

Abstract

Flow measurement is one of the mostly measured physical quantities in industry. It is of great economic importance. Pressure losses by measuring devices must be avoided and measurement errors should be as small as possible. These conditions are fulfilled with ultrasonic gas flow meter. The problem up to now was the difficult signal processing of the complex modulated ultrasonic signals.

Two types of flow meter by means of ultrasound, cross correlation meter and vortex flow meter respectively, are thoroughly researched in this work. The signal processing is based on the interaction between ultrasound and turbulences, from which the ultrasound is modulated both in phase and amplitude.

Analytic signal is used to model the complex modulation based on which the Hilbert Transform is introduced. The reconstructed signals through software Hilbert Transform not only keep a good result dealing with phase modulation part but also yield fairly good results when dealing with amplitude modulation part in cross correlation measurement. It is believed that the amplitude modulation signal is not applicable for measurement, which is a conclusion drawn in the case of the common Quadrature Amplitude Demodulation(QAD).

Demodulation is traditionally carried out by QAD. Extended Kalman Filter is applied to make demodulation in this dissertation. It is not only used in phase but also amplitude demodulation. This method, taking advantage of the same information required by using QAD, yields better demodulation results with less noise and overcomes the disadvantages such as phase jumping at high velocities using QAD.

The combination of cross correlation method with vortex method forms a self-monitoring system and overcomes the systematic error of pure cross correlation method resulting in less uncertainty and higher reliability. Inclination of bluff body in vortex flow measurement is investigated and the measurement in disturbed flow is also initially studied.

Keywords: ultrasonic flow measurement, signal processing, Hilbert Transform, Kalman Filter, cross correlation flow meter, vortex flow meter