Over-reading modeling of the ultrasonic flow meter in wet gas measurement

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Over-reading modeling of the ultrasonic flow meter in wet gas measurement

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Abstract: In this paper, the basic mechanism of two-path ultrasonic flow meter is studied, investigating the propagation characteristics of the ultrasonic wave in stratified and annular two-phase flow. The experimental results suggest that void fraction and liquid film thickness at the reflected point of the ultrasonic wave are the primary factors that lead to the over-reading of the ultrasonic flow meter. Based on the film thickness estimation correlation a USM over-reading model for determining the gas phase flow rate is developed under the certain circumstances, in which the liquid flow rate is assumed known. The experiments at the line pressure range of 0.2 to 1.1MPa in two-phase flow were conducted to validate this developed model. A DN80 V-turn one-time reflected two-path ultrasonic meter was used. By comparing the experimental data with the master meters' data, all the relative deviations of the predicted points by the model were within ±15% and in addition, 88% points drop within the error band of ±5%. As this work depends on the propagation characteristics of the ultrasonic wave in two-phase flow, it provides the basis for further establishing a flow measurement model of wet gas by the use of ultrasonic technology.

Key words: Ultrasonic meter; Wet gas; Over-reading; Liquid film thickness

1. Introduction

As a specific subset of gas-liquid two-phase flow, wet gas widely exists in various manufacturing processes in industry. According to the definition of the technical report by International Organization for Standards (ISO/TR11583) [1], wet gas refers to the two-phase flows of gas and liquid in which the flowing fluid mixture consists of gas in the region of more than 95% volume fraction. This definition is adopted in this study and all the experiment conditions were within this scope. Recent decades have witnessed a rapid development of traditional, as well as new, industries, such as oil and gas industry, chemical engineering, metallurgical engineering, nuclear reactor engineering and aerospace engineering, which has imposed more stringent requirements on wet gas metering. However, due to the complexity inherent in wet gas metering, it appears to be a difficult and challenging task in most industrial applications. The presence of liquid will cause single phase flow meters to give an incorrect gas flow rate