Volume Fraction Measurement by Using Cesium Source Beam

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Abstract

An experimental study are presented using a cesium source beam for void fraction measurement in two phase oil-water mixture.A neutron source were used with activity of 0.6 μCi.The empty small plastic tubes were used for simulating the void through of the mixture.The results show that the void fraction(oil /water) value increases linearly with a count recorder by the detector.

Keyword: Volume Fraction,Void Fraction,Neutron Source,Two Phase Flow, Radiation.

Introduction

An important quantity in measuring and predicting the average density , pressure drop , flow pattern , …. Etc. of a flowing two – phase flow mixture in pipes is the void fraction.It is equal to the ratio of the volume of gas to the total volume of gas-liquid mixture in the finite length of the pipe line.One of the methods used for void fraction measurement is the radiation attenuation technique. The main advantage of this technique [Kendoush,1989]are:

-No physical contact of probes with the two – phase flow medium ; this avoids flow perturbation.

Relative easiness of the calibration method. -

The use of neutron source for void fraction measurement offers the following advantages :

-Relatively good accuracy

-The neutrally charged neutrons can easily penetrate thick walled steel pipes.

Multiphase flow is the simultaneous flow of two or more phases in direct contact in a given system. It is important in many areas of chemical and process engineering and in the petroleum industry, e.g. in production wells and in subsea pipelines. The behavior of the flow will depend on the properties of the constituents, the flows and the geometry of the system. There are four combinations of two-phase flows namely: gas-gas, gas-liquid, gas-solid, liquid-liquid, solid-solid and solid-liquid. Liquid-liquid flows, the subject of the present project are extremely important particularly in two-phase flow applications in horizontal pipes, for instance in the oil industry. In the oil industry, the dispersion of oil-in-water or vice versa usually appears in the oil well, to produce a fully oil in the well from offshore to onshore is one of the major problem for examples to investigate the physical of the pipe and the physical properties of the liquid that can affect the flow structure and production [Hussain et al., 2008].

The study of steam explosions involves intense three-fluid (melt or high-temperature solid clouds interacting with **a** coolant subjected to phase change - boiling or condensation) interactions. That is, very rapid transients in two or more spatial dimensions, and such as is at the frontier of multiphase flow science including the formulation of the field equations and constitutive laws on the one hand, and experiments intended to help identify mechanisms or verify mathematical models on the other. The internal structure of such transient multiphase interaction zones is of particular interest and value in this endeavor, but probing this internal structure presents major experimental challenges. To a large degree this is due to the hostile environment created by the high temperature melt, or the presence of solid particles in the case of using particle clouds [Angelini et al., 2000].

Emulsion stability is one of the most important factors governing the shelf life of foods, pharmaceuticals, cosmetics, etc. Principally, emulsions are dispersed, multiphase systems consisting of at least two insoluble liquids [Kostoglou, 2010].

In previous investigations, many researchers applied radiation technique on two-phase flows. However, very few studies have been reported on measurements of cross-sectional phase fractions of multiphase mixtures [LI Zhi-biao, 2005]. Oil wells produce widely varying amounts of oil, water and gas and exhibit a wide range of multiphase flow patterns. As a result, economical, accurate, real-time measurement of individual well production has remained a long-standing challenge for the industry. Current methods typically involve some form of separation of the produced fluid prior to measurement. Historically, producers have relied on three phase separators to divide the production streams into single-phase oil, water and gas stream for measurement using conventional, single-phase flow meters. Although generally effective, three phase separators have several properties including size, cost and limited turndown ratios that have driven the industry to seek alternative solutions. Recently, the maturing of online water cut and gas/liquid separation technology has enabled the industry to consider compact approaches based on two-phase separation [Daniel Gysling, 2005].

Measurement of multiphase pipe flow of gas, oil and water is not at all trivial and in spite of considerable achievements over the past two decades, important challenges remain. These are related to reducing measurement uncertainties arising from variations in the flow regime, improving long term stability and developing new means for calibration, adjustment and verification of the multiphase flow meters (GeirAnton ,2007).

The aim of this work is to calculate the the void fraction of mixtures of two component (oil – water) mixture (i.e.to calculate the average volume of oil mixed with water experimentally by using neutron source beam.

Experimental Procedure and Measurement

Layout (1) shows a typical arrangement of void fraction measurement based on allowing a collimated beams of nuclear radiation to traverse the cross section of the pipe . The neutron source is positioned diameterically on the opposite side of the detector . The attenuation of a beam of radiation when passing through oil – water medium of path length(L) is given by :

$$I = I_o \exp\left[2\sum_{w} T + \sum_{T} L\right]$$

Where:

I= Intensity of radiation beam incident on the detector ($cm^{-2}. S^{-1}$)

I_o=Intensity of radiation beam emitted from the neutron source ($cm^{-2}.s^{-1}$)

Σ_w =Macroscopic cross – section of the material of the pipe wall (cm^{-1})

T = Thickness of the pipe wall (cm)

Σ_T =Total Macroscopic cross – section of the oil water mixture (cm^{-1})

The total macroscopic cross - section of radiation interaction with the oil – water mixture is:

$$\Sigma_T = \alpha \Sigma_{oil} + (1-\alpha) \Sigma_f.$$

Where:

α=Void fraction

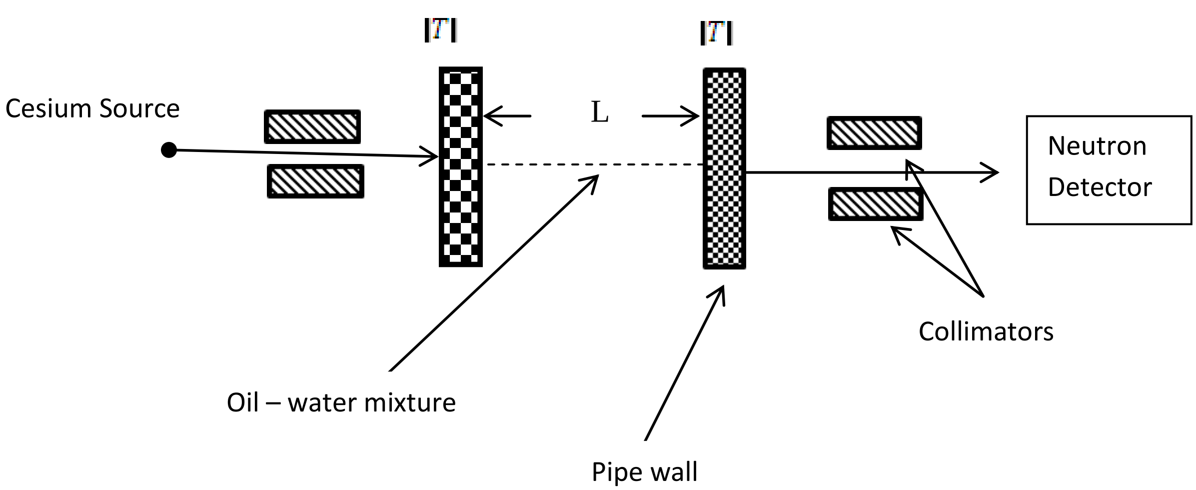
Σ_{Oil}=Macroscopic cross-section of oil (cm^{-1})

Σ_f=Macroscopic cross-section of water (cm^{-1})

A Pyrex tube (I .D. of 8.62 cm and 0.3 cm thickness) was filled with demineralized water.

Small diameter (0.6), empty plastic tubes were used for void simulation by inserting them Into the Pyrex tube (an arrangement of patient relevance to bubbly flow).I_{Oil},I_f and I detector reading were taken with the empty plastic tubes immersed in the water Filled in Pyrex tube . This was done for every time a certain number of plastic tubes were used to get the actual value of void fraction from the mock –up arrangement. The extreme case of droplet flow was also simulated by filling the plastic tubes with water and putting them into the empty tube. This method ensures that the thickness of the plastic tubes was canceled.

The experimental arrangement for measuring the void fraction consists of cesium source of 0.6 μCi activities and an 3He proportional counter of 2.54 cm .O.D, 25.4cm active length and 10 bar gas pressure The sensitivity of this counter was 45 count /s per neutrons/cm.s.



Layout (1) Schematic Diagram of Volume Fraction Measurement by Cesium Source Beam

Results & Discussion

In this research, we investigate the probability of using cesium source beam as a technique for measuring volume (void) fraction for water in mixture of oil – water. Fig.(1) shows the relationship of volume fraction of oil in water versus neutron count / min. , we find that the increase in the volume fraction will increasing neutron count / min because the density of oil is less than of water, the absorption cross-sectional area of the oil is less than the absorption cross-section area of the water, therefore the neutron count per min. will increasing . Fig.(2) shows the decrease in neutron count per min. with increasing volume fraction of water in oil , in this case we saw that the density of water is larger than the density of oil, the absorption cross-sectional area of water is greater than that of oil which lead to decrease the count per min. of the detector.

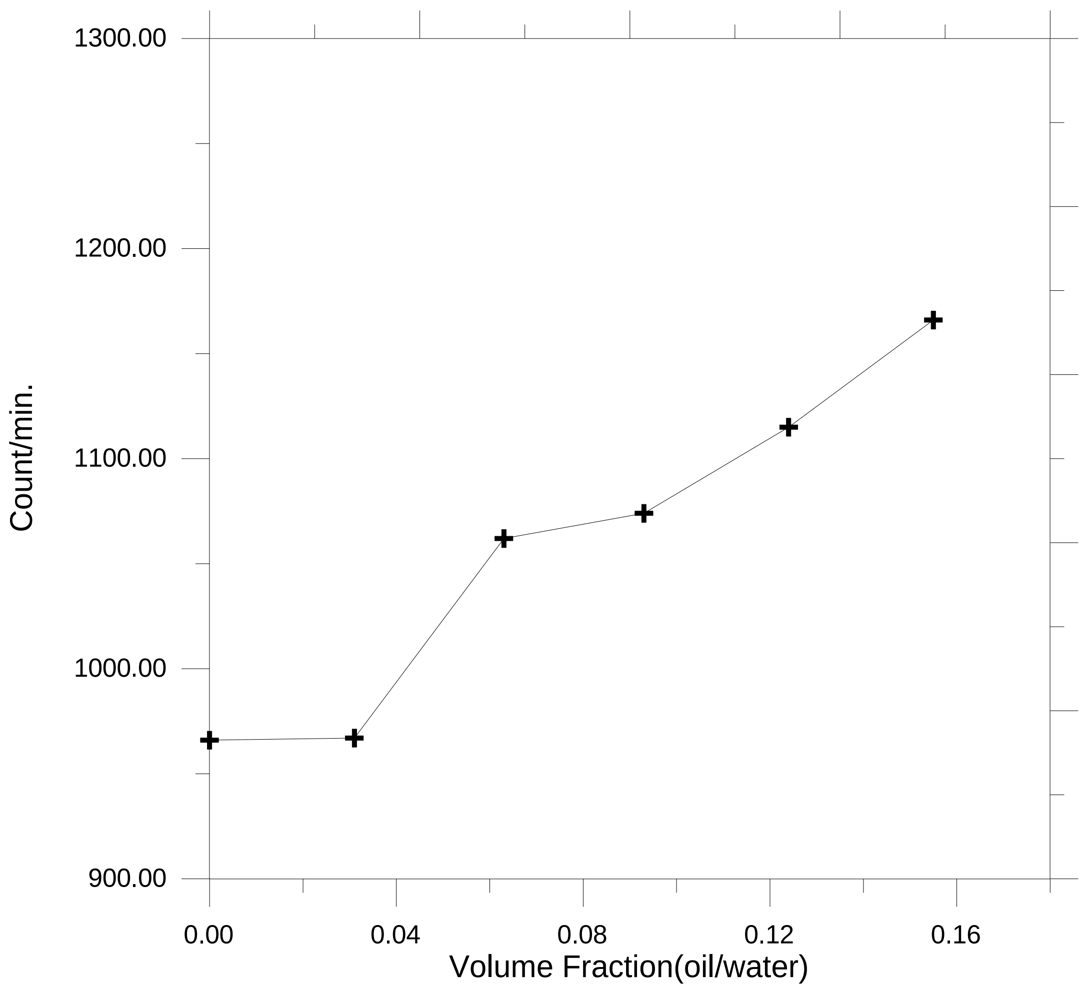


Fig.(1)Experimental Results of Volume Fraction(oil/water) Versus Count per Min.

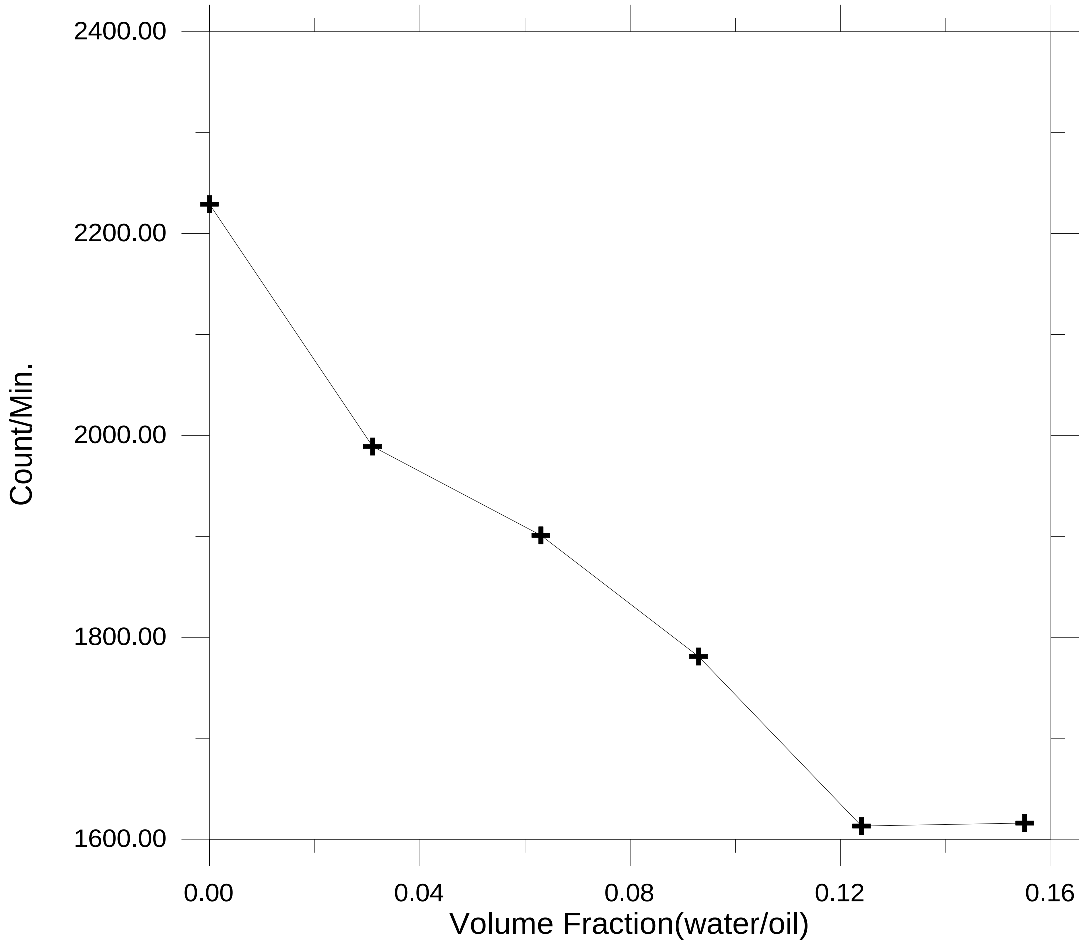


Fig.(2)Experimental Results of Volume Fraction(water/oil) Versus Count per Min.

Conclusions

From the present work we can deduce the following conclusions:

1. The increase in the volume fraction of oil/water will increasing neutron count per min.

2. The increase in volume fraction of water/oil will decreasing the neutron count per min.

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