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REA-DC-3 AND PROGRAM X

Process Tube Assembly - Design Criteria (Preliminary)

A. Process Tube Assembly General Requirements

The process tube assembly functions to provide a water-cooled channel through the reactor into which uranium slugs are inserted for processing. The channel consists of a cylindrical tube with 2 ribs towards the bottom of the inside diameter which supports the slugs in a central location. Thus providing an annular space around the slugs for the cooling water used to remove the heat generated by fission of the uranium.

Because of the relative movement between the graphite and the biological shield as the result of graphite growth and thermal expansion, the portion of the process tube which extends through the biological shields at the front and rear faces must be protected against sharp bends that would prevent movement of the slugs through the tube. This requires a design which will permit such relative movement, and maintain shielding around the opening through the shield.

In addition, the process tube assembly requires provisions for introducing the cooling water flow at each tube at the inlet or front face and for discharging the coolant at the outlet or rear face. Provisions are also required for opening the tube at the inlet and outlet faces to charge and discharge the slugs.

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B. Process Tube Assembly Design and Operating Requirements

1. Process Tube

- a. The process tube will have an active zone of 28.34 ft. making it 47' - 2" from vanstone to vanstone. It shall accommodate slugs 1.440" in diameter, centrally with an annulus between the slug and the inside diameter of the tube of 0.438 sq. in., to allow a maximum flow rate of 45 gpm. The tube will be made from 2S aluminum clad on the inside with 0.010" of 72S aluminum. It will withstand a maximum operating front face pressure of 600 psi, and a maximum temperature of 185° F. * Additional information on the maximum tolerable inhours absorption, pressures, temperatures, and sizes is given in HDC-2433 Determination of Optimum Annulus Size and Tube Length for RDA-DC-3 Reactor.

2. Front and Rear Face Connectors

- a. The front face connector will be of the pigtail type with an outside diameter of about 1". It will withstand a maximum operating pressure of 600 psi and allow for an axial expansion of 0.75".
- b. The rear face connector will withstand an operating pressure of 75 psi, an axial thermal expansion of 0.75", and provide a connection for a thermocouple.

3. Nozzles

- a. The front face nozzle will be cast from 356 T6 aluminum and it will provide the means to charge the 1.440" diameter slug, an orifice, a strainer, and a pressure tap.
- b. Also, the rear face nozzle will be cast from 356 T6 aluminum and it will have provisions for the discharging of the slugs, and a place for a pressure tap.

4. Gunbarrel

- a. The gunbarrel consists of two parts. One part is an extruded tube that extends from the outside face through the biological shield and into the graphite. The gunbarrel extension would be made up from a short piece of tube with the key slots and flange threads machined in it. This gunbarrel will be removable and it will deflect the same as the "C" type gunbarrels. The portion of the gunbarrel passing through the shield shall be designed to permit 0.100" vertical displacement on the end of the assembly which enters the graphite, together with a slope of the tube at that point of 1/4" per foot. In the maximum deflected position, a slug 8" long and 1.440" diameter will pass through the process tube.

5. Doughnuts

- a. The cast iron doughnuts and sleeves will allow the 2 piece gunbarrel to deflect the same as "C" before bottoming. However, their outside diameter has been decreased because of the smaller lattice spacing and to allow the use of a standard size tube through the shield. Also, this should be an improvement shielding wise.

* HDC-2513 - Permissible Design Pressure For 2S-14H-72S Clad Process Tube

** HW-23049 - Deflection Test of Single Gunbarrel Assembly

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6. Bellows Assembly

- a. With the two 3" front crossheaders and the rectangular crossheader on the rear, there will be clearance to use the metal expansion bellows. These bellows will allow a thermal expansion of 0.75" on each face. Also, a static seal is completed around the gunbarrel that will withstand a maximum gas pressure of 60" of water.
- b. As an alternate, a rubber expansion seal may be used on either one or both unit faces. The rubber bellows form a static seal on the centering flanges and on the gunbarrel. It may be removed without interference from a single 4 1/4" crossheader.

Please review and return your comments through your representative to the writer by April 11, 1952.

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