Thermal Analysis of Bar Element with Convection at the Tip Using Labview, ANSYS software's and Analytical Method

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Abstract**-The temperature measurement devices have been modified to the requirement of time. There are various temperature measurement devices these days. The thermocouple connected to digital temperature measurement device is one of them. A modern way of measuring temperature using virtual instrumentation Labview is used in the work. Experimental results of DAQ setup Labview are comparing with ANSYS and analytical method.**

Keywords: **DAQ setup, Labview, Ansys, convection tip, temperature profile**

I. INTRODUCTION

Experimental method by using data-aquisition system: for finding temperature distribution experimentally we took a mild steel rod with diameter 22mm & length 150 mm. Then we put heating element of capacity 35watts (soldiering iron element)on one side of the rod upto length of 40 mm which we will call as wall afterwords.then we put three thermocouples of k type at distances 0, .04 ,.08 mm respectively from the wall to measure temp. On the surface of the rod.Then we connected our object to data-aqusition device using SCXI module, which is a device which senses input analog signals and convert it into digital signal and shows results on computer. Afterwards electrical heating was done till steady state reached and results for steady state were noted. The practical setup is shown below in the picture.

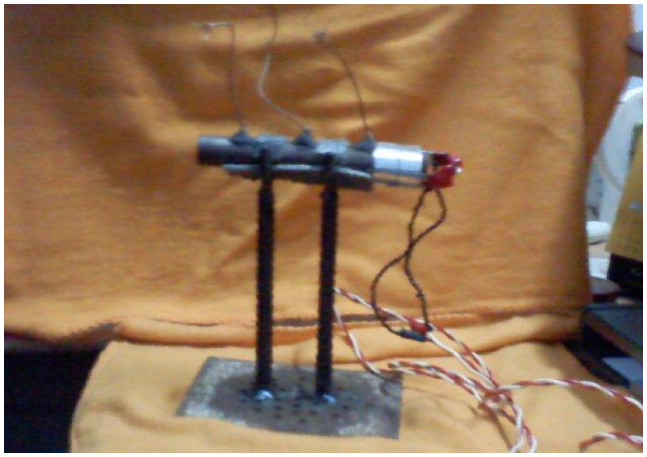


Fig. 1 Experiment Setup

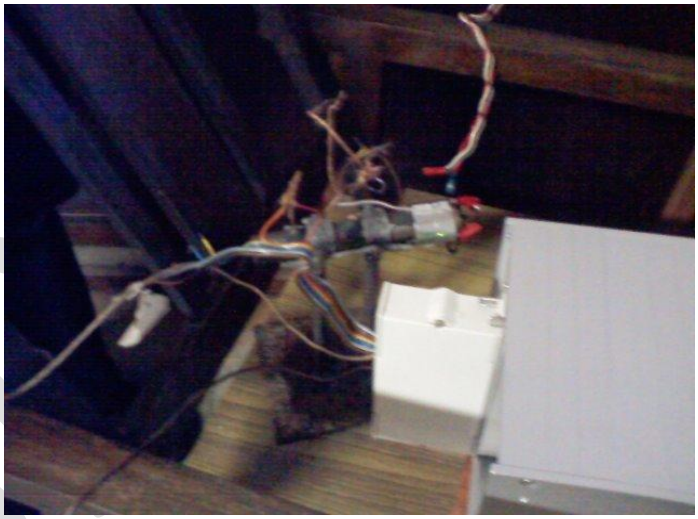


Fig. 2 Object connected to data acquisition system

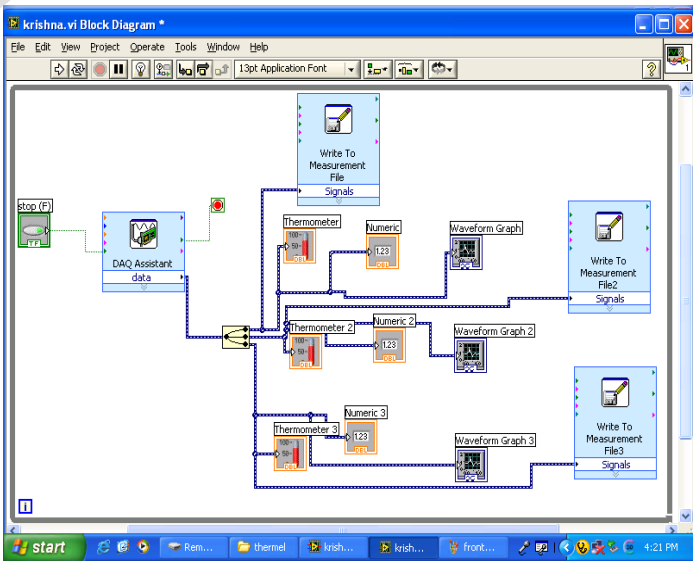


Fig. 3 Block diagram of Labview program

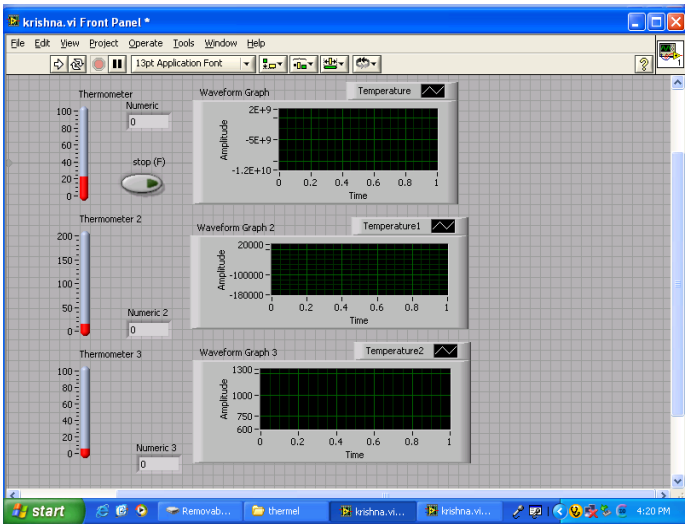


Fig.4 Front panel of Labview

The results found experimentally are:

Length / Temperature	X= 0 m	X= 0.04m	X=.08 m
T_0	160 ^{0} c		
T_1		149 ^{0} c	
T_2			134 ^{0} c

Table.1 Temperature variation with length in experiment methods

II. ANALYTICAL METHOD

By analytical method the calculations for the fin with convective tip were done using formula:

$$\frac{T_x - T_\infty}{T_o - T_\infty} = \frac{\cosh m(L-x) + \frac{\mathrm{h}}{\mathrm{mk}}\sinh m\,(L-x)}{\cosh mL + \frac{h}{mk}\sinh mL}$$

Where, $T_0 = Wall\ temperature$

$T_\infty = Ambient\ temperature$

$T_x = Temperature\ with\ lenght$

P= perimeter

$$m = \sqrt{\frac{hp}{kA}}$$

h=heat transfer coefficient

p=perimeter of the rod

k=thermal conductivity

A=area of the rod.

By putting all values in the formula the result found was:

Length / Temperature	X= 0 m	X= 0.04m	X=.08 m
T_0	160 ^{0} c		
T_1		149.76 ^{0} c	
T_2			142 ^{0} c

Table.2 Temperature variation with length in analytical methods.

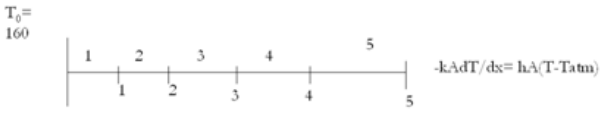
III. FINITE ELEMENTS METHOD BY USING ANSYS

The governing differential differential equation for the steady state analysis with one dimesional conduction and convective heat loss is given by:

$$k\frac{d^2t}{dx^2} + q = \frac{Ph}{A}(T_x - T_\infty)$$

And the elemental level equations derived can be written as

$$\frac{k}{L}[1 \quad -1, -1 \quad 1] + \frac{PhL}{6A}[2 \quad 1, \quad 1\ 2][T_1 - T_2] = \left(q + \frac{\rho h\, T_\infty}{A}\right)\left\{\frac{L}{2} \quad \frac{L}{2}\right\} + \{q_0 \quad q_1\}$$



Boundary condition:

1. at x = 0, $t_0 = 160^o$ c
2. $at\ x = L, \quad -KA\frac{dT}{dx} = \mathrm{hA}\,(T_x - T_\infty)$

V. RESULTS FOUND BY ANSYS

Length	Experimental Method	Analytical Method	ANSYS Method
	Temperature in ^{O}C	Temperature in ^{O}C	Temperature in ^{O}C
X=0 mm	160	160	160
X=0.04mm	151	149.76	153
X=0.08mm	134	142	145

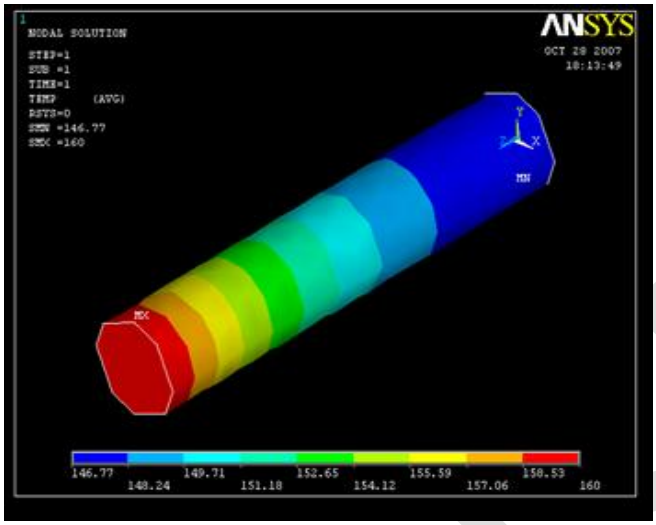


Fig.5 Temperature Variation along the bar length

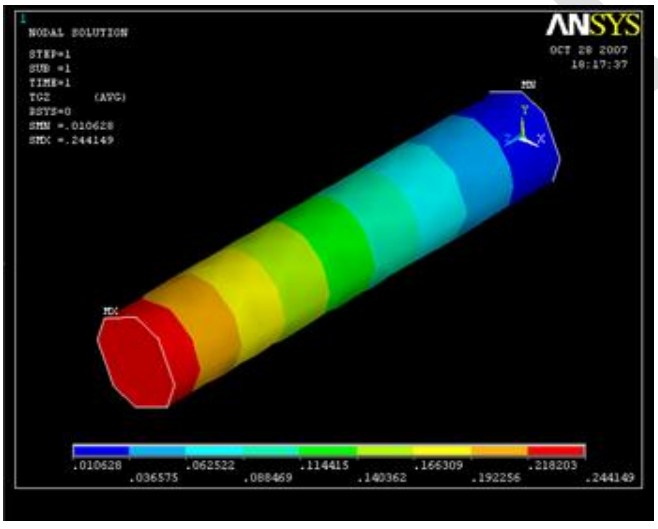


Fig.6 Temperature gradient

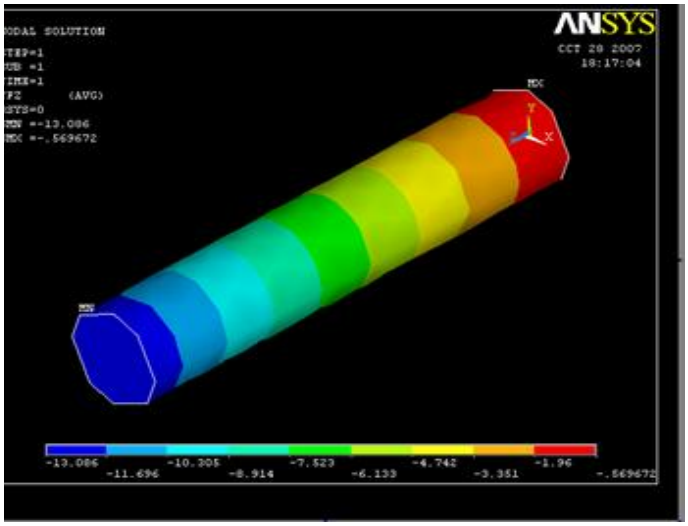


Fig.7 -Heat Flux variation along the bar

Result:

Table.3 Comparison of different method results

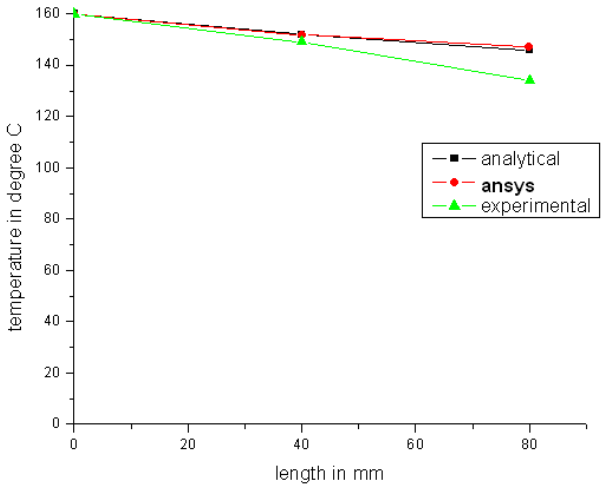


Fig.8 Result of different methods

VI. CONCLUSION

The temperature variation by different method has been calculated. It has been found that maximum temperature drop at tip in case of experiment method and minimum temperature drop at tip in case of ANSYS method. Analytical method result is between the experiment and ANSYS method.

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