Effect of Superficial Velocity on the Characteristics and Parameters of Plug Flow Pattern in a Horizontal Pipe

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Submission date: 26-Aug-2019 07:44PM (UTC+0700)
Submission ID: 1163598879
File name: No._2,_3,_4._MINI_SYMPOSIUM_proceeding.docx (16.92K)
Word count: 698
Character count: 3695

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ABSTRACT: In a two-phase gas-liquid flow, as part of an intermittent flow, has many flow pattern phenomena. The flow pattern occurs because differential superficial velocity of gas and liquid, and also the pressure fluctuation. Therefore, the study about plug flow is very important to obtain its parameters and characteristic data. Image processing method was applied to obtain the parameters, and characteristic of plug flow. In this experiment, horizontal transparent acrylic pipes with internal diameter of 19 mm was applied. A high-speed video camera (400 frame per seconds) was also used to visualize the pattern. Those observed videos were converted by Aisesoft Total Video Converter. After that the videos were changed into images with VirtualDub to analyze the parameters and characteristic of plug flow. The parameters of plug flow includes liquid superficial velocity and gas superficial velocity fraction whereas the wave characteristics consists of wave velocity and wave frequency. The results showed that a more apparent gas-liquid interface could be determined through this technique and the pattern of plug flow was also explained with the characteristics. The present results were also supported by the available previous studies.

Keywords: Superficial velocity, image processing, parameters of plug flow, characteristics of plug flow.

1. INTRODUCTION

The simultaneous flow between gas and liquid inside the pipelines requires more intricate analysis then single phase flow due to the different physical properties of the two phase, gas or liquid flow rates, and pipe geometry. Plug flow is known as elongated bubble flow without dispersed gas bubble. For a reason, a good understanding on parameters and characteristics on plug flow is truly needed to make database for a more clearly description on the slugging mechanisms.

Measuring techniques on the two-phase flows are still producing many data and challenges to complete database in two-phase flows. The previous techniques to know about two-phase flow by using flow measurement and image processing. Visualization techniques for horizontal flow was used by…

2. EXPERIMENTAL METHODS

In this experiment used transparent acrylic pipes with 19mm internal diameters. Air and water were used as working fluid. A depth visual observation of gas-liquid flow behavior was conducted by a high-speed camera while the capture video of process plug flow in 200D internal from the start gas-liquid out from mixer. A schematic layout of the experimental in Fig. 1.

This present work is involving 25 experimental data which covers the liquid superficial velocity (J_L) from 0.883 m/s to 2.061 m/s and that of gas superficial velocity (J_G) from 0.118 m/s to 0.589 m/s. The experimental data ranger is presented in Fig. 2 in the form of co-current horizontal flow pattern of Mandhane et al.

2.1. Steps of digital image processing

Each video was extracted into sequence image, through Virtual Dub software, this software changed video into images.

The processed of image processing are:

1) Image selection
   First step is selection image from frame-frame
2) Cropping image
   Then, input to CorelDraw X7 and crop the image until the plug flow see clearly.
3) Calculating Data
   The next step is calculating data in characteristics of plug flow

2.2. Matrix of Experiment

Data retrivial is done in three times in each research matrix. The final data is taken from an average of three times the results of experimental data on image processing. Table 1 is the matrix of this experiment.

3. RESULT AND DISCUSSION

1) Plug Wave Velocity

To calculate plug wave frequency, used the equation of Van Hout et al (2002):
The data of plug wave velocity can be show in Fig. 3.
Fig. 3 is revealed that the average plug wave velocity increased as the increased of gas superficial velocities (J_G) and liquid superficial velocity (J_L).

2) Plug Frequency

Plug frequency is total of plug flow per second. In Fig. 4 show the result of plug frequency. Under the constant J_L, the plug frequency decreases as the increase of J_G. For instances, the plug frequency can be obtained as the wave frequency.

4. CONCLUSION

1) Under a constant JL, plug wave velocity increase with increase of JG.
2) Under a constant JL, plug frequency decrease with increase of JG

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