Purdue University
School of Nuclear Engineering

NUCL 355 - Nuclear Thermal-Hydraulics Laboratory

Lab 8: Two-Phase Natural Circulation

Introduction

The two phase natural convection loop shown in Figure 1 consists of a compressed air inlet at the bottom and a separator at the top. Flow is induced by the pressure difference between the two-phase riser and the single-phase downcomer. The downcomer has an inside diameter of 1.025 in. The orifice plate in the downcomer is 0.252 in. diameter. Other loop dimensions are given in the figure.

Objectives

The objective of this experiment is to obtain a curve of the flow in the loop vs. the void fraction in the riser.

Experiment Procedure

1. Read the pressure ranges of the two DP cells and write them down in your lab book. The corresponding output ranges are 1-5 Volts.
2. Make sure the valve in the low flow air flow meter is fully open and the other one is closed.
3. Make sure the inlet needle valve is slightly open.
4. Open the inlet ball valve.
5. Set the air flow rate with the needle valve to the following values: 2, 5, 10, 15, 20, 30 SCFH and 1 SCFM.
6. Sketch the flow regime in the riser at each flow.
7. Measure the voltage output of the 2 DP cells at each flow. Take 10 readings at each flow and average them to obtain time-averaged pressure drops.

Useful Information for the Lab Writeup

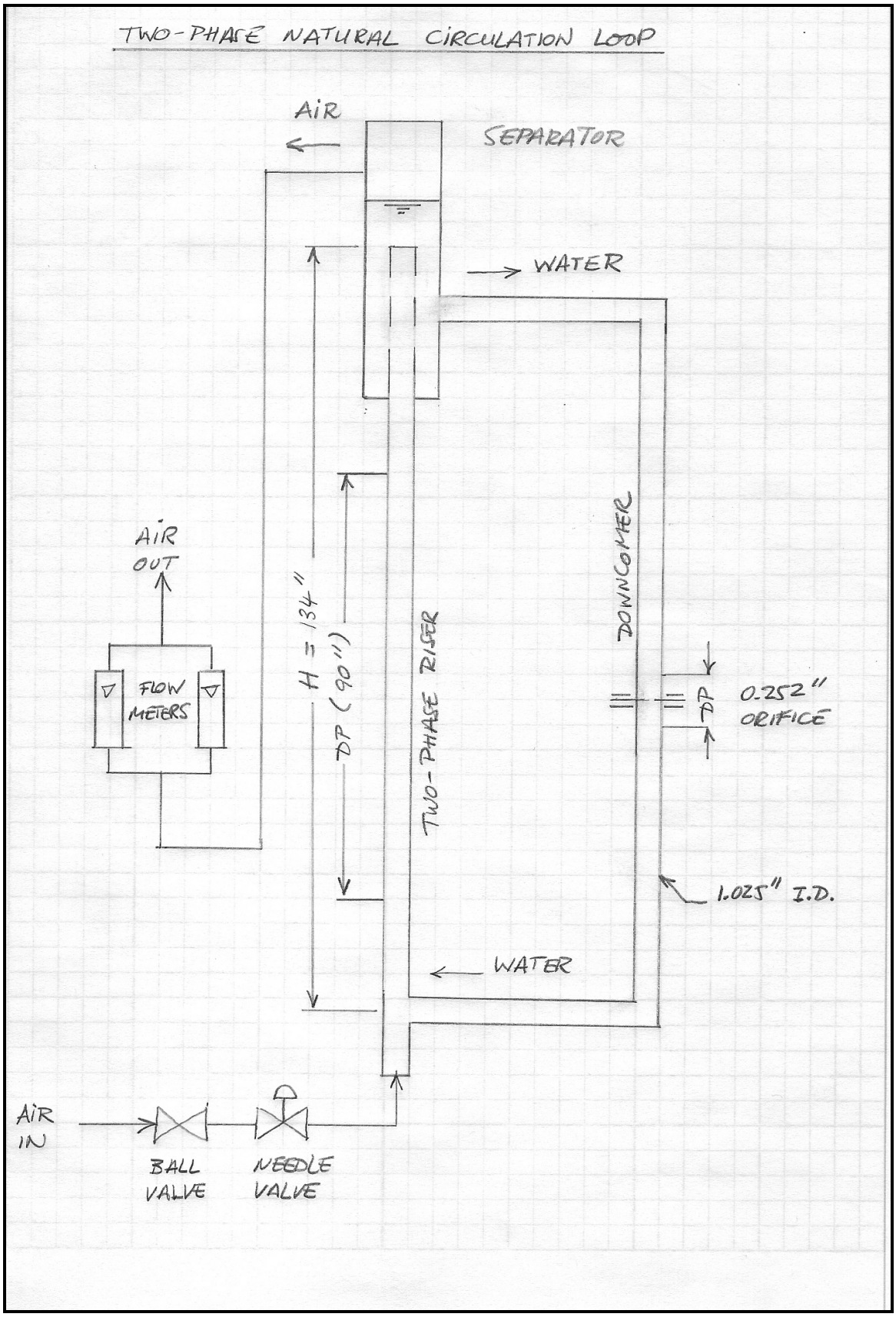
For each air flow rate calculate and tabulate:

1. The pressure drop across the riser and the orifice plate.
2. The standard error of the pressure drops.
3. Calculate the mass flow rate across the orifice plate. Write down one sample calculation.
4. Do an error propagation analysis to calculate the error of the flow rate. Include one sample calculation.
5. Calculate the void fraction in the riser and associated error.

Results and discussion:

1. Compare and discuss the pressure drops across the riser and the orifice plate.
2. Plot the mass flow rate across the orifice plate vs. the void fraction.
3. Plot the mass flow rate across the orifice plate vs. the air flow rate.
4. Discuss the relevance of the second plot to the design of a boiling water reactor. (Hint: what is the limitation to the flow during natural circulation?)

Note: Include error bars in your plots.


TWO-PHASE NATURAL CIRCULATION LOOP
AIR
SEPARATOR
WATER
AIR OUT
FLOW METERS
H = 134"
DP (90")
TWO-PHASE RISER
DOWNCOMER
DP
0.252" ORIFICE
1.025" I.D.
WATER
AIR IN
BALL VALVE
NEEDLE VALVE