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February 7, 1951

INTERIM REPORT #1, FT 105-402-P
INSTALLATION AND INITIAL OPERATION

This document consists of

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TABLE OF CONTENTS

- I. Introduction
- II. Summary
- III. Details and Discussion
 - A. Installation
 - B. Operating Details
 - C. Power Requirements
- IV. Conclusions
- V. Bibliography
- Appendix
 - A. Installation Procedure
 - B. Data-Graphite Samples

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I. INTRODUCTION

The effect of temperature on the properties of graphite is being determined by exposing samples to pile neutrons at controlled temperatures in the range 75°C to 225°C. The first series of samples were charged into the newly installed dry, water-cooled test channel at B Pile on January 23, 1951. This report presents details of the charging operation and observations noted during the initial operation of the test.

II. SUMMARY

Graphite samples in four heater slugs were charged into the dry, water-cooled test channel at B Pile, which consists of an inner tube in a process tube with cooling water flowing in the annular space between the tubes. The installation of the inner tube and the charging of the samples presented no difficulties and several methods for reducing charging time were noted. Operating details and power requirements for the circuit are included. The actual sample temperatures are 215°, 157°, 135°, 108° and the control settings for equilibrium operation are 36 on Variac Scale for a current of 4.8 amps at 28 volts.

III. DETAILS AND DISCUSSION

A. Installation

The test channel was installed without difficulty following the procedure outlined in Section A of the Appendix. Operations on the front and rear faces were conducted simultaneously and the time required for the installation was one hour.

The slugs, enclosed in a 5-foot section of 1-1/2 in. aluminum tubing, were brought to the entrance of the inner tube and charged by pushing them through the tubing and into the inner tube with 1-1/4 in. OD perf slugs which were slipped over the end of the lead-wire cable. The slugs moved easily into the inner tube with apparently no galling or binding. Nineteen 8 in. long perf slugs and five 12 in. long shield slugs were charged, thus locating the upstream end of the 4 ft. long chain of heater slugs at a point 17.6 ft. from the front gun barrel flange and essentially straddling the fore and aft center line of the pile.

The inner tube opening was plugged by passing the lead cable through a #8 neoprene stopper and painting the seams with Glyptal.

Slug charging required one-half hour but the major delay was caused by difficulty in removing the scotch tape which held the split cylinder spacers to the heater slugs.

Since the slugs were enclosed in a section of aluminum tubing the taped joints had to be removed individually in cramped quarters between the tubing and the open end of the inner tube.

A half-round trough in place of the section of 1-1/2 in. tubing would have allowed the joints to be untaped all at the same time, on the elevator and would have reduced the charging time to 10 minutes.

The lead wires, consisting of four thermocouples and two heater leads, were connected with solderless connectors and placed in a water tight junction box. This job required only 20 minutes and was done by an instrument mechanic.

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B. Operation Details

An abstract of the log book is presented below:

Date	Time	Recorder Points °C						Cont-roller °C	Amps	Variac	Power Level
		1	2	3	4	5	6				
1-23	1730										Start-
	1850	2	43	45	83	80	2	115°C	2.6	16	365
	2000										325
	2100	115	65	65	123	125	100	193	5.2	30	---
1-24	0005	120	66	66	130	132	118	214	5.7	31.9	250
	0530	Inlet temp. 5.9°C Outlet 7°C									
	0900								6.0	36	
	0930							215	6.0	36	

An error in shunting points on the 6 point recorder cause the following points to print together, 2 & 3, 4 & 5, 6 & 1. This has been corrected so that the recorder now prints 1 & 2, 3 & 4, 5 & 6 together. Potentiometer checks of the temperature readings on the recording instruments showed a negligible error.

The panellit pressure, on the inlet side of the orifice has been approximately 135 psi, which is 20 psi higher than the anticipated pressure as determined from flow laboratory tests. It is believed that this higher pressure results from tenacious film clinging to the process tube in which the inner tube was installed. The flow laboratory tests were conducted with a new process tube and the difference in tube surface condition could easily cause this effect. The panellit gage was changed to one reading in the 100-200 psi range and the tripping limit raised to 195-200 psi. After three weeks of operation, the inlet pressure is 136 psi so film buildup is similar to that occurring in regular metal tubes and may be handled with the normal purging procedure.

C. Power Requirements

As a result of low inlet water temperatures (2-5°C) the circuit has required more power than that calculated on a basis of an average 15°C sink temperature. Current limitations in the circuit hold the maximum temperature of the samples to 215°C instead of the proposed 225°C. It will be no problem to maintain this sample temperature since the inlet water temperature will increase through the length of the test.

The temperatures are controlled by relays in an on-off controller which is reading the highest sample temperature. The controller is set to maintain 215°C with a cycle of $\pm 3^\circ\text{C}$.

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Low Power: $E = 25$ volts, $I = 4.8$ amps

High Power: $E = 30$ volts, $I = 5.8$ amps

Total Resistance of Parallel Circuit = 3.56 ohms

Line Resistance - $R_L = 0.84$ ohms

Voltage at parallel circuit:

$$E_P = E_T - \frac{E_T R_L}{R_T}$$

$$E_P = E_T - \frac{E_T (0.84)}{0.84 (3.56)}$$

$$E_P = 0.81 E_T$$

Power at a heater

$$P = E_P^2 / R = (0.81 E_T)^2 / R$$

	Low	High
1.	9.2 watts	14.9 watts
2.	20.4	31.9
3.	32.9	51.2
4.	44.4	69.2
Line	25.0	35.8
	131.9	203.1

IV. Conclusions

1. The procedure for the installation of the test channel has proved workable and should be adopted as standard for future installations.
2. Sample slug charging technique may be improved by charging the slugs from a half-round trough.
3. Heater design and circuit control are adequate for maintenance of the desired controlled temperatures.

V. Bibliography

- (1) HW 19617 - PT 105-403-P - Controlled Temperature Exposure of Graphite - F. M. Haussler - Dec. 1, 1950.
- (2) HW 20196 - Controlled Temperature Exposure of Graphite - F. M. Haussler - Feb. 7, 1951.
- (3) HW 20197 - Design of Dry, Water-Cooled Test Channel - F. M. Haussler - Feb. 7, 1951.

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APPENDIX

P.T. 105-403-P

A) PROCEDURE FOR INSTALLATION OF INNER TUBE AND CHARGING OF SAMPLES

P Division will have discharged tube and removed nozzles, exposing gun barrel flange faces.

1. On rear face, install new nozzle pigtail, and packing gland. On front face, install new nozzle and new extended studs.
2. Run-in 3-foot probe with push pole. When front of probe is approximately in center of threaded portion of rear packing gland, mark pole at location of Van Stone flange in front nozzle.
3. Withdraw pole and probe and lay along side new tube in work area.
4. Cut new tube to proper length using the guide marks on the push pole.
5. Smooth cut end of tubing and polish tube surface at point where O-Ring will rest. (2 in. to 4 in. from cut end)
6. Insert bullet nose in tube.
7. Charge tube.
8. Remove rear packing gland and remove bullet nose. Install shielding slugs.
9. Slip O-Ring over front Van Stone flange and seat tube. Install packing gland.
10. Install rear O-Ring and washer, replace rear packing gland. Install rear sealing mandrel. Raise water pressure to normal (75 psi), check for leaks, and if none found, retire from rear face.
11. Charge shielding slugs.
12. Insert rubber plug.
13. Retreat.

B) Data - Graphite Samples (from HW-3370-1, page 21)

Casing#	Sample#	ko	po	Lo	Heater #	Temp. °C
1	93-95	233	11.8	2.9015	1A	105-115
2	93-90	246	12.0	2.8808	4A	215°
3	93-92	229	11.84	2.9004	4A	215°
4	93-17	252	11.84	2.8893	3A	155-165
5	93-18	244	11.80	2.8813	3A	155-165
6	93-14	249	11.64	2.8722	2A	135-145
7	93-16	240	11.80	2.9003	1A	105-115
8	93-91	257	12.16	2.8887	Reject	-
9	93-13	242	11.76	2.8852	Reject	-
10	93-23	243	11.60	2.8768	2A	135-145

Thermal Conductivity ko = cal/gm - cm² - °C/cm

Electrical Resistivity Po = ohm/cm

Length Lo = inches

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