommended that these settings be established as standard for counting powders and SC material. These settings will give a fail-safe value regardless of the state of the Pu.

4. It is recommended that before and after each counting, the counter should be checked with a standard. A 627 gram piece of Pu is available for this check. The counts/min value of the standard will be posted on the counter.

5. It is recommended that the following equation be used to determine the current counts/min limit per charge-in:

$$(1200)(n\text{-}g\text{-}s)(K) = \text{counts/min allowable above background}$$

Where 1200 is the fail-safe value
n-g-s is the current neutron/gram/second value
and K is a constant

The neutron counter check gives a fail-safe value of 1200 grams. To ever attain this value the charge would have to be nothing but pure Pu and the Pu would have to exist in pieces greater than 627 grams. This value allows for a 250 gram heel in the dissolvers. The constant K is based on the 627 gram piece of Pu and is determined by the following equation:

$$K = \frac{(\text{counts/min of 627 g. piece of Pu})}{(627)(43)}$$

where 43 is the n-g-s of the 627 g. Pu pieces

6. The operational limit is set at 700 grams. The accountability value of all material charged to the dissolvers must be less than 700 grams.

7. As an added safety factor in counting slag and crucible cartons, it is recommended that any single carton (2 crucibles) in excess of 300 grams, as determined by the neutron counter, be set aside for special charging (low number of crucibles per charge).

Future Study:

It may be possible to distinguish between the different energy levels of neutrons directly from Pu and neutrons from alpha-neutron reactions (PuF_4). A study should be made to determine this possibility. If the lower energy alpha-neutron reactions can be screened completely, then the Pu can be accurately determined by the neutron counter.

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Finished Products Technology Operation
Research and Engineering Operation
Chemical Processing Department

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CURRENT RECUPLEX DISSOLVER LIMITS

Date: _____

Gain: _____ Voltage: _____ Discriminator: _____

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I. Nuetron Counter Check

	Counts/Min.	Instrument Setting on 2K x 100 Scale (a)
Background	_____	_____
Standard 627 g. Pu piece (subtract background from instrument reading)	_____	_____
Allowable charge-in limit	_____	_____

Grams by neutron counter (Reading on 2K x 100 Scale (b))

(_____) = grams Pu

NOTES: (a) If reading goes over 50, use 10K x 100 Scale and multiply reading by 5 to keep everything on the same basis.

(b) Always subtract background from instrument reading.

II. Accountability Value

Each single charge should contain less than 700 g. Pu.

The above limits hold for all types of charges, i.e., S & C alone, S & C plus powders, powders alone, Z crucibles, Z crucibles plus powders, etc.

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