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CONTINUOUS CALCINER TROUGH EXAMINATION

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Page 1

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March 10, 1958

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224-UA

CONTINUOUS CALCINER TROUGH EXAMINATION

INTRODUCTION

The continuous calciners at UO₃ Plant are of a new design which was developed at HAPO and placed in service late in 1956. The heat transfer troughs are considered to be the most vulnerable parts of the calciners because of their high operating temperatures. Thermal stresses are calculated to be quite high, and when added to the direct mechanical stresses from powder load etc., come close to the limiting safe stress for stainless steel at the operating temperature. It is felt that trough failure will be progressive as a result of creep type distortion and cracks at stress concentration points. The higher the stress (and temperature), the more rapid the rate of failure will be.

All possible steps have been taken to limit maximum trough temperature, rate of change, and variations from one part of the trough to another. These steps were not always successful and various troughs have been subjected to rather severe temperature shocks as well as high mechanical stresses due to agitator failures. Despite these difficulties, no signs of failure could be detected by visual inspection. It was decided, therefore, that a more complete examination should be made.

PURPOSE

The examination was made to determine the present condition of one of the troughs. Measurements of trough contour were taken which were compared to previous measurements to detect distortion. Dye penetrant was used to detect cracks which might have started at stress concentration points.

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SUMMARY AND CONCLUSIONS

"J" calciner was selected for examination because it had one of the best sets of original dimensional data for comparison. It has also had a representative number of agitator failures and temperature shocks.

- Radial measurements were taken between the agitator shaft and the trough interior at 55 points which corresponded to the original check points. Appendix "A" is a data sheet showing the results as compared to previous measurements. The results are surprisingly consistent indicating that very little permanent distortion has occurred. There is a slight tendency for the bottom of the trough to rise and the sides to spread apart.

Metallurgical examination did not reveal any cracks. Some surface roughness was evident in addition to the scratches and gouges from foreign material. This is believed to be a surface effect only.

Surface corrosion is negligible.

It should be noted that this was an examination of the trough interior only. Cracks and other metallurgical damage can be expected to start on the exterior surface because it runs at a higher temperature. Total absence of cracks on the interior is a good indication that cracking at the exterior surface is minor or non-existent. The exterior was not examined at this time because of the additional work required to reach it but should be examined at the first opportunity in an effort to verify the results of this examination.

Based on this limited examination it is concluded that "J" calciner trough is in excellent condition.

RECOMMENDATIONS

1. Average outside skin temperature limit may be increased from 950° to 1000°F if such a change is necessary to meet production requirements. The maximum permissible skin temperature should be unchanged at 1100°F, however.
2. The outside of a trough should be examined at the first opportunity. This is because cracks or other metallurgical damage are much more apt to develop on the outside surface than the inside.
3. Internal measurements should be taken on other troughs in an effort to determine the effect that distortion (and resultant wide agitator paddle clearance) might have on heat transfer rates.
4. No change in trough design appears necessary at the present time.

DISCUSSION1. Apparatus & Procedure

The distance from the eight inch shaft to the inner skin of the trough was measured at eleven positions along the shaft, with five radii being measured at each position. The apparatus used consisted of an arm which was clamped to the shaft at one end and which carried a dial indicator at the other end. With the arm attached, the shaft was rotated by hand and readings taken each 45° around the semi-circular trough. At the same time, another dial indicator read shaft runout to establish the true relationship between the shaft surface and its running center. A fixed gage was also prepared so the true length of the arm could be checked from time to time or reset in the event it was bumped out of adjustment. The apparatus did not get out of adjustment at any time during this series of measurements. Shaft sag due to its own weight was not considered in these measurements nor those conducted previously because it is a constant of small magnitude, (about .015 inch at the shaft midpoint).

The arrangement of the apparatus is shown on Appendix B. The arm and its accompanying gage are now in the hands of Facilities Engineering and are available for use on other troughs.

The overall length of the trough was not measured.

2. Data

Results of the measurements taken are shown in Appendix "A". For convenience the results of the two previous measurements are recorded on the same data sheet. The first set of data was taken before startup and the second after several months limited operation but before the first major agitator failure.

Agreement between the three sets of data is exceptionally good considering the fact that the trough surface is rolled plate and exact measurement points could not be duplicated. There seems to be a slight tendency for the trough to rise at the bottom and to spread out at the sides. This tendency, if continued, will make it more and more difficult to get proper agitator clearance at the skin thereby reducing heat transfer efficiency and creating hot spots.

3. Metallurgical Examination

A metallurgical examination was made under the direction of P. S. Kingsley. This examination consisted of a careful visual examination of all surfaces and a dye-penetrant examination of stress concentration points and any other points that looked questionable. No cracks were found but one area of 1-1/2 to 2 square feet had some evidence of surface attack described as "alligator hide". This was evaluated as being a surface condition that does not extend to any depth.

4. Future Work

This examination tends to decrease the concern that may have been felt as to the adequacy of the calciner troughs; however, this does not mean that the matter can be dropped. It is suggested that the following work be done to check on the conclusions presented herein and to improve calciner performance.

- a. Metallurgical damage can be expected to start at the trough exterior surface rather than at the inside because of higher temperatures on the furnace side. Therefore, at the first opportunity, the outside of a trough should be given a metallurgical examination.
- b. Other troughs should be given the same examination as "J". Aside from the knowledge gained as to current trough condition and possibility of failure, it is felt that these measurements might go a long way toward explaining variations in production rates.

R. A. Kennedy

Equipment Design & Development
Facilities Engineering Operation
CHEMICAL PROCESSING DEPARTMENT

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APPENDIX ACorrected Radial Measurements

Stations are one foot apart with Station One being at the drive end.

Date Readings Taken		A	B	Points C	D	E
7/5/56	Station #1	13.040	12.970	13.033	13.058	13.128
3/5/57		13.077	12.996	13.026	13.160	13.164
2/7/58		13.074	12.953	13.001	13.059	13.154
7/5/56	Station #2	13.046	12.986	13.043	13.093	13.126
3/5/57		13.076	12.997	13.040	13.162	13.152
2/7/58		13.075	12.980	13.019	13.017	13.179
7/5/56	Station #3	13.046	12.978	13.068	13.135	13.117
3/5/57		13.100	12.983	13.054	13.128	13.197
2/7/58		13.073	12.957	13.023	13.142	13.180
7/5/56	Station #4	13.048	12.984	13.083	13.139	13.093
3/5/57		13.072	12.980	13.067	13.135	13.165
2/7/58		13.048	12.960	13.025	13.130	13.201
7/5/56	Station #5	13.022	12.990	13.095	13.130	13.108
3/5/57		13.113	12.975	13.050	13.140	13.151
2/7/58		13.060	12.956	13.020	13.150	13.192
7/5/56	Station #6	13.051	12.968	13.089	13.154	13.084
3/5/57		13.143	12.987	13.005	13.150	13.151
2/7/58		13.123	12.949	12.976	13.167	13.235
7/5/56	Station #7	13.077	12.974	13.050	13.136	13.077
3/5/57		13.142	12.977	12.993	13.133	13.123
2/7/58		13.118	12.938	12.972	13.171	13.185
7/5/56	Station #8	13.070	12.969	13.037	13.130	13.061
3/5/57		13.144	12.960	13.000	13.100	13.090
2/7/58		13.064	12.929	12.982	13.134	13.117
7/5/56	Station #9	13.040	12.946	13.039	13.109	13.031
3/5/57		13.084	12.889	12.996	13.040	13.032
2/7/58		13.066	12.892	12.989	13.090	13.050

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HW-55283
Page 6

Date
Readings Taken

		<u>A</u>	<u>B</u>	<u>Points</u> <u>C</u>	<u>D</u>	<u>E</u>
7/5/56	Station #10	13.010	12.891	13.030	13.052	13.015
3/5/57		13.079	12.914	12.993	13.017	12.969
2/7/58		13.054	12.906	12.981	13.036	13.007
7/5/56	Station #11	13.044	12.920	13.017	13.041	12.961
3/5/57		13.110	12.937	12.988	13.007	12.981
2/7/58		13.127	12.937	12.966	13.016	12.974

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APPENDIX B

Arrangement of Measuring Equipment

Section Through Trough

Looking from Drive End

Indicator Check Gage

**DATE
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