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A COMPARATIVE STUDY OF VIBRATION CONTROL IN CANTILEVER BEAM AND U-TUBE CORIOLIS MASS FLOW METER USING LAB VIEW

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ABOUT ARTICLE

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Abstract: Vibration is a significant issue in flow measurement devices that can lead to inaccurate measurements. This paper presents a comparative study of vibration control in two common flow measurement devices, a cantilever beam and a U-tube Coriolis mass flow meter. The study uses LabVIEW software to control and measure vibration levels in each device. Various vibration control methods, including passive and active damping techniques, are implemented and compared. The results show that both devices can benefit from effective vibration control techniques, but the optimal method depends on the specific characteristics of each device.

INTRODUCTION

The measurement of mass flow rate is a vital process in many industries, including oil and gas, food and beverage, and chemical processing. The Coriolis mass flow meter is a widely used device for measuring mass flow rate due to its high accuracy and robustness. However, Coriolis mass flow meters are susceptible to vibration interference, which can affect their accuracy. In this study, we compare the performance of a cantilever beam and a U-tube Coriolis mass flow meter in terms of their susceptibility to vibration and the effectiveness of vibration control using LabVIEW. Accurate flow measurement is crucial in many industrial processes, and various flow measurement devices are used for this purpose. However, one common issue in these devices is vibration, which can cause measurement errors and reduce accuracy. Vibration control is, therefore, an important aspect of flow measurement.

This paper presents a comparative study of vibration control in two commonly used flow measurement devices, a cantilever beam and a U-tube Coriolis mass flow meter. The cantilever beam is a common type of flow sensor that operates based on the deflection of a beam under fluid flow. The U-tube Coriolis mass flow meter operates based on the Coriolis effect, where the flow of fluid in a vibrating U-tube causes a phase shift in the vibration of the tube.

In this study, we use LabVIEW software to control and measure the vibration levels in each device. The study compares various vibration control techniques, including passive and active damping methods. The effectiveness of each method is evaluated based on the reduction in vibration levels and the resulting improvement in measurement accuracy.

The rest of the paper is organized as follows: Section II describes the cantilever beam and U-tube Coriolis mass flow meter in detail. Section III discusses the LabVIEW software used in the study. Section IV presents the various vibration control techniques implemented and compared in the study. Section V presents the experimental setup and the results of the study. Finally, Section VI summarizes the findings and discusses the implications of the study.

METHOD

The cantilever beam and U-tube Coriolis mass flow meter were subjected to different levels of vibration using a shaker table. The vibration signals were acquired using a piezoelectric accelerometer and processed using LabVIEW. The effectiveness of vibration control was evaluated by comparing the accuracy of mass flow rate measurement before and after applying the LabVIEW-based vibration control system.

Cantilever Beam:

A cantilever beam flow sensor was constructed using a thin metal beam with strain gauges attached to measure deflection.

A test rig was constructed to pass fluid flow through the sensor and induce vibration.

LabVIEW software was used to measure and record the vibration levels in the beam.

Various passive and active vibration control methods were implemented in LabVIEW, including mass damping, viscoelastic damping, and active feedback control.

U-Tube Coriolis Mass Flow Meter:

A U-tube Coriolis mass flow meter was used for the study, consisting of a U-tube vibrating at a resonance frequency.

The device was connected to a fluid flow loop to generate flow-induced vibration.

LabVIEW software was used to measure and record the vibration levels in the U-tube.

Various passive and active vibration control methods were implemented in LabVIEW, including mass damping, viscoelastic damping, and active feedback control

Experimental setup:

A test rig was constructed for each device, and the flow rate was varied to induce different levels of vibration.

A range of vibration control methods were implemented in LabVIEW for each device and evaluated for their effectiveness.

The vibration levels were measured using accelerometers and recorded using LabVIEW.

The results were analyzed to compare the effectiveness of different vibration control techniques in each device.

Data analysis:

The data collected during the study were analyzed using statistical methods to compare the effectiveness of different vibration control techniques in each device.

The effectiveness of each technique was evaluated based on the reduction in vibration levels and the resulting improvement in measurement accuracy.

Overall, the study used LabVIEW software to compare the effectiveness of various vibration control techniques in two different flow measurement devices, a cantilever beam and a U-tube Coriolis mass flow meter. The study involved the construction of test rigs, the implementation of various vibration control techniques, and the measurement and analysis of vibration levels in each device.

RESULTS

The results show that both the cantilever beam and U-tube Coriolis mass flow meter are susceptible to vibration interference, with the U-tube Coriolis mass flow meter being more sensitive. The LabVIEW-based vibration control system was effective in reducing the vibration interference, resulting in an improvement in the accuracy of mass flow rate measurement for both devices. However, the cantilever beam showed better performance in terms of accuracy and stability compared to the U-tube Coriolis mass flow meter.

DISCUSSION

The study highlights the importance of vibration control in mass flow rate measurement and shows that LabVIEW-based vibration control systems can be effective in reducing the effects of vibration interference. The better performance of the cantilever beam can be attributed to its simpler design, lower sensitivity to vibration, and lower power consumption compared to the U-tube Coriolis mass flow meter. However, the U-tube Coriolis mass flow meter still offers higher accuracy than the cantilever beam for certain applications.

CONCLUSION

The study concludes that both the cantilever beam and U-tube Coriolis mass flow meter can benefit from the implementation of LabVIEW-based vibration control systems to improve their accuracy in mass flow rate measurement. The choice of device depends on the specific application requirements, with the cantilever beam offering better performance in terms of accuracy and stability for applications with low flow rates and the U-tube Coriolis mass flow meter offering higher accuracy for applications with higher flow rates.

REFERENCES

[1] QiaoShaojie, Wang Shuai, ZhengDezhi, Fan Shangchun-Analysis and Suppression of Mechanical

Coupling Vibrations of Coriolis Mass Flowmeter2010 International Conference on Intelligent

Computation Technology and Automation978-0-7695-4077-1/10 $26.00 © 2010 IEEEDOI

10.1109/ICICTA.2010.213

[2] Yao Kai, Zhao Jianhui, Li FanFinite Element Analysis of the Influence of Vibration Disturbance on Coriolis Mass Flow Meters2010 International Conference on Intelligent Computation Technology and Automation978-0-7695-4077-1/10 $26.00 © 2010 IEEEDOI 10.1109/ICICTA.2010.213

[3] Liu Shigang1, Xie Dailiang1*, Tao Shan2Design and Simulation of Fluidic Flowmeter for the Measurement of Liquid Flow inMicrochannelElectromagnetic2012 Third International Conference on Digital Manufacturing & Automation

[4] Arunshankarjayabalan ,Umapathy,Sliding mode controller with multi sensor data fusion for Peizo actuated structure,2011 –Rasearch gate

[5] KV Gangatharan ,Arun P ParameshvaranParametric modelling and FPGA based real time active vibration control of a peizo electric laminate cantilever beam at resonance -2014-Reasearch gate

[6] F J Arnold , RL XiemenesR.Aruthur , S SMuhlenA Driver for Peizo electric transducer with control of reasonance- -2015-science direct

[7] Ahmed A , Ali Rana Abdul Rahman lateel Mohamed waelsaseedIntelligent tunning of vibration mitigation process for single link manipulation using fuzzy logic 2017-science direct

[8] ReissomWeldigiorgis ,Prasad Krishna , K V GangatharanVibration control of a smart cantilever beam using srain rate feedback 2014 –science direct

[9] Asan Gain A labview based data acquisition systems for vibration monitoring and analysis 2002-SCRND

[10] JozeKutin, Andrej smercnik , Ivan BajsicPhase locking control of the coriolis meter ‘s resonance frequency based on virtual instrumentation-2003 science direct