論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Study of ultrasonic velocity profiling method on boiling two-phase flow
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出典(和文)	学位:博士（工学）, 学位授与機関:東京工業大学, 報告番号:乙第4122号, 授与年月日:2016年2月29日, 学位の種別:論文博士, 審査員:木倉　宏成,竹下　健二,加藤　之貴,赤塚　洋,相樂　洋
Citation(English)	Degree:, Conferring organization: Tokyo Institute of Technology, Report number:乙第4122号, Conferred date:2016/2/29, Degree Type:Thesis doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

2013.8改訂

（論文博士）

論　文　要　旨（英文）（800語程度）

（Summary）

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（要　旨）

Thesis title: "Study of Ultrasonic Velocity Profiling Method on Boiling Two-Phase Flow"

In the thesis, the study of ultrasonic velocity profiling method on boiling two-phase flow is presented. The main objective is to develop new ultrasonic velocity profiling techniques to measure boiling flow, specifically, subcooled flow boiling. The thesis includes five chapters as summarized below.

Chapter 1: "Introduction". The background and introduction of the thesis are presented. Boiling has long been acknowledged as one of the most efficient heat transfer mechanisms. It is widely used in water-cooled nuclear reactors. However, it is not fully understood due to the highly complex nature of the flow. Closure models are widely used. Experimental data are strongly required.

Two-phase flow measurement methods have been developed. However, they still have limitations. Moreover, very few methods can measure velocity distribution. The ultrasonic velocity profile (UVP) method is powerful to measure velocity profile. It has important advantages such as being non-intrusive; no requirement of optical access etc. It has been applied to two-phase flow measurement. Commercial UVP systems are available. However, their application to two-phase flow measurement has difficulties. Their cost is high. Custom UVP signal processings based on the pulsed Doppler method (UDM) or the cross-correlation method (UTDC) have been developed. In UVP measurement, ultrasonic-reflector condition is an important factor. So far suitable signal processing technique for a particular reflector concentration has not yet been examined. In this study a new UVP signal processing technique based on the spike excitation and auto-correlation UDM is developed (Chapter 2). Comparative measurements and analyses by using UDM and UTDC have been carried out. The spike-excitation UDM is applied to the multiwave UVP method (Chapter 3). A new method to measure the condensation rate in subcooled flow boiling is developed (Chapter 4).

Chapter 2, "Development of a UVP method by using spike excitation and pulsed Doppler techniques". The development of a new signal processing technique for UVP method is presented. The technique is based on the auto-correlation UDM and the spike excitation techniques. Spike pulser/receivers (P/Rs) are widely available in the ultrasonic testing. Spike technique may enable high spatial-resolution measurements. Previously, it was not used with the UDM. The damping of the spike signal is found to be the key to the successful measurement of liquid velocity. Besides, the use of auto-correlation calculation for analyzing echo signal is important. When the damping is low, measurement of liquid velocity is enabled by auto-correlation calculation.

Original software and hardware have been developed. The spike-excitation auto-correlation UDM (namely Spike_UDM) has been established. Validation has been carried out. High accuracy of the measured data has been confirmed. Measurements by using UDM and UTDC signal processings have been carried out. The measurement length of UDM, which includes Spike_UDM, is larger than that of UTDC.

Chapter 3, "Development of a multiwave UVP method by using spike excitation and pulsed Doppler techniques for two-phase flow measurement". The application of the Spike_UDM technique to the multiwave UVP method is executed. The multiwave UVP method exploits a specially designed multiwave sensor. The sensor has two piezoelectric elements. The 8MHz element (3mm diameter) has cylindrical shape. It fits in the hollow of the 2MHz element (10mm diameter). The sensor is able to emit/receive two frequencies 2- and 8MHz simultaneously. Two synchronized spike P/Rs are used for the two frequencies. The multiwave UVP method enabled simultaneous/separate measurement of liquid- (by 8MHz frequency) and bubble (by 2MHz frequency) velocity profiles along one measurement line. However bubble data are included in the measured data of 8MHz frequency. A new phase separation technique is developed to remove the bubble data from the 8MHz data.

Original signal processing software and hardware have been developed. The Spike_UDM multiwave UVP method has been established. Validation has been carried out. The accuracy of the measured dada has been examined. The new phase separation technique has been applied and validated.

Chapter 4, "Development of a new method to measure the condensation rate in subcooled flow boiling by using two ultrasonic frequencies". The development of a new method to measure the condensation rate is presented. The condensation rate is an important parameter in both experimental and numerical simulations of boiling flow. It is defined as v_c=-dR/dt where R is the bubble radius; t is time. Spherical equivalent bubbles are used. The new method uses two simultaneous UVP measurements of the bubble surface velocity (top and bottom surfaces). v_c is calculated by using the two measured data. The principle of the method is established.

Validation has been carried out. First, UVP measurement is confirmed to be adequate for the measurement of the condensation effect on the bubble surface velocity. Next, the new method is validated by the measurements of adiabatic air-water bubbly flow and subcooled boiling.

Chapter 5, "Conclusions". Insights from the Chapter 2 to 4 are summarized in this chapter.