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Flow Field Analysis for Ultrasonic Flow Meter

Yuko OSHIMA[1], Toshiyuki TAKAMIYA[2], Shigeyuki ITO[3]

1) RDC, Ricoh Co.Ltd., Tsudukiku, Yokohama, 224-0035, Japan, mail: oshima@rdc.ricoh.co.jp

2) Ricoh Elemex Corporation, Omori Nishi, Otaku, Tokyo, 143-0015, Japan: t.takamiya@mail.rex.grp.ricoh.co.jp

3) Ricoh Elemex Corporation, Sakuragaoka, Chikusaku, Nagoya, 464-0025, Japan: s.itou@mail.rex.grp.ricoh.co.jp

Corresponding author ***Yuko OSHIMA***

Abstract

Basic principle of ultrasonic flow meter is to measure the time difference of ultrasonic wave between the go and the back signals traveling through the gas flow. There are various types of meters, such as the direct, the single reflection or the double reflection types. The flow field is one of the most important factors of the meter together with the sensors, the electric circuits and the system. That is, the signal to the noise ratio of the sensor depends on the flow condition of the passage of ultrasonic wave. Typical pattern of the ultrasonic flow meters are analyzed from the viewpoint of fluid dynamics, using CFD, hot-wire measurement and visualization with PIV method. The flow fields considered are with low turbulence level.

Keyword*: Ultrasonic flow meter, Hot-wire measurement, Flow visualization, PIV*

The ultrasonic gas meter is one of the new types of flow meters, and due to its compactness; is replacing the membrane type (integral type), which has been widely used. These types of flow meters measure the traveling time difference of ultrasonic wave between the transmitting and the receiving ports inserting inside the gas flow. Thus the transmission of ultrasonic signal depends strongly on the gas flow condition, that is, laminar or turbulent. In this paper, the flow fields of the meter is analyzed from the viewpoint of fluid dynamics. Experimental measurements using hot-wire anemometer is carried out for various types of the meters for the air flow, and the flow visualization with hydrogen bubble method is also done for water, and the images of the flow field are analyzed by PIV. The result obtained showed that the single reflection type is more preferable than the direct type, since the sensor can be set at positions where the flow effect is less. Also honeycomb panel is useful to decrease the turbulent level, that is, to increase the S/N ratio.

CFD analysis is carried out using the software FLUENT for the conditions corresponding to the experimental models. The agreements with the experimental data are very good.