Available online at www.sciencedirect.com
ScienceDirect
Journal of Hydrodynamics
2011,23(1):89-94
DOI: 10.1016/S1001-6058(10)60092-3
www.sciencedirect.com/science/journal/10016058

# THE CALCULATION OF THE PROFILE-LINEAR AVERAGE VELOCITY IN THE TRANSITION REGION FOR ULTRASONIC HEAT METER BASED ON THE METHOD OF LES*

LIU Yong-hui, DU Guang-sheng, TAO Li-li, SHEN Fang
School of Energy and Power Engineering, Shandong University, Jinan 250061, China,
E-mail: liu@mail.sdu.edu.cn

(Received October 31, 2010, Revised December 21, 2010)

**Abstract:** The measurement accuracy of an ultrasonic heat meter depends on the relationship of the profile-linear average velocity. There are various methods for the calculation of the laminar and turbulence flow regions, but few methods for the transition region. At present, the traditional method to deal with the transition region is to adopt the relationship for the turbulent flow region. In this article, a simplified model of the pipe is used to study the characteristics of the transition flow with specific Reynolds number. The $k-\varepsilon$ model and the Large Eddy Simulation (LES) model are, respectively, used to calculate the flow field of the transition region, and a comparison with the experiment results shows that the LES model is more effective than the $k-\varepsilon$ model, it is also shown that there will be a large error if the relationship based on the turbulence flow is used to calculate the profile-linear average velocity relationship of the transition flow. The profile-linear average velocity for the Reynolds number ranging from 5 300 to 10 000 are calculated, and the relationship curve is obtained. The results of this article can be used to improve the measurement accuracy of ultrasonic heat meter and provide a theoretical basis for the research of the whole transition flow.

**Key words:** ultrasonic heat meter, Large Eddy Simulation (LES) model, profile average velocity, linear average velocity, pipe

## Introduction

At present, the technology level of the homemade ultrasonic heat meter is not high and the flux measurement accuracy can not meet various requirements. The measurement accuracy is mainly depend on two factors : (1) the signal collection by the electronic component, (2) the relationship of profile-linear velocity of flow. Its flow measurement principle is shown in Fig.1.

The ultrasonic Transducer A (TRA) and Transducer B (TRB) not only can emit the ultrasonic impulse (with an incident angle $\theta$ ), but also can receive the ultrasonic signal. Because the ultrasonic velocity in the downstream and upstream is different, the time for the ultrasonic signal to reach the two ultrasonic transducers is different, with a time difference $\Delta t$ . The linear average velocity $v_l$ is obtained by capturing this time difference

$$v_l = \frac{\Delta t c^2}{2D\left(\tan\theta\right)^{-1}} \tag{1}$$

where $D$ is the diameter of the pipe.

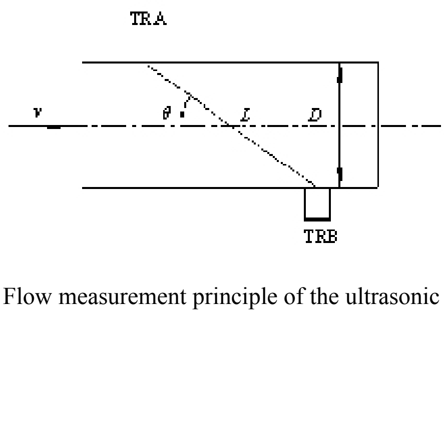


Fig.1 Flow measurement principle of the ultrasonic heat meter

* Project supported by the National Natural Science Foundation of China (Grant Nos. 10972123, 10802042), the Natural Science Foundation of Shandong Province (Grant No. Y2007A04).
**Biography:** LIU Yong-hui (1981-), Male, Ph. D. Candidate
**Corresponding author:** DU Guang-sheng,
E-mail: du@sdu.edu.cn