CHAPTER I

INTRODUCTION

In two-phase flow, the coexistence of liquid and vapor phases, whose velocities are observably different, makes it very difficult to describe its hydrodynamic behavior. The void fraction distribution is also not necessarily uniform across a channel. Therefore, the relationship between the quality, the void fraction, and the volumetric flow fraction varies according to flow pattern. The kinematic equations, such as Zuber's, are developed for defining these relationships between flow parameters, with void profiles and velocity profiles as the basic starting point. However, the void and velocity profiles are merely the manifestation of the interaction that determines the flow structure between the two-phases and the interfacial momentum transport. If the evaporation-condensation process take place, we add on the interfacial mass and heat transfer as controlling processes. Thus, the basic underlying foundations for two-phase flow are the set of conservative and constitutive equations. Unfortunately, the basic set of equations is rather inconvenient to use and researchers have had to make simplifying assumptions that are sometimes controversial. This is why the model equations are still very lively subjects of research.

Design engineering problems are quite the opposite. Equations must be simple for design purposes. Even kinematic equations with known void profiles sometimes are too complicated to use. Thus, in many cases, the design engineers use the simplified equations with assumptions of homogeneous, no slip, and frozen or equilibrium, etc.

Two-phase flow can be found in all condensers, evaporators or boilers. It is also important in a variety of other equipment and in pipelines. Knowledge of two-phase flow is important in determining the pressure losses in the units, in determining limits such as the critical flow limit, and in forming a basis for a number of aspects of heat transfer coefficient calculation. In order to obtain a better appreciation of the special consideration involved in cryogenic piping system applications, it is necessary to review the behavior of materials at cryogenic temperatures including the physical and thermodynamic properties of cryogenic fluids. The piping used in cryogenic systems obviously must meet the structural demands imposed by low temperature conditions. From an economic point of view, the thermal efficiency of the piping system must be carefully considered since the heat addition to the system will ordinarily result in loss of product.

Only a rather small amount of two-phase pressure drop data is available for cryogenic fluids compared to other nonmetallic fluids. The two-phase flow of cryogenic fluids is complicated by the fact that because of heat infiltration liquid is continuously being vaporized. When a piping system is being designed, an initial pipe size and insulation type must be selected before the piping configuration is developed. However, after the piping system is developed, the pipe size selection is finalized by calculating the pressure drop based on the actual piping configuration and insulation selection and comparing it to the pressure head available.

Cryogenic piping system design is one of the routine work that computer programme can assist to find the suitable solution of pipe size and pressure drop. Different versions of the basic pressure drop programmes are used to calculate the liquid, gas or two-phase pressure drop through pipelines and fittings such as the PDROP2-4 programme of BOC Process Plants. Nevertheless, this software is developed by foreign enterprises or researchers, which can not consider the effect of heat transfer through pipe insulation to the dryness fraction and only horizontal pipeline can apply to. It requires many cryogenic properties data that may be provided from outside prediction of simplify mathematical equations which may cause a large error in the even of the user not being familiar with the basis of cryogenic process and thermodynamics. This software must be run under DOS only. There is the print function but can not save the calculated result as a file.

As the above reason, the new version of cryogenic piping systems simulation programme is developed to reduce the limitations and to increase the database management system by using procedural language and Object Oriented Programming (OOP) technique which provide Graphical User Interface (GUI) that runs under Windows 95 will necessarily present the user with a windows-style interface to link with other programmes flexibly.

1.1 Objectives

The objectives of this works are as follows:

1. To develop a computer programme for calculating the value of parameters necessary for cryogenic piping systems simulation.

2. To build up a database management system for supporting the cryogenic piping systems simulation.

1.2 Scope of Work

Design of piping system in this work is specific to the basic design, which is in responsibility of process engineer. The design comprises selection and sizing the piping system. The selection includes the appropriate choosing of pipe material and its insulation for adequacy of safety and type of cryogenic fluids. The sizing is pipe size selection that meets the design conditions of required pressure drop, flow rate and pipe configuration (Horizontal, Vertical and Inclination) with minimum vaporization.

This software is used for estimating pressure drop and size of the pipeline for both single and two phase flows. The programme also includes the database managerial part, which collects data of cryogenic fluids properties, properties of pipe material and fittings used in cryogenic pipeline and safety requirements. This database managerial part is used to support the operation of main programme. Furthermore, the database of this programme can be added for developing and improving its ability, as user required.

The cryogenic piping systems simulation programme was tested its reliability and performance by comparison with the data from real industrial situation and the calculated results of other programmes.