CHAPTER III
METHODOLOGY

3.1 Determination of Feedstock Temperatures

The aim of this section is to construct a profile of the effects of the temperature on the product yields. This can be implemented by changing the temperature of the feed stock entering the first distillation unit, which can be from 150^{o}C to 250^{o}C and at an increment of 10^{O}C. The % yield, as measured by the product volumes starting from their initial boiling point (IBP) to their T90 or final boiling point (FBP) mark, will be determined for each of the six products at that given temperature. The profile, and thus the optimum operating condition for each of the products can then be obtained from the plot of the product % yields against their respective temperatures.

The temperature of the feedstock entering the first of the five distillation units can be changed and controlled at the furnace. At this part of the plant, an increment increase of 10^{O}C from 150^{O}C to 250^{O}C can be obtained.

Direct measurement of the product volume, after having reached the steady-state, would not be an accurate determination of the product % yields. This is due to the fact that the boiling ranges and the values of IBP and FBP for each product can vary between each given temperature. The shifts in IBP and FBP values (together with boiling range discrepancies) could lead to either an overestimation or underestimation of the product volumes. An unambiguous means of measuring product % yields might be by measuring the volume of each of the product distillates based upon a standard boiling range. A standard boiling range will be employed for each of the products studied in

A standard boiling range will be employed for each of the products studied in the project. The range between IBP and T90 of commercial-grade standard (as used by this plant) will be employed for each products. The temperatures are shown Table 1.1. Using the difference between T90 and IBP, the volume of normal plant operating condition prior to temperature experience will be equal to 90 cm^3. Variation in product volumes caused by temperature changes can then be standardized against the 90 cm^3 volume mark and the differences can be converted to % yields. Therefore, in order to avoid artefacts in volume measurements caused by fluctuations in the boiling ranges (IBP and FBP shifts), the method employing commercial boiling range as used by the plant will be employed. For example, light distillate from this plant normally has an IBP value of 188^oC and a T90 value of 318^oC (thus a range of 130^oC and a known volume of 90 cm^3). The % yields of light distillate at each temperature change can be determined as follows:

1. Measure the volume of sample distillate (V_1) obtained at temperature T_1 from the IBP value of 188^oC to the T90 value of 318^oC.
2. Volumes of other distillates (Vn) obtained from other temperature (Tn) settings are then measured by volume distillation against the same temperature scale (188 to 318^oC).
3. The % yield (Xn) is then calculated as follows:

   $(Vn/90\ cm^3) \times 100$
4. The % yield and temperature profile can then be obtained by plotting temperature (Tn) against % yields (Xn)

3.2 Determination of Reflux Ratio and Product % Yield Profile

In this section of the experiment, temperature and reboiler steam feed-rate will be kept constant. The recycle stream (a measure of the rate of reflux) will be measured by means of top temperature of column or by pump capacity. The % yield of each product will be calculated as previously described. Volume measurements of the products will be determined against a constant temperature scale (specific for each product) and the % yield can then be calculated from the percent ratio of the sample volume and the T90 and IBP volume range (90 cm^3). The profile of the reflux ratio and the % yields can be obtained by a plot of either the pump capacity or recycle stream flow-rate against product % yields.

3.3 Determination of the Effects of Feed Flowrate on Product Yields

In order to determine the effects of feed flowrate on the yields of the products, parameters such as feedstock temperature, reflux ratio and steam feed flowrate were kept constant. Normal feed flowrate used in the process is 43 gallon per minute (GPM). The lowest value that the flowrate could be adjusted to in the experiments was 41 GPM. A value below the 41 GPM mark would result in dry heating (hot-spot) of the pipe circulating through the furnace. A result that is due to the insufficient amounts of feedstock entering the furnace pipe system. Other values of feed flowrate that were used in the experiments were 43, 45 and 47 GPM. A flow rate greater than 47 GPM was not attempted due to the problem of inefficient heat transfer in the furnace pipe system - a result of the feed remaining in the pipe due to insufficient capacity of the pipe. The feed flowrate was adjusted by increasing or decreasing the valve aperture. The feed flowrate was detected by a flowmeter located in front of the furnace.