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DOME END SUPPORT RING PRE-IRRADIATION TEST

Work Order 51801

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INTRODUCTION:

Prior to running the scheduled irradiation tests on the Dome End Support Ring (No. 15/W301) at the G.T.R. reactor, certain pre-irradiation tests were required. These tests were conducted in the Engineering Mechanics Laboratory at the request of the Test Planning Group.

PURPOSE:

Pre-irradiation tests were required for several reasons. First, to establish that the test rig could impart the necessary stresses on the test specimen; Secondly, to develop a cooling system for the test rig which would meet the temperatures required for environmental testing; Third, to conduct a 100 hr control test on at least one specimen of the support ring and verify its suitability for inclusion in testing at the G.T.R. reactor.

CONCLUSIONS:

It was not possible to attain the required stresses on the test specimen using the test rig as received from Test Planning. Design modifications to the test rig resulted in marked improvement in the results obtained; however, the required calculated stress levels still could not be achieved. The stress values obtained were, however, considered satisfactory to Test Planning.

TEST EQUIPMENT:

The dome end support test rig was fabricated as described in manufacturing drawing 709J820. A photograph of the rig is included in this report as Fig. 1. Eastman 910 cement was used to apply the strain gages to the test specimens.

There are cements more desirable for use in applying strain gages to titanium metal, but their use involves a much longer installation time than was available for this purpose. The strain gages, however, were carefully installed and functioned satisfactorily. The test rig, as described on drawing 709J820, did not impart the required stresses to the test specimen and modifications were required. The modifications performed on the test rig included slotting of the top clamp to provide more versatility in loading, changing the angle of load path on the bottom clamp, and increasing the amount of weight on the lever arm from 150 lb to 230 lb.

The apparatus for cooling the specimens to the desired operating temperature of -210°F is illustrated in Fig. 4. This apparatus consists of two copper pipe manifolds which spray streams of liquid nitrogen on the test specimen. An electric solenoid valve, controlled by a temperature controller and thermocouple, maintained the proper test temperature by controlling the flow of liquid nitrogen.

A deflection measuring device was used to measure deformation of the test specimen. This device, consisting of a metal strip with strain gages attached to each side, was mounted to the test rig so that movement of the lever arm stressed the metal strip. The change in strain indicated the extent of movement in the lever arm and consequent deformation in the test specimen. The resulting data is plotted in Fig. 10.

PROCEDURE:

A two inch wide simulated section of the dome end support ring was instrumented with C6-121 strain gages and placed in the test rig. This setup is illustrated in Fig. 2. The location of the strain gages on the test specimen is shown in Figs. 3A and 3B. Liquid nitrogen was sprayed on the specimen until the desired temperature was achieved. The previously described temperature control apparatus maintained this temperature throughout the test run. Loads up to 150 lb, in 20 lb increments, were applied through the lever arm. The resulting stresses at each point on the test specimen appear in Table 1.

The test rig was then modified to obtain higher strain loads on the test specimen. Loads in varying increments, up to 230 lb, were again applied through the lever arm. The loads obtained after modification of the rig appear in Table 2. The final loading arrangement of the specimen is shown in Fig. 9.

The 100 hr control run was conducted at the contemplated operating temperature of -210°F , and the data recorded as noted. Only one specimen was used in the 100 hr test. Figs. 5, 6, and 7 are photographs of the test setup taken while the test was in progress. Fig. 8, taken immediately after completion of the test, shows the test setup insulation removed.

RESULTS:

Using Fig. 3 as reference; the stress values, assuming $E = 17 \times 10^6$ psi, at points A, B, and C were approximately 33,000 psi, 19,500 psi, and 38,000 psi respectively on the test specimen with the rig as received from Test Planning. After the modifications noted previously in this report, stress values at points A, B, and C were increased to approximately 51,000 psi, 30,500 psi, and 60,000 psi respectively; which is about 10,000 psi lower than calculated values. These average stress values were considered satisfactory to Test Planning.

The temporary liquid nitrogen cold box devised for the 100 hr control test performed satisfactorily and maintained the test at the proper cryogenic temperature (-210°F) for the duration of the test. At the conclusion of the 100 hr test, examination of the test specimen indicated that there was a slight bowing condition in the test specimen. The weight loading on the lever arm, which was required to simulate the operating stresses on the test specimen, may have been too great and thus caused distortion in the thinner section of the

test specimen. With the present design of test rig, it does not appear probable that this bowing or "set" in the test specimen can be eliminated.

DISCUSSION:

It is apparent from the strain gage readings, that it will be almost impossible to establish the two required stress levels with any type of single loading system. The test rig was capable of producing only a ratio of 0.60 between the two stress points. The required stress levels called for a ratio of approximately 0.40. We are of the opinion that with an additional moment, produced by a lateral load, the desired stress levels could be attained.

Subject: Stress of Support Ring - Run 1

TABLE 1 - Strain Levels Obtained Under Original Conditions
(Values are given in micro inches)

Load (lb)	Gage Positions							
	2	3	4	5	6	7	8	9
0	0	0	0	0	0	0	0	0
20	130	125	-404	475	440	930	-930	505
40	310	295	-490	795	575	1,440	-1,415	835
60	490	470	-485	1,055	625	1,790	-1,730	1,100
80	660	650	-445	1,275	610	2,050	-1,960	1,320
100	805	805	-405	1,470	600	2,260	-2,260	1,530
0	15	10	30	-5	-20	-20	30	30
40	315	300	-485	800	575	1,440	-1,405	835
80	640	635	-460	1,280	630	2,055	-1,980	1,325
100	805	810	-425	1,465	580	2,245	-2,160	1,525
120	950	975	-345	1,660	580	2,435	-2,305	1,720
140	1,095	1,135	-280	1,830	565	2,585	-2,435	1,890
0	15	25	35	0	-15	-15	20	33
40	305	305	-485	800	580	1,440	-1,440	835
80	630	645	-455	1,285	635	2,055	-1,990	1,330
100	790	810	-405	1,470	600	2,255	-2,170	1,525
120	945	980	-345	1,655	570	2,420	-2,420	1,705
140	1,065	1,100	-310	1,820	555	2,575	-2,445	1,885
150	1,125	1,160	-290	1,900	550	2,650	-2,505	1,965
0	-15	8	10	-15	-30	-30	-5	19

Subject: Stress of Support Ring

 TABLE 2 - Final Stress Conditions
 (Values are given in micro inches)

Load (lb)	Gage Positions					
	2	3	5	6	7	9
0	0	0	0	0	0	0
20	120	125	574	1,096	1,096	600
40	270	263	981	1,733	1,718	1,018
60	457	437	1,282	2,101	2,090	1,320
40	242	246	978	1,744	1,730	1,023
20	100	97	603	1,164	1,151	629
0	16	20	9	0	-8	16
40	293	281	993	1,745	1,734	1,029
80	632	618	1,554	2,424	2,393	1,610
120	1,037	1,195	2,014	2,830	2,802	2,056
160	1,334	1,320	2,389	3,140	3,106	2,261
200	1,667	1,595	2,765	3,370	3,335	2,806
225	1,851	1,775	2,970	3,490	3,455	3,015
200	1,632	1,605	2,740	3,380	3,343	2,810
160	1,340	1,311	2,390	3,140	3,108	2,465
120	1,017	1,000	2,006	2,840	2,815	2,070
80	650	633	1,574	2,441	2,412	1,634
40	348	320	1,010	1,746	1,730	1,055
0	67	68	54	62	65	83
225	1,809	1,728	2,984	3,506	3,473	3,020
230	1,850	1,761	3,020	3,534	3,474	3,031
0	72	73	64	64	84	90
0	0	0	0	0	0	0
225	1,695	1,692	2,900	3,454	3,413	2,955
230	1,733	1,724	2,938	3,477	3,434	2,990

Fig. 1

Fig. 2

FIG. 3A- STRAIN GAGE LOCATIONS
(FOR TABLE No.1)

FIG.3B- STRAIN GAGE LOCATIONS
(FOR TABLE No.2)

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 8

FIG. 9