**Experiment 9 : First order and Second order system**

**9.1**  
**Title :** Study of step response of thermometer  
**Aim :** To study the response of thermometer for step change  
**Procedure**:

* The heating bath was filled with clean water by opening the inlet valve.
* The beeper was switched on and the timer was set to 3 seconds interval.
* The heater was switched on to heat the water bath to nearly its boiling point and the heater was then switched off.
* The thermometer was brought to room temperature and inserted in the bath as soon as the heater was switched off.
* The readings of the thermometer was noted till the temperature attended a steady state.

**9.2  
Aim :** To study the response of thermowell for step change  
**Procedure :** It was the same as in 9.1, only the thermometer was replaced by a thermowell.

**9.3  
Title :** Study of sinusoidal response of a thermowell  
**Aim :** To study the response of a thermowell for a sinusoidal singal.  
**Procedure:**

* Inlet valve of heating bath was opened and water was supplied to it a constant rate.
* The thermometer was inserted in the inlet and the thermowell was inserted in the outlet of the water bath.
* The cyclic timer was set to 30seconds on-off time for the heater.
* A sinusoidal pattern was observed by taking the thermometer and thermowell readings after steady state was reached.
* The amplitude could be controlled by the water flow rate or the on-off time.

**9.4  
Aim :** To study the response of mercury manometer for a step change  
**Procedure :**

* The mercury level of the manometer was set to 0 on the scale.
* The blower was switched on and the needle valve and the outlet vent were adjusted to raise the mercury level till about 200mm.
* The vent was released and the pattern of the mercury height was noted down.
* The time of oscillation was also noted down.
* The process was repeated for different step changes.

**Manometer data :**

* Manometer fluid : mercury
* Dynamic viscosity= 0.0016 kg/ms
* Mass density=13550 kg/m3
* Column length=760mm
* Tube diameter=0.005m

**9.5  
Aim :** To study the response of a water manometer for a step change  
**Procedure:** Same as 9.4, only the manometer is different.

**Manometer data :**

* Manometer fluid : water
* Dynamic viscosity= 0.001 kg/ms
* Mass density=993 kg/m3
* Column length= 1.050m
* Tube diameter= 0.022m

**Discussions:**

* The main sources of error in this experiment were human error while taking the readings and setting the beeper to exact 3 seconds.
* The water flow might not be constant.
* The on-off cycle wasn’t exactly 30 seconds.
* From the results we can see that the response of the thermometer was faster than the thermowell because the well adds to some resistance in the heat flow.
* The sinusoidal wave was very accurately observed.
* The manometer readings were too fast and had to be video simulated.