Chemical Engineering 4903, 4905

FIGURES AND TABLES FOR ENGINEERING REPORTS

Figures and tables differ in style from one company or university to another but the following rules are most generally observed.

(1) Often each figure or table is placed on a separate page with no other figure or table or text on the page. However, a small figure or table may be placed on a page which also contains text.

(2) Normally a report will have figures and tables. If the information is a data plot or a drawing, it is called a <u>figure</u>. If it is a list of numerical values, equipment descriptions or specifications, or of operating conditions, etc., it is called a <u>table</u>.

(3) Normally the figure or table is presented as soon after being first cited in the text as practical, or all figures and tables are placed together at the end of the text. Pick one of these two arrangements, and use it throughout the report.

(4) No figure or table is included which is not referred to in the text. The function of the figures and tables is to expand on and/or clarify what is said in the text. If you don't mention and/or discuss illustrative material in the text, you have no reason to include such material.

(5) The size and placement of figures or tables should allow for binding of the pages.

(6) Each figure and table has its own figure or table number and its own detailed caption. Figure captions go below the figure. Table headings go above the table.

(7) The figure caption, the designations of the axes on the graphs, and the other descriptive material are prepared neatly as part of the figure.

(8) When the figure compares experimental data to a theoretical or correlation equation, the experimental data points should be shown as easily recognized points. The theoretical or correlation values are shown as a continuous curve. Although it may be necessary to calculate some values in order to plot the theoretical curve on your figure, the values so used should not be shown by symbols on the figure. Normally when constructing a theoretical curve on a plot, compute several values, mark the points as dots on the figure, and then draw a smooth curve through the points.

(9) There are two widely used styles of figure captions. <u>Use either style, but be consistent.</u> One places the figure number, underlined, above the title, e.g.,

<u>Figure 1</u>
Flow diagram of distillation column.

The other puts the figure number, bold faced, at the left, and indents the title, e.g.,

Figure 1 Flow diagram of distillation column.

(10) Some authors like long figure titles, which contain a great deal of explanatory material, e.g. the titles on pages 3, 4, and 5 of this document. Others like much shorter titles, with the explanation in the text, e.g. the titles on pages 9 and 10 of this document. Either is acceptable in reports in this department.

(11) Some authors like the title to be a sentence fragment, e.g., "Flow diagram of distillation column". Others like it to be a full sentence. "The flow diagram of the distillation column is presented here". Either is acceptable in reports in this department.

Pages 3, 4 and 5 are three figures adapted from Yongjue Park, "The Formation of Bubbles from Submerged Orifices," Ph.D. thesis, University of Utah, Salt Lake City (1974). Consider the following points on each.

First Figure (Figure 4-1, page 3): This is a flow diagram. Those parts which are standard devices ordinarily are shown schematically; i.e., the tank, rotameter, valves. Those parts which are not routine (the presaturator and the bubble column) are shown more pictorially to make clear to the reader how they function. In both cases the idea is to show function rather than actual appearance. In other parts of a report dealing with mechanical details other drawings would show the actual appearance of each device. In a flow diagram one is not interested in appearance of apparatus nor in the actual physical arrangements (i.e., which part is actually to the left or right). Generally flows are drawn from left to right, unless there is a good reason to do it some other way. This figure is almost too wide to be mounted vertically on the page; orientation with the caption along the right side of the page might be preferred.

Second Figure (Figure 5-1, page 4): This is an example of how to present raw data recorded on chart paper. The author cut out a piece of the chart, glued it to a sheet of bond paper and then typed on the necessary comments, legends, etc. By this process, he obtained the necessary margin space for binding and adequate room to type on the caption, etc. Note that this figure is bound with the legends/caption to be read from the right side of the page.

Third Figure (Figure 5-2, page 5): This is a plot showing experimental values. The data are plotted as a semi-log plot, and "theoretical" lines are indicated.

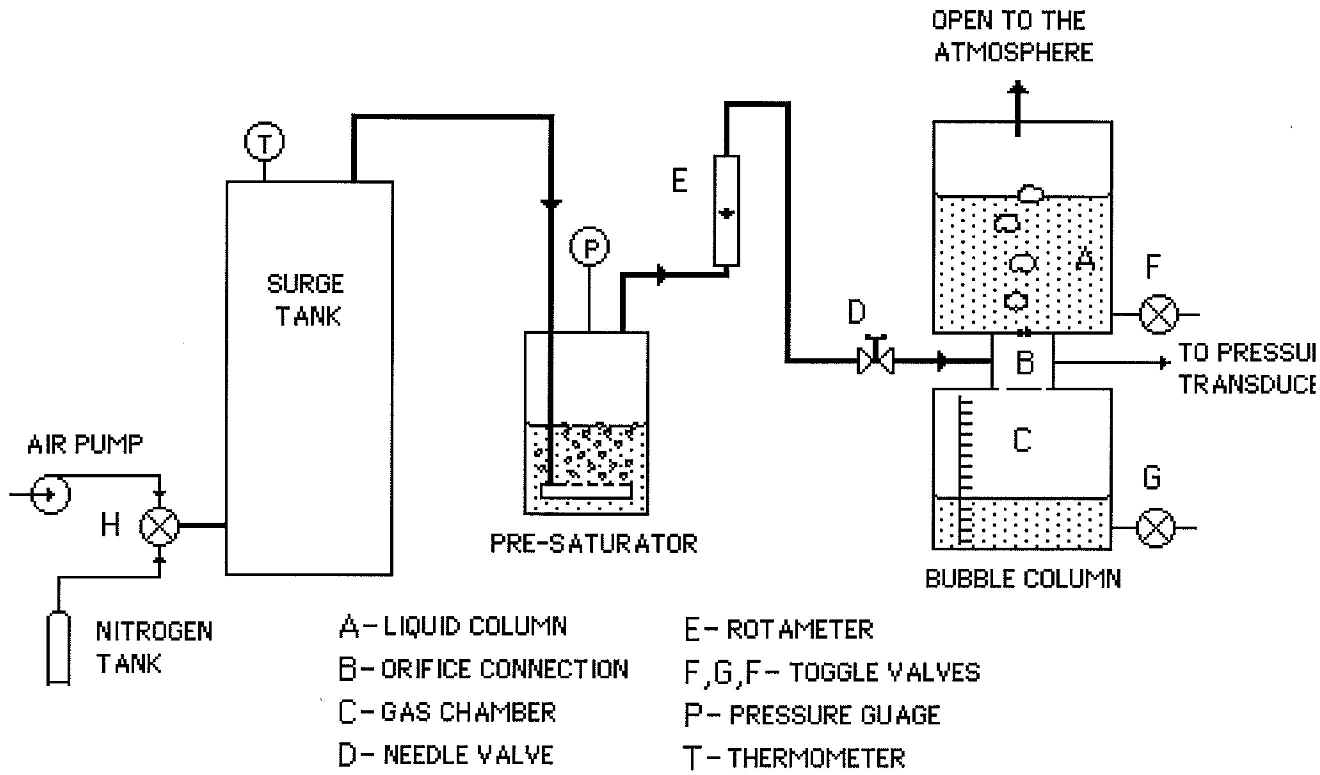

Figure 4-1 A schematic diagram of the experimental, atmospheric- pressure system is shown here. Either air or nitrogen may enter the surge tank. The gas is then saturated with water and flows at a controlled rate into the Bubble Column. Bubble measurements are made in the liquid column, A, and the gas chamber, C, collects any weepage water.

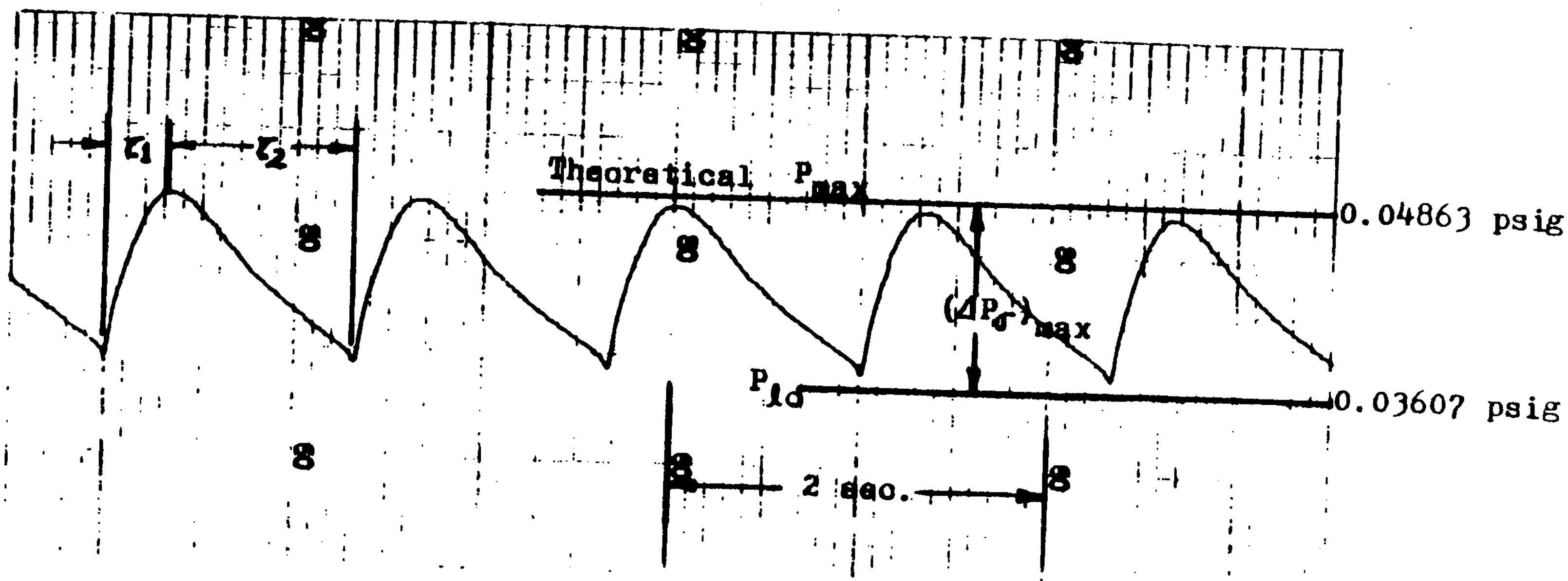

Figure (5-1). Pressure Fluctuation in Constant-Flow Regime. (Run W1-B1-S9-1; Air-water System at 12.5 psia, Brass Orifice of D_o = 0.330 cm, V_c = 11.7 cc, q_i = 3.30 cc/min, f = 45.5 Bubbles/min., V_{bf} = 0.73 cc)

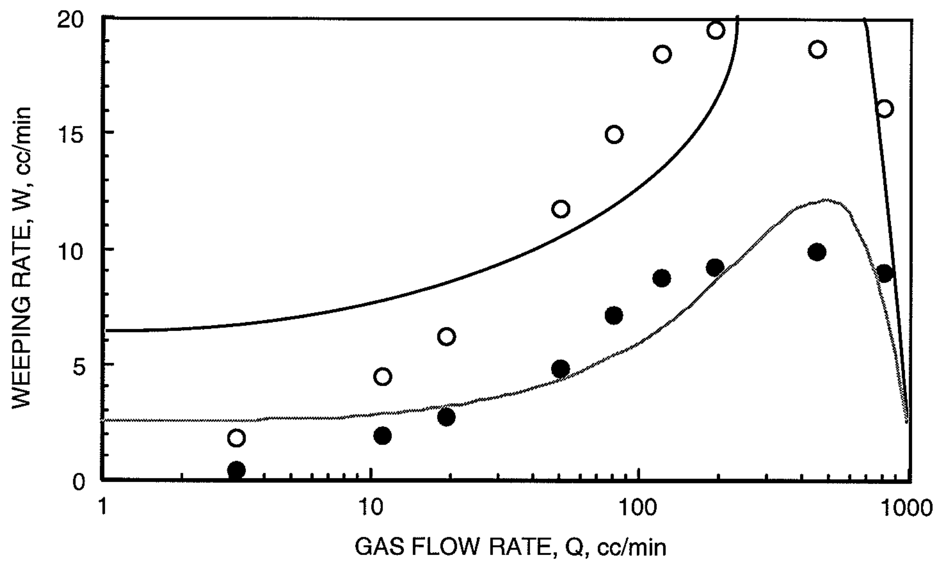

Figure 5-2 The effect of the gas flow rate on liquid weeping rates is shown here. The system was air and water at an average pressure, P_{ave}, of 12.5 psia and a chamber volume, V_c, of 602 cc. The open circles are for the case of the B2 orifice and the closed circles are for the T2 orifice. The lines are drawn according to the theory of L. Squares et al [56].

Students have a hard time deciding what to put in their flow diagrams. Most often students try to prepare a **picture** of the equipment. The figure on page 8 is an example of that. It is presented exactly as the student put it in his report. It represents considerable work by the student, but it is an **unsatisfactory figure** and received a **poor grade**. Its mistake is trying to show what the equipment looks like, rather than its **functional relationship**.

The figure on page 9 shows **what the student should have submitted** instead of the figure on page 8. It is much less of a picture, and much more of an abstract diagrammatic representation of the major pieces of equipment and their interrelationships. Standard symbols are used for the pump, control instruments, control valves, rotameters, tanks and tank vents. The control lines are shown with cross hatches to make clear that they are control lines, not flow lines. Some engineers would show the flow coming into the bottom of rotameters, and out the top, but most would show it as it is shown here, assuming that the reader knows the detailed piping of rotameters. Many details are left out, because this is about as much information as can practically be presented on a single page. Most of the instruments which give information but do not control flows are not shown.

The figure on page 10 is copied from an actual refinery piping and instrumentation (P and I) diagram. This is only part of an 11 x 17 sheet. It shows more detail than either of the figures on pages 8 or 9, but about the same level of abstraction as on page 9. To get more detail on the page, it covers less material. Observe:

1-The names of the principal pieces of are listed at the top. This is common convention in complex P and I diagrams, but not commonly used in simple ones.

2-The input stream enters at the lower left, with an arrow, and with information showing where it comes from. If the whole of this drawing were shown, one would see all output streams leaving the right of the figure, with information about where they go.

3-For each control valve the two block valves and the bypass valve which allow the control valve to be removed and serviced are shown. Those are also present on our laboratory column, but were not shown on page 9 for want of space.

4-The only trays in the column shown are those which have input lines, or withdrawal lines or a manhole.

5-Exchanger E-3118 is shown in the simplest possible schematic form. No effort is made to show what it **looks like**. (It is almost certainly a vertical, shell-in-tube, thermosiphon reboiler, like the one on our laboratory column).

6-Pipe sizes are shown. For example, before and after the bottoms flow control valve two 3" to 2" reducers are shown.

7-Instruments which indicate but do not control are shown. For example at the top of the column a temperature indicator (TI) is shown. Below it is a temperature recordertransmitter (TRT) which sends a temperature signal to the flow recorder-controller (FRC). It would be worth your while to figure out what all those abbreviations stand for.

8-There is a simple numbering scheme used for equipment and valves. Please figure out what that is and be prepared to discuss it.

9-There is at least one drafting error on this figure. Please find it and be prepared to discuss it.

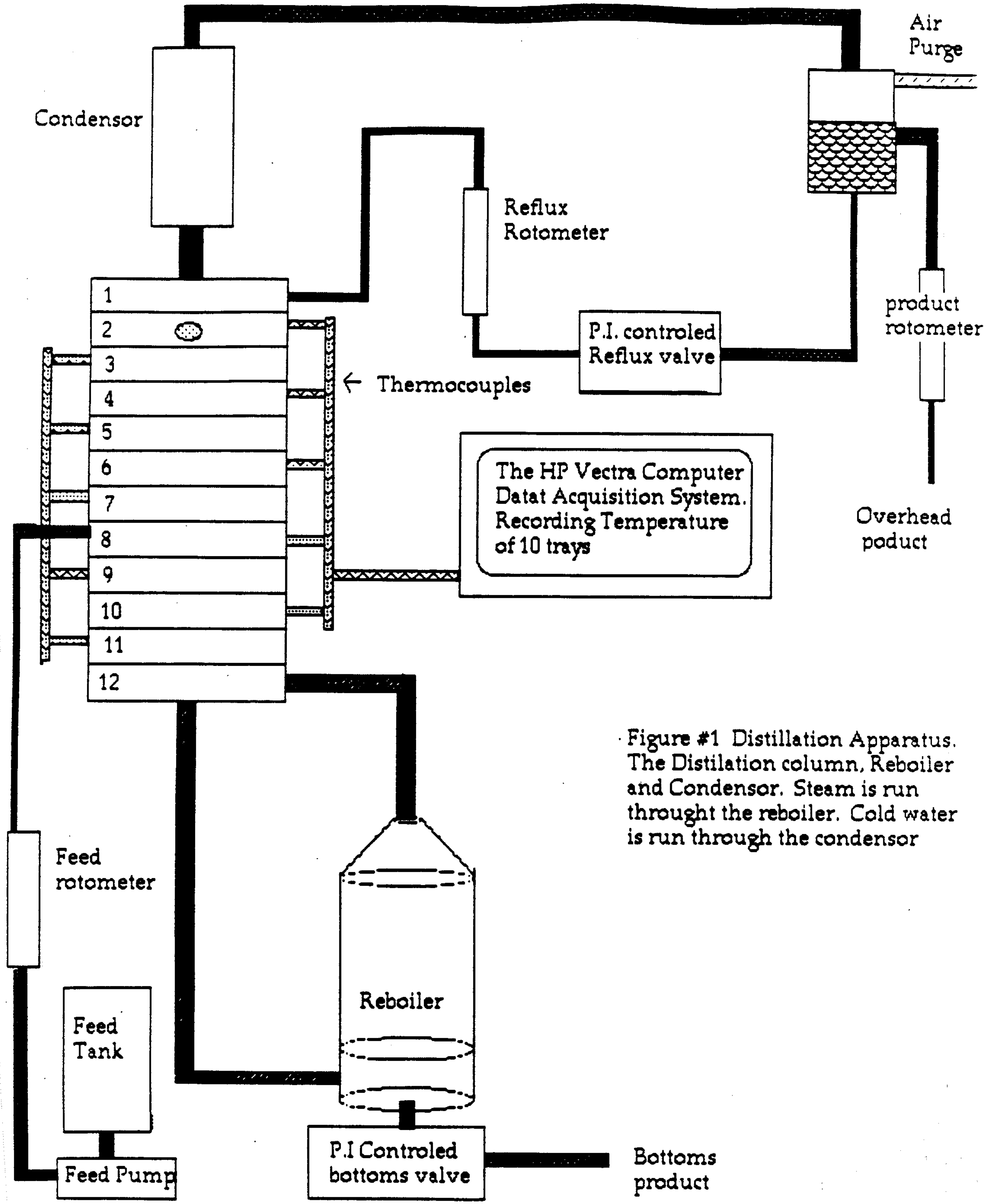

Figure #1 Distillation Apparatus. The Distilation column, Reboiler and Condensor. Steam is run throught the reboiler. Cold water is run through the condensor

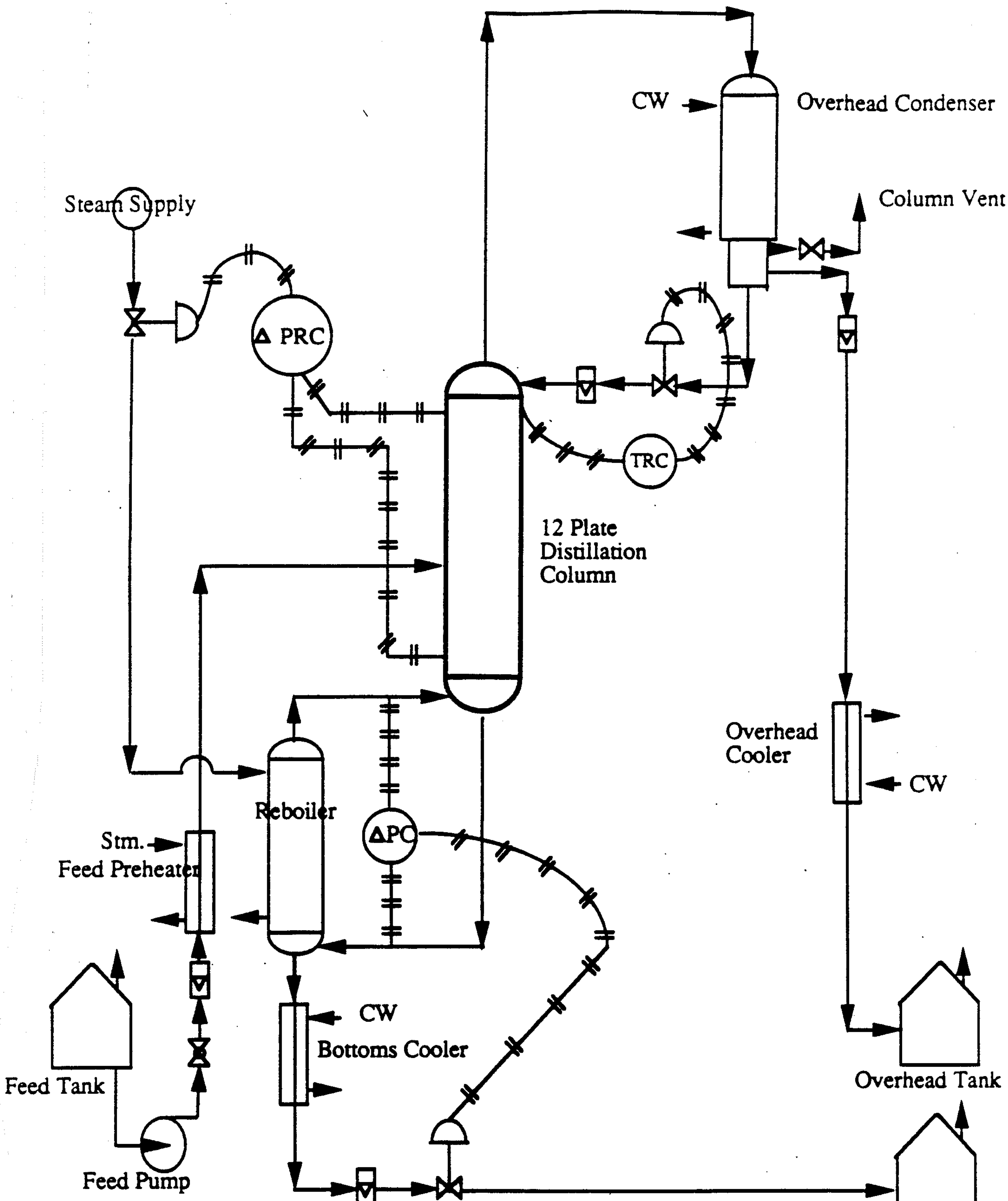

Figure 1

Flow diagram of the Ch.E. Laboratory Distillation Column, showing only the principal pieces of instrumentation.

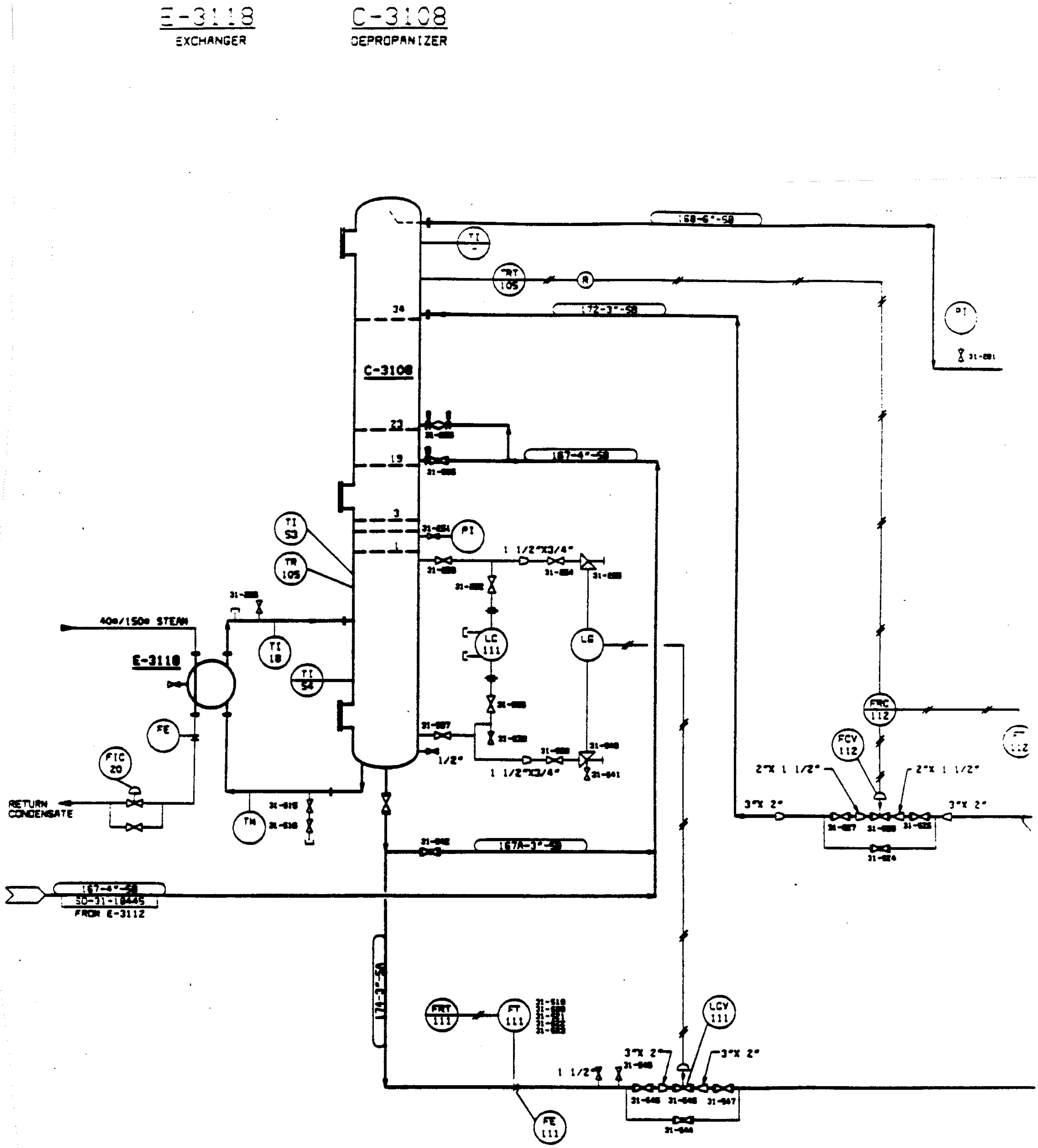

Figure 3

Part of an actual refinery piping and instrumentation diagram.