Design and Simulation of MEMS Anemometer

N. Kothari, D. Tandon, R. Mishra
Birla Institute of Technology & Science, Pilani, Rajasthan, India

Introduction: This paper concentrates on the design and simulation of a MEMS wind speed sensor (Anemometer) which is sensitive to low wind speed. The sensor is based on the thermal anemometer principle; designed using COMSOL Multiphysics and subsequently simulating its working.

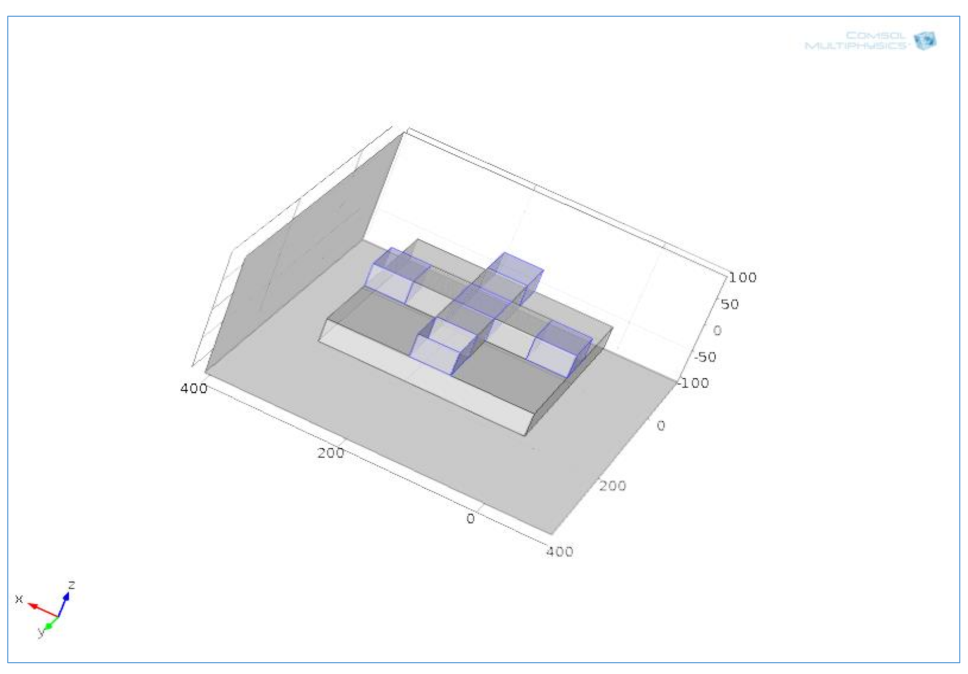
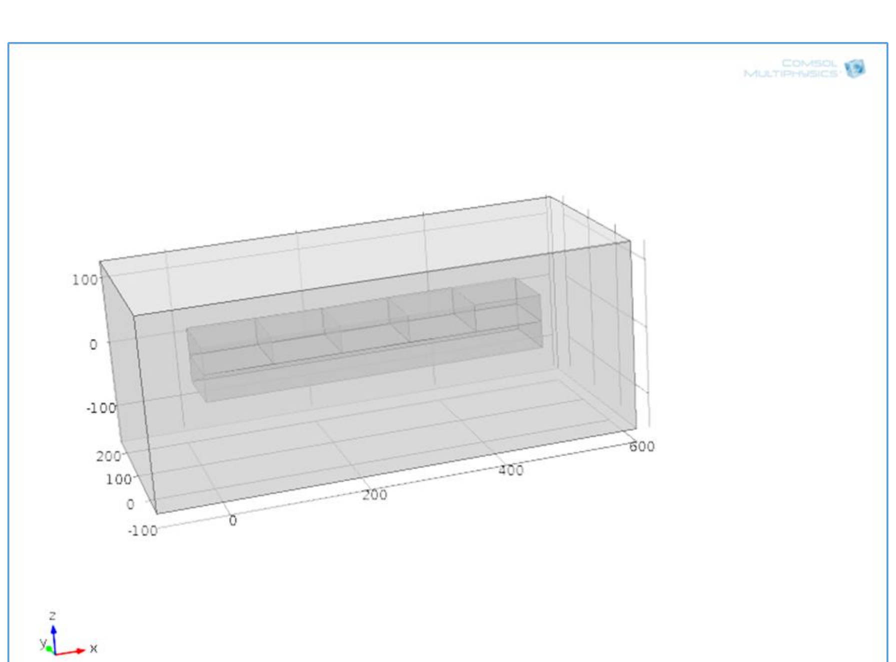


Figure 1. Geometry

Computational Methods: The design and simulation of this model is done with keeping in mind the scalability issues. We assume a lumped heat capacity model for the heater. Since our analysis is based only on convective model we will neglect conduction and radiation effects.

$$Gr = g\,\beta\,\Delta T L^3 / v^2$$

Conjugate heat transfer physics was used to simulate the design. An air velocity of 5cm/s and heating power of 0.0005 W to source was provided.



Surface 2 > Heater > Surface 1

Figure 2. Geometry and Design

Results: The rate of heat transfer is of the same order as the value obtained in our simulation.

$Gr=1.95\times10^{-6}$ $Re=0.35$ $Pr = 0.7$

$T= 400K$ $Nu = 0.664\times Re^{0.5}\times Pr^{0.33}$

$h = 174.6\ Wm^{-2}K$ $Nu = 0.35$

Rate of heat transfer= 0.00015 W

.

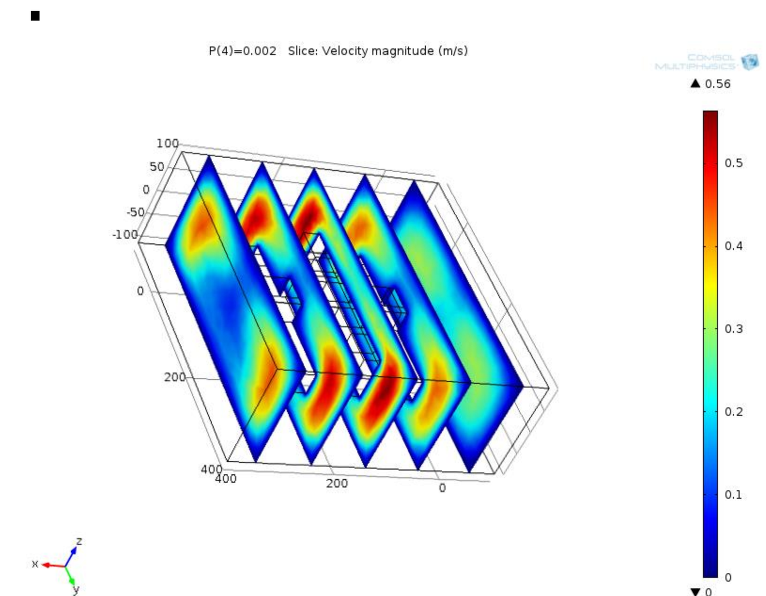


Figure 3. Velocity Plot

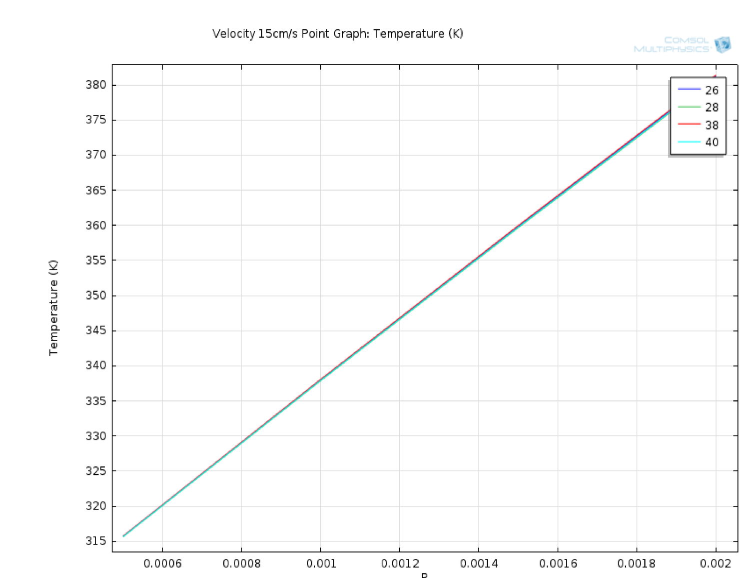


Figure 4. Point Graph

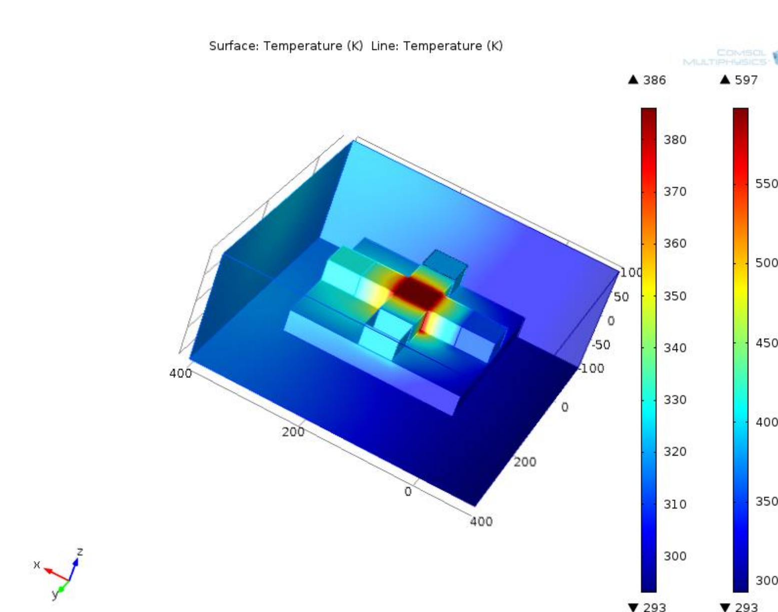


Figure 5. Bi-directional flow

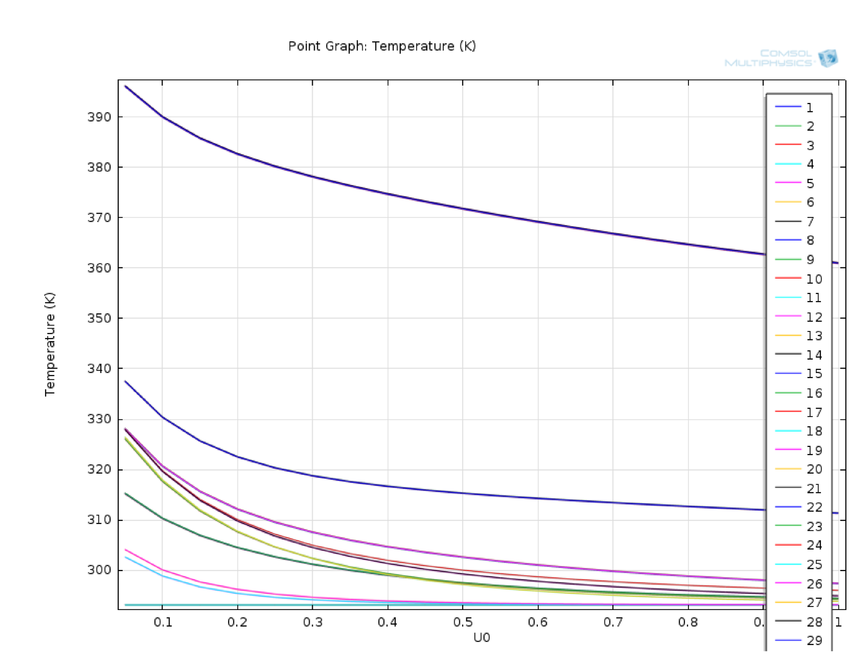


Figure 6. Temperature plot

Conclusions: The relation between the temperature of the heating element and the power input with different inlet velocities was plotted and graph obtained was a straight line which was in accordance with what was predicted using the theoretical relations.

References:

1. Buder, U., and A. Berns. "AeroMEMS Wall Hot-Wire Anemometer on Polymide Foil Measurement of High Frequency Fluctuations." *IEEE* (2005): 545.
2. Neda, T., and K. Nakamura. "A Polysilicon Flow Sensor for Gas Flow Meters. "Sense Actuators" A.54 (1996): 626.

Excerpt from the Proceedings of the 2015 COMSOL Conference in Pune