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B.M. Tien 3-24-92

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INTERIM REPORT #2

TEST PROJECT #29

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"C" AND "D" MACHINES FUNCTIONAL AND LIFE TESTS

INTRODUCTION:

This is the second interim report to be issued on this test project. The previous report is HW-21807, dated August 3, 1951.

This test project is being carried on for the purpose of testing certain machines which are designed to charge and discharge reactor units with process metal while the unit is in operation. Satisfactory charging of process pieces while the reactor is in operation would eliminate the necessity for regularly scheduled shutdowns now required for charging operations. These presently required shutdowns are costly in terms of production time, and may cause undesirable thermal stresses in the unit as it changes power level. If charging can be accomplished during operation, reactor shutdowns would only be necessary for maintenance or emergency purposes. During the testing of these metal handling machines, problems have arisen involving the behavior of the process pieces as they are charged. Because these problems directly affect the charging operations, they are being closely investigated also.

The machines covered by this report are designated as pressurized machines since

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they contain the same water pressure as the end of the process tube on which they are located. Actual mechanical operation of the charging and discharging has been described in the first interim report, and will not be repeated here. In most of the test work covered by this report, the full scale pressurized charging machine was replaced with a small charging cylinder. The charging operation was simplified by this change.

SUMMARY:

Several operational difficulties - other than those reported in the first interim report - were noted in the "D" machine. The ejecting head in the "D" machine, which performs the ejection of the process pieces, operates with some difficulty when the slug column is not held so that the piece in the discharging crosshead is free. The slug holder provided for this purpose can adequately hold the column when there is a solid piece under the holding piston, but a perforated dummy slug yields under the force, and permits the slug column to move downstream at high flows. This can be corrected by redesigning the perforated dummy slugs.

A recommended modification to the "D" machine would include a provision allowing the bar-plug to be brought up against the discharge end of the slug column before it is released by the slug holder. This would prevent the entire slug column from jarring as it moves downstream one slug length. An orifice could be adjusted to control the speed at which the column moves into the ejector. This has been done manually during past testing.

When the first tests were made on the pressurized charging equipment, it was noted that the column could not be properly backseated without applying prohibitive forces. Investigation by means of X-rays showed the slugs to be badly cocked - even off the ribs - when charged at flow rates proposed for C-pile. Slug cocking, of course, is intolerable from a heat transfer aspect. Figure 2 shows an example of the cocking encountered. The perforated dummies are four inches in length rather than the usual eight inches because the discharging crosshead can handle only the former length at present.

On the basis of rather extensive tests, it has been possible to arrive at certain conclusions regarding slug cocking and its influence on pressurized charging.

Allowing process pieces and dummies to rifle down the process tube by the water flow in the tube while charging under pressure may not be the primary cause of cocked slugs. There is some evidence that mere movement or agitation of the slugs under certain flow conditions may cause the slugs to cock. Slugs were found cocked after a charge had been inserted without allowing them to rifle in the tube. In at least one case, X-ray examination of slugs immediately after their entry into the inlet end of the process tube showed them to be cocked. Straight process tubes have been used in experiments to date, so the effect of graphite growth is not the cause of the particular phases of slug cocking which have been observed.

That backseating may be a contributing factor to cocked slugs has been considered. X-ray pictures of a charge before backseating and after backseating - or attempts at backseating - indicate neither a clearcut improvement nor a worsening of the condition.

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It is possible to backseat a standard charge of uranium and dummy slugs in the process tube provided they are properly aligned on the ribs. The backseating can be accomplished at any flow rate and inlet pressure up to 45 gpm and 425 psig respectively.

The addition of water soluble lubricating oil to the process water (15% oil) during charging does not allow backseating of the entire slug column if the slugs are cocked. In general, backseating of the slug column as required by the present pressurized "D" machine is undesirable from several standpoints. The slug cans may become severely galled during the backseating movement, particularly where backseating must be done without lubrication. The galling may become sufficiently severe to actually rupture the can, or at least reduce the wall thickness to a point where corrosion can complete the penetration during the irradiation period. Backseating will cause considerably more wear on the process tube ribs than is now caused by standard slug movement.

Backseating may cause the entire column to bow upward off the ribs, forcing a number of the slugs against the top and sides of the process tube. Since the tube will be operating at a normal power level during pressurized charging, the reduced heat transfer from such a slug position would not be permissible. Indeed, it is conceivable that some slugs might remain in this position during a considerable portion of the irradiation period, aggravating the condition even more.

Eight-inch uranium slugs become cocked as frequently as four-inch pieces when charged at normal pile operating flows of 24 gpm and up. Contouring the ends of the eight-inch slugs to a convex spherical surface did not keep the slugs from becoming cocked, although it did improve the alignment somewhat.

When the cocked slugs were first detected, it was thought that the same condition might be occurring in the piles. X-ray pictures were taken of four tubes of slugs charged with the same technique now used in all 100 Areas. No slugs appeared to be cocked when full flow was resumed. This series of tests was carried out under rather ideal conditions, and is not thought to be conclusive.

Further tests are planned which will define the factors involved in slug cooking. The requirements necessary to eliminate this condition will determine how continuous charging and discharging machines must operate.

DETAILS:

Test Equipment

The test facilities for testing pressurized charging and discharging machines are located at the 189-D Test Laboratory, 100-D Area. These facilities consist of a single tube mock-up which includes gunbarrels, centering flanges, nozzles and pigtailed mounted on a supporting framework. Water pressure is supplied to the process tube by a 4-stage Fearless pump which will provide 500 psi pressure in the supply header. The system is designed in such a way that the process water can be recirculated if desired. The closed system involves a 400 gallon retention tank and coils to cool the process water. This system can be converted from an open pure water system to the closed system without hindering operation. The closed system is used when it is desired to introduce lubrication into the process water while charging. The oil-water mixture is reused to save the cost of oil required. Charging oil is added to the water in the retention tank in the water circulating system so that the proportions of oil and water can be adjusted to 15% and 85% respectively. These

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proportions are the same as are used in the present 100 Area charging operations with the standard charging technique. Normal flow conditions are set up in the process tube (approximately 200 psi inlet tube pressure and 23 gpm flow rate). These conditions are maintained for a sufficient length of time to let the oil and water mix uniformly.

Pressurized Charging

The full scale pressurized charging machine is composed of a simple housing into which can be put the various assemblies to be tested. These assemblies include the Tube Seal, Double Extension Ram, Tube Sweep Ram, and Sealing Plug Extractor, which are the only components of the originally designed pressurized machine purchased. The charging machine is of sufficient length that 30 4-inch pieces can be pushed into the tube in one stroke. As mentioned before, in a considerable portion of this test work, the full scale charging machine was replaced by a five slug pressurized charging machine in order to simplify the operation.

It was found that backseating could be accomplished only when the slugs had been very gently washed down the process tube to make up the solid column. Under these conditions the entire column could be backseated several times without difficulty at any water flow rate. Results of these tests showed that the addition of lubricating oil had little if any effect on the backseating operation. Whether or not backseating was possible seemed to depend more on how the slugs were charged into the process tube. In an effort to eliminate any effect the incoming jet of water might exert, the pigtail entry was reoriented so that it discharged vertically downward into the process tube. The force exerted by the water tended to hold down the slugs in the tube rather than push them against the sides. This did not eliminate the cocking however. Figure 1 is a sketch of a method designed to eliminate the entire effect of the water jet.

Forces as high as 7000 pounds were used unsuccessfully in many of the attempts to backseat full columns of slugs. In two or three cases 10,500 pounds of force failed to move the slug column back toward the inlet end of the tube so that the sealing bar-plug could be inserted and locked in place at the discharge end.

Examination of the process tube and the pieces after backseating attempts were made showed very little severe damage to the slugs or to the tube ribs. This points to the fact that the slugs were probably becoming cocked in the process tube so that each of the pieces could contribute considerable resistance to the backseating force applied.

Unpressurized Standard Charging

A process tube mock-up with a standard charging machine was used in the 108-D building to charge slugs by the standard charging procedure. Four tube-fulls of slugs were charged in this manner and X-ray pictures were taken of each tube to determine whether or not any cocked slugs had resulted from the charging operation. The charging procedure was performed exactly as it is in the 100 Areas, including the feature of not seating the column after the discharge nozzle cap is replaced. As flow conditions were brought up to normal the column washed down the tube when the inlet pressure had reached approximately 150 pounds. Charging forces used in these tests were very similar to standard forces found in actual operation, requiring approximately 400 pounds of force to push the new charge of slugs.

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Examination of the X-ray films after they had been developed revealed that none of the slugs were cocked in the process tube. It must be kept in mind that only four tube-fulls of slugs were charged however, and it is very possible that occasionally a slug will become cocked in the process tube due to charging. A long series of process tube charges would have to be made to determine more accurately whether or not an occasional slug does get cocked in the process tube.

FUTURE WORK:

A "C" process tube will be charged with an approximate standard pattern of dummies and reject uranium pieces (21 four-inch aluminum perfs, 8 solid aluminum dummies, and 64 four-inch uranium pieces in this order). Flow conditions of 20 gpm will be established and the upstream end of process tube will be filled with aluminum perfs so that none of the pieces in the new standard charge will rifle down the process tube more than one foot. The new pattern will be charged in the same order as outlined above and each time one piece enters the tube, one will be discharged. This procedure will keep the process tube full and will eliminate excessive rifling of the slugs. As the first uranium pieces enter the process tube nozzle, X-ray pictures will be taken of the inlet end of the process tube. Repetition of the above procedure at decreasing flow rates should make it possible to determine whether or not the slugs are being cocked by mechanical difficulties or by flow irregularities.

If slug cocking is due to flow rate it may be affected by changing the shape of the process pieces or charging the pigtail entry port in order to reduce turbulence at the inlet. If mechanical difficulties are responsible, the inlet nozzle and/or the charging and discharging technique may be altered.

J. C. Wood
FILE TECHNOLOGY UNIT
ENGINEERING DEPARTMENT

JG Wood:rb

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FIGURE NO. 1

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TYPICAL COCKING PATTERN OF ALUMINUM DUMMIES AND 4" PERCS

TOP VIEW

TYPICAL COCKING PATTERN OF 8" URANIUM PIECES

TOP VIEW

TYPICAL COCKING PATTERN OF 4" URANIUM PIECES

FIG 1

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