CHAPTER I
INTRODUCTION

Two-phase gas-liquid flow in vertical pipes has received attention from chemical industries especially on the applications on the transport of oil and gas in wells. Many industrial processes utilize pipes and equipment that are operated in two-phase flow regimes. These types of flow are often founded in numerous practical situations: production of steam and water in geothermal power plants, emergency core cooling of nuclear reactors, the simultaneous transport of gas and oil in vertical wells, and heat and mass transfer between gas and liquid in chemical reactors. The main existing flow regimes are the bubble, the slug, the churn, the annular, and the mist flow regimes. The major complexity in two-phase flows results from the growth and the collapse of the gas-liquid interfaces which give rise to various flow regimes.

These regimes are important in themselves because they can influence heat and mass transfer phenomena. Thus the first stage in analyzing a two-phase flow is usually to determine the prevailing flow regimes. Bubble flow is characterized by bubbles which are small when compared to the tube diameter and which are dispersed more-or-less randomly in the liquid continuum within the tube. If the number of bubbles increases with increasing gas flow-rate, large cap-shaped bubbles are formed by collisions, adhesions, and coalescence. When the diameters of these bubbles are nearly equal to the tube diameter, this marks the end of the bubble flow and the start of the slug flow. The churn flow pattern has been variously called 'froth', wave entrainment, dispersed plug, and semi-annular. The flow pattern is characterized by an abrupt increase in the pressure gradient and a maximum in the hold-up ratio. In the slug and churn flow regimes, pressure fluctuations are large and can induce damage to equipment. So, it is important to know their characteristics.

The annular and mist flow regimes are usually encountered in the flow of gas-liquid mixtures at high gas rates and gas/liquid ratios. The annular flow regime in gas/liquid system is characterized by an upward moving, continuous, smooth-to-wavy film of liquid on the tube wall and a much more rapidly moving gas in the central core, containing entrained droplets of liquid in a concentration which may vary from low to high. The liquid film may be wholly in laminar motion or it may be laminar only nearest the wall, and turbulent nearest the gas-liquid interface. Annular flow is the predominant flow pattern in evaporators, natural gas pipelines, and steam heating systems. With the further increase of the gas flow rate the liquid film becomes progressively thinner while the number of the droplets in the core flow increases. Finally, the film will be removed from the wall and a pure mist flow occurs.

Predicting a vertical two-phase or multiphase flow behavior in oil and gas-condensate wells is of great practical significance and importance. Pressure losses encountered during a concurrent vertical flow of two or three phases enter into a wide array of design calculations. Such design considerations include: tubing size and operating wellhead pressure in a flowing well, well completion or re-completion scheme, and artificial lift in low-energy reservoir. So, the pressure gradients in two-phase flow are very important factors for oil and gas industries.

In this work, various flow regimes were produced by varying the inlet gas and the liquid flow rates. We used pure water and aqueous glycerol solution as the working liquids. Glycerol is a very viscous fluid and it can become more fragile with increasing pressure. The chemical structure of glycerol is ($CH_2OHCHOHCH_2OH$)..

The objective this research is to focus on pressure drops in all flow regimes and investigates differences in the flow patterns found between the pure water and the aqueous glycerol solution. In particular, we want to investigate the effect of liquid viscosity on the flow pattern regimes and the corresponding pressure gradients at each flow regime. Moreover, the measured pressure gradients from the experiments will be compared with those predicted from the theory proposed in the literature.