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Analysing Coriolis Flow Meter Using Intellisuite

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Abstract

This paper reports the design and various analysis of U-tube Coriolis flow meter in INTELLISUITE software. The flow meter is designed in Blue print and the dynamic, Coriolis and frequency profile in Thermo-Electro Mechanical (TEM) analysis is done.

Keywords: Coriolis flow meter; U-bend; Nano; Dynamic; Frequency; Coriolis analysis.

1. Introduction

Coriolis flow meter is a meter used to measure the mass velocity and density of the element flowing through it. This flow meter works on the principle, the "swinging" is generated by vibrating the tube(s) in which the fluid flows. The amount of twist is proportional to the mass flow rate of fluid passing through the tube(s). Sensors and a transmitter are used to measure the twist and generate a linear flow signal. Coriolis mass flow meter can be used in variety of application such as in industries such as food beverage, oil, gas. To reduce downtime, to increase process efficiency, improve quality and consistency. Also used in biomedical.

Various sensors can be used in Coriolis flow meter, in this paper piezoelectric is used as the sensor, it works on the principle when an object undergoes a force or pressure the mechanical deformation takes place which leads to generate electrical energy. CFM measures the output directly and accurately compared to other volumetric meters.

To design and simulate Coriolis flow meter in nano size several software's can be used such as, COMSOL, ANSYS, INTELLISUITE. In this paper, INTELLISUITE software is used, it is the industry leading toolkit for MEMS layout design, advanced process stimulation, FEA, parametric analysis, system simulation, packaging analysis and more. Covering all aspects of the MEMS design cycle it gives the end to end software solution for MEMS objects.

In [1] a fabrication technology to realize fluidic channels at the surface of a silicon wafer, Coriolis type flow sensors have been realized in which a freely suspended channel is brought into vibration so that the moving fluid experiences Coriolis forces. The Coriolis forces excite another vibration mode which can be detected optically or capacitive. In [2] owing to the technology growth, especially in Microsystems technology and Nanotechnology, new products will provide new ways to sense variables that are crucial for product improvement and system reliability. A big concern of the scientific community is the measurement of low level flow measurements, especially for the biomedical and/or systems on a chip approaches. In [3] growing demand from the semiconductor industry for multi-component gas sensing for advanced process control applications. Microelectromechanical systems (MEMS) based integrated gas sensors present several advantages for this application such as ease of array fabrication, small size, and unique thermal manipulation capabilities. In [4] the significant phase shift parameter is modeled for various input factors like sensor location, mass flow rate and length of tube. In [5] Modal analysis is performed for the meso and micro U-tube Coriolis flowmeter using FEA CAD tool, COMSOL. As the mass of Coriolis flow meter reduces, the resonant frequency increases.

This paper explain the process of designing the CFM in nano size which is developed in INTELLISUITE software. The design of CFM is carried out in Blueprint and the various analysis such as, dynamic, frequency and Coriolis are carried out in TEM analysis.

In Section 1 design and simulation of U-tube flow meter is discussed. In Section 2 frequency analysis for U-tube flowmeter is addressed. In Section 3 dynamic analysis for CFM tube is discussed. In Section 4 Coriolis analysis for U-bend CFM tube is addressed

2. Design and Simulation of U-Tube

The CFM is also known as inertial flowmeter is the device that measures mass flow rate of a fluid or gas travelling through a tube .The principle of CFM, fig.1 when there is mass flow in the tube and tube vibrates in its natural frequency a twist will be occur in the tube where there will be phase shift between the inlet and outlet, which can be measured by the sensor attached to the flow meter.
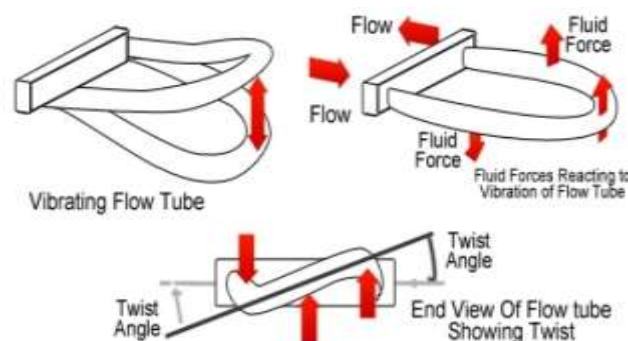

Fig 1. Coriolis flowmeter.

2.1. Blue Print

By the use of tools in the blueprint the construction of the Coriolis flowmeter is done. Blueprint is an application of INTELLISUITE to design the layout Fig.2 of the object using geometrical shapes. The shape is done by using lines and infinite line, point, polyline and arc option. The layers are defined in layer option, in which the layers materials, colour are done.
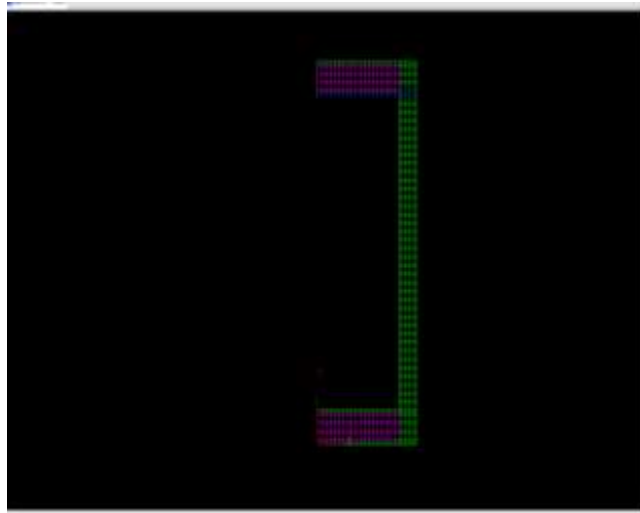

Fig 2. Blueprint.

2.2. 3D Builder

3D builder is used to make the object layout into 3D dimension and in the 3D builder the structure fig.3 of the object can also be created. Meshing can be done by auto or manual meshing. Meshing process to calculate the point where the loads are applied.
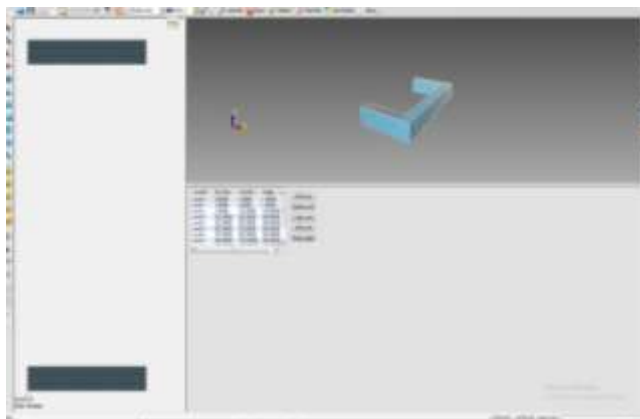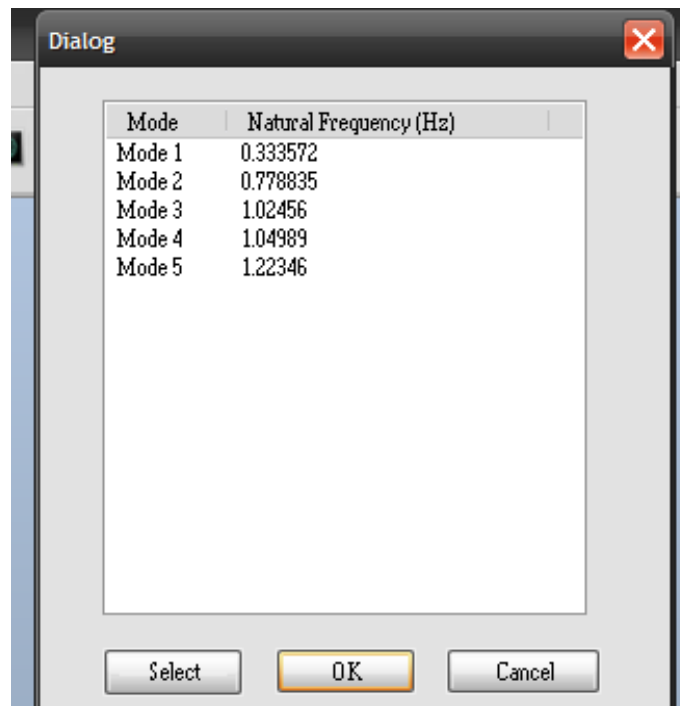
Fig.3. 3D structure.

2.3. Thermoelectricmechanical (Tem)Analysis

- Frequency Analysis:

In simulation select the frequency analysis and give the number of modes to find the natural frequency of each node in the structure. In Analysis select the start frequency analysis, a command prompt window pop up where it run the corresponding result. After in Result click the natural frequency fig.4, which show the frequency of the number of modes given. The display mode of each node can be done by animation mode.

Fig 4. Natural frequency.

- Dynamic Analysis

In simulation select the dynamic analysis, in which iteration and period of interval is valued. In material Check/Modify, damping material and in Fluid entity select the corresponding entity in the structure. After the simulation and material selection, give load condition, in which voltage is given as the load input to the piezoelectric sensor of the CFM and also give the boundary condition, select the fixed option and give the fixed faces of the structure. Select the analysis to start the dynamic analysis, where a window popup for the iteration and inner cut of the structure. A command prompt fig.5 popup runs the number of increment, iteration of each increment. After the completion of the operation select the 2D mechanical analysis to get the graphical result for the flow rate vs time fig. 6.
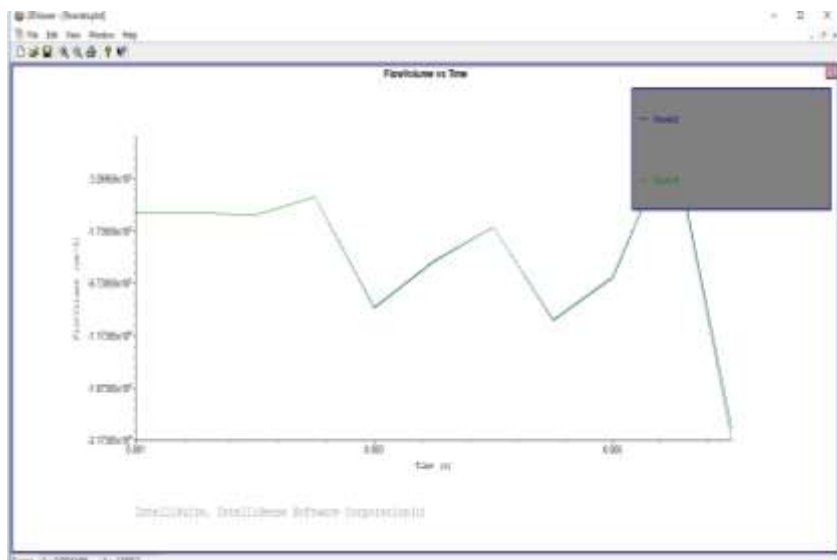
Fig.5. Command Prompt

Fig 6. Flow volume Vs time

- Coriolis Analysis

In simulation select the frequency analysis and give the number of modes to find the natural frequency of each node in the structure. In load select the Coriolis effect and apply it to the structure where the Coriolis window popup to give the spin rate, rotation axis and point in rotating axis values. In Analysis select the start frequency analysis, a command prompt window pop up where it run the corresponding result. After in Result click the natural frequency, which show the Coriolis frequency fig.7 of the number of modes given. The display mode of each node can be done by animation mode.
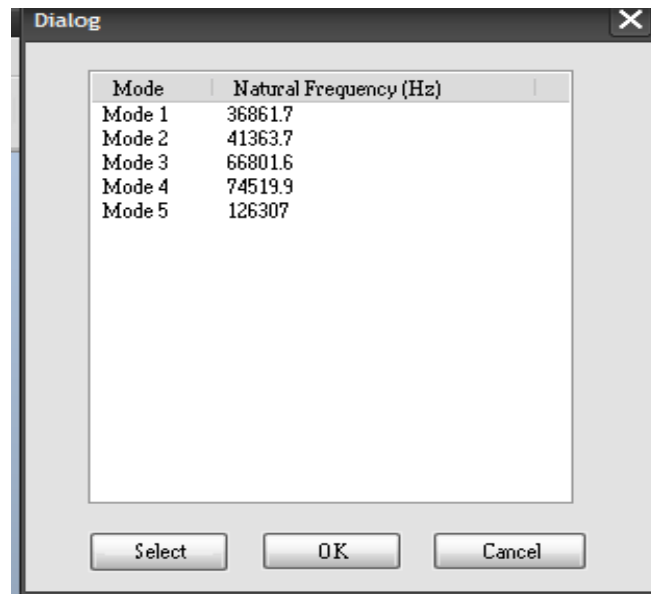
Fig 7. Coriolis in all 5 modes.

3. Conclusion

In this paper,. the process of designing the CFM in nano size which is developed in INTELLISUITE software.The design of CFM is carried out in Blueprint and the various analysation such as, dynamic, frequency and coriolisis are carried out in TEM analysis.

The pressure of various parts of the meter is also diagonalized and very useful to find the velocity of the fluid in direct method of measurement. This micro sized flow meter can be used in biomedical field, industries for micro fluid measurements and in research laboratory.

4. Future Work

After the structure is created in nano size export it to the rapid prototyping for printing the structure in 3D.

Acknowledgement

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