

PROBLEM JJ-1

HEAT UP AND QUENCH USING THE WHOLE BOILING CURVE (PART 1)

Introduction - This problem is divided into two parts - developing the whole boiling curve from a quench experiment and then using a curve like that to predict the temperature-time relation for a surface in system which undergoing LOCA.

Part 1 - The goal of the experiment described below is to determine the whole boiling curve from a quench test on the test section. The test section is short enough so that the fluid conditions at the point in question hardly change in the course of the experiment.

A schematic of the loop is shown in Figure 1 while a detail of the test section and its dimensions is shown in Figure 2. The pre-heater delivers at constant pressure a constant mass velocity and quality to the test section. The pressure, mass velocity, and quality, are all quantities that can be controlled in the loop.

The test section is (hopefully) long enough so that, at the center, axial conduction is not a problem. It is short enough so that fluid conditions don't change appreciably at its center during the transient. It is thick enough so that the transient is sufficiently slow that the thermocouples welded to the outside give a fair measure of the inside temperature. It is thin enough so that (hopefully) the error in extrapolating the temperature from the outside to the inside is acceptable.

In order to run this experiment the loop pressure, flow, and inlet temperature are fixed. The power to the preheater is set giving a known and controllable quality at the test section. The test section is isolated and heated, externally, to the desired initial temperature. The heat is turned off, the recording equipment started and the quench undertaken by opening valve 1 and closing valve 2. Temperature and time for the thermocouples in the central section of the test section are recorded. For this experiment we would like you to answer the following questions.

A. What is the most important underlying assumption in the design of this experiment if we are to use the results to predict temperature-time in a LOCA? (One sentence should be enough.)

B. Sketch temperature versus radius in the wall of the test section.

C. Estimate the temperature difference between the inside and the outside of the test section, assuming (dT/dt) is everywhere the same in the test section and is 15°C/sec . Do this calculation assuming the material is first copper and then stainless steel.

D. In terms of the outside temperature and a uniform dT/dt , develop expression for the inside heat transfer coefficient which is appropriate

E. Sketch the outside wall temperature-time curve you expect for an experiment of this kind. Identify the various critical points and heat transfer regimes on this curve.

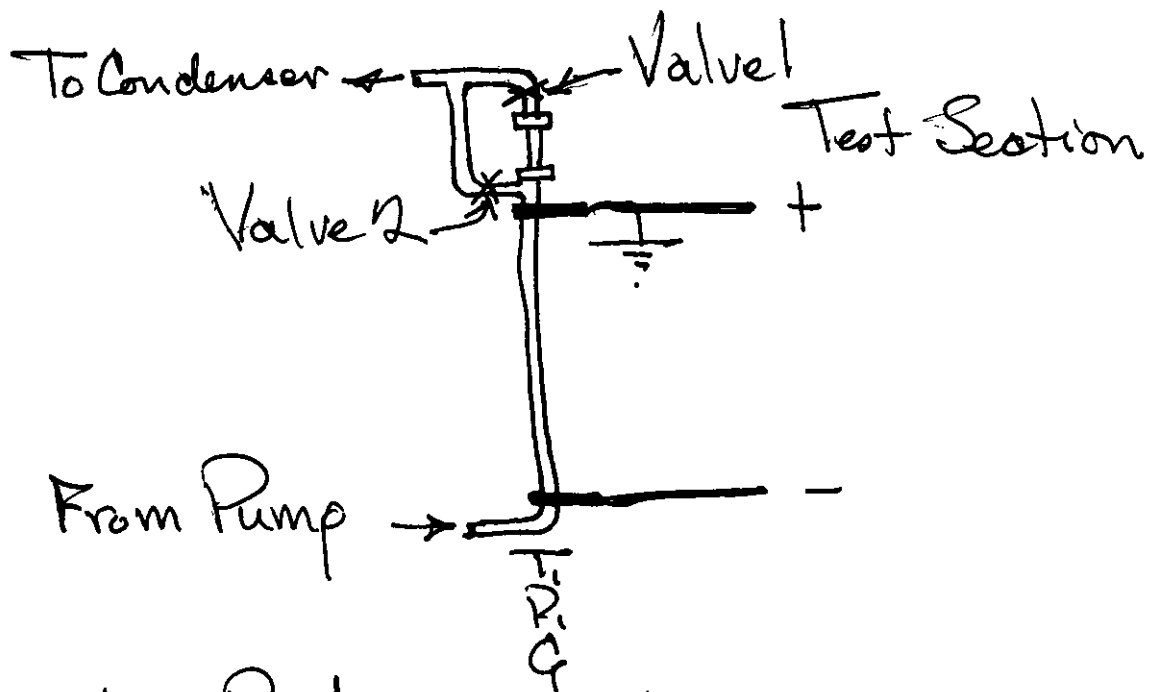


Figure 1 - Preheater and test section schematic

$L = 20\text{ cm}$
 $ID = 1\text{ cm}$
 $OD = 2\text{ cm}$

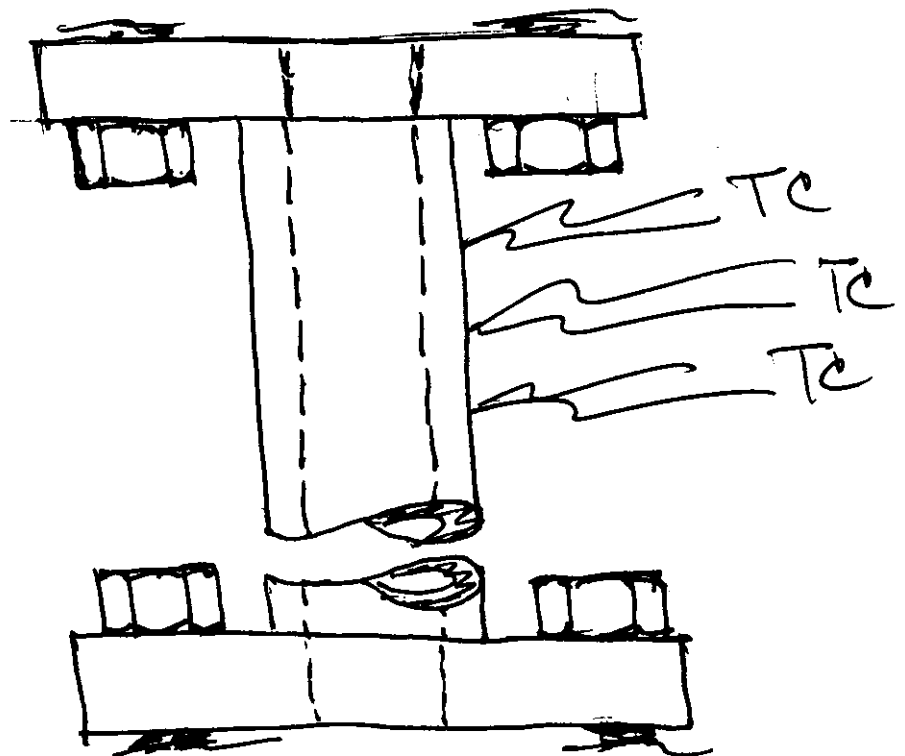


Figure 2 - Test section detail