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INCORPORATED

ALBUQUERQUE DIVISION

APPLIED RESEARCH AND DEVELOPMENT

MASTER

TEST PROCEDURE

EMISSION OF 304 AND 347 STAINLESS STEEL TUBING AND SPECIAL COATINGS

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1. INTRODUCTION

- 1.1 General. This document establishes the test methods and procedures to be followed in determining emissivity of Type 304 or 347 stainless steel tubing used as pressure tubing and thermocouple shielding for the Phoebus 1B Reactor.
- 1.2 Testing. All emissivity tests will require the assembly indicated in Figure 1 with five foot long test specimens. Emissivity testing will be performed at the ACF-Alameda Laboratory; however, thermocouple response and calibrations, and a LN₂ submersion paint evaluation test will be performed at ACF-SAW prior to the emissivity testing at Alameda.

2. INSTRUMENTATION

- 2.1 Temperature Measurement. Two temperature measurements will be recorded via thermocouples and the Dymec 2010B digital recording system. The two Chromel-Alumel thermocouples will be positioned inside the test specimen to record temperature at the test specimen mid-point and approximately 1/2 inch down from the top mirrored disc. These two thermocouples will exit through Conax type fittings and will be referenced to a 32°F cold junction in an ice bath. The circuit for these thermocouples is shown in Figure 2. Pertinent information on these thermocouples is given in the Instrumentation List (Table 1).
- 2.2 Voltage Measurement. One voltage measurement will be recorded via the Dymec 2010B digital recording system. This voltage will be picked up at the ends of the test specimen just inside the 304 stainless steel mirrored discs. The voltage leads will exit through Conax type fittings. The circuit and data flow is shown in Figure 2. Range, sensitivity and other information is indicated in the Instrumentation List (Table 1).
- 2.3 Current Measurement. One current measurement will be recorded via the Dymec 2010B digital recording system. This current will be picked up as current through the test specimen and, like the voltage and thermocouple leads, will exit through Conax type fittings. The Instrumentation List (Table 1) indicates measurement parameters such as range, sensitivity, recording media, etc., while data flow is indicated in Figure 2.
- 2.4 Vacuum Pressure. The requirement to maintain chamber vacuum pressures of 10⁻⁵ to 10⁻⁶ torr (Torr = 1 mm Hg absolute) during testing will be provided by a roughing pump, cold trap, oil diffusion pump and foreline. The roughing pump will provide the initial evacuation of the test chamber. As the chamber is evacuated to approximately 100 microns Hg by the roughing pump, the cold trap and diffusion pump will be valved into the test chamber. The diffusion pump will operate continuously to hold the test chamber at 10⁻⁵ to 10⁻⁶ torr. Initial pressure will be monitored by the thermocouple gage, while an ionization gage will be used to monitor the 10⁻⁵ to 10⁻⁶ torr pressure range. The visual display of vacuum pressure will be manually recorded at five minute intervals for each test.

Figure 1. TEST FIXTURE ASSEMBLY AND SPECIMEN

Figure 2. TEST DATA FLOW BLOCK DIAGRAM

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3. TEST PROCEDURES

3.1 Specimen Preparation. Twenty (20) five-foot long specimens each of 304 and 347 stainless steel tubing will be tested. Five specimens of each type of stainless will be tested at each of four temperatures (400, 600, 800, and 1000°F), and will be prepared as follows:

- (a) One specimen will be oxidized (heated at 1000°F for one hour).
- (b) Four specimens will be coated with special emissive coatings.
 - (1) Pratt and Lambert
 - (2) National Lead Co. #46H47 Enamel
 - (3) Proco #H402S Aluminum Paint
 - (4) Pittsburgh Paint

The coatings will be applied and cured by Department 411 Test Cell personnel per manufacturer's instructions.

3.2 Test Fixture Assembly. The test fixture will be leak checked prior to the initial specimen testing to insure adequate vacuum sealing of all pass-throughs and both end flanges. After adequate vacuum sealing is accomplished, disassemble the fixture, clean and coat the test chamber with the previously tested paint (3M Black Velvet), making sure that both primer and paint are adequately cured. This coating will be checked prior to each successive test and recoated if necessary.

Install each specimen as follows:

- (a) With both end flanges and mirrors (Item 2, Figure 1) removed, insert the specimen in the test chamber; set the two mirrors in place; and then anchor the specimen through the insulated holder (Item 3, Figure 1).
 - (b) Attach the weight (Item 6, Figure 1) and flare the specimen tubing to attach the weight and still permit thermocouple insertion into the tube.
 - (c) Insert the two thermocouples per Figure 1 and identify as listed in Table 1. (The circuit diagrams are noted in Figure 2.)
 - (d) Attach the voltage and current leads per Figures 1 and 2 and identify per Table 1.
 - (e) Attach the end flanges and secure all connections for vacuum seal.
- 3.3 Purge and Liquid Nitrogen Fill. Attach the purge line and purge the test chamber with warm dry nitrogen gas at approximately 5 psig for a minimum of 10 minutes. Remove the purge lines and seal the purge line connections.

Evacuate the test chamber down to 10^{-5} to 10^{-6} torr and introduce liquid nitrogen into the external jacket. When cool-down is complete and the external jacket is filled with liquid nitrogen, slowly apply DC power to the test specimen.

3.4 Test Duration. Apply DC power to the test specimen and slowly bring the specimen up to the test temperature by adjusting the output of the power supply. When the specimen temperature is stabilized, record data continuously for a minimum of 60 minutes. Maintain the liquid nitrogen level in the external jacket and maintain specimen temperature during the test run. The vacuum must be maintained during the test. If the vacuum pressure rises above 1×10^{-5} torr the test will be considered invalid and will have to be repeated.

4. DATA HANDLING

4.1 Data Collection. Data required during testing (four measurements on the Dymec and one manually recorded measurement) will be programmed by setting the Dymec 2901A Scanner Programmer as follows;

- (a) a one-second sample period and a 0.10-volt scale for the two temperatures
- (b) a one-second sample period and a 100-volt scale for the voltage measurement
- (c) a one-second sample period and a 0.10-volt scale for the current measurement

4.2 Data Reduction. Data reduction will be accomplished via BCD (Binary Coded Data) 8 level punch tape and an IBM 1620 computer. Reduction programs including various calibration corrections and operations will be written by Department 431. Data plotting of emissivity as a function of time may also be accomplished by IBM plotting.

5. PHOTOGRAPHIC COVERAGE

Photographs will be taken of the test setup and during any test phase which may give test information.