

## Thermofluids

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**Abstract:** This research work deals with the implication of modern retailing at not only in Dhaka, Bangladesh but also the whole district in Bangladesh with main objectives to find out technological activity, impact on modern welfare.

**Keywords:** Conduction, Heat Flux, Thermal Conductivity, Mixtures of Perfect gases, Enthalpy

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### I. Introduction

The application of the principles of Thermofluids to bulk matter is divided into the “Thermal” and “Fluids” of Mechanical Terms. The entire subject is often called continuum mechanics, particularly when we adopt the useful model of matter as being continuously divisible, making no reference to its discrete structure at microscope length. Thermofluids is concerned with the rising and downing the temperature, explosion things, transferring heat etc. What, then, is a thermal? Any temperature, pressure can be main part of this source.

### Headings

The term consists of two words. “Thermal” meaning Heat and fluids which refers to liquid, gases and vapors. Thermal fluids or Thermofluids is a branch of science and engineering divided into four sections: 1) Heat Transfer, 2) Thermodynamics, 3) Fluid Mechanics, 4) Combustion.

### II. Indentations And Equations

#### Heat Transfer

This module describes conduction, convection, and radiation heat transfer. The module also explains how specific parameters can affect the rate of heat transfer.

Heat is always transferred when a temperature difference exists between two bodies. There are three basic modes of heat transfer:

- Conduction involves the transfer of heat by the interactions of atoms or molecules of a material through which the heat is being transferred.
- Convection involves the transfer of heat by the mixing and motion of macroscopic portions of a fluid.
- Radiation, or radiant heat transfer, involves the transfer of heat by electromagnetic radiation that arises due to the temperature of a body.

#### Heat Flux

The rate at which heat is transferred is represented by the symbol  $Q$ . Common units for heat transfer rate is Btu/hr. Sometimes it is important to determine the heat transfer rate per unit area,

or *heat flux*, which has the symbol  $Q''$ . Units for heat flux are Btu/hr-ft<sup>2</sup>. The heat flux can be determined by dividing the heat transfer rate by the area through which the heat is being transferred.

$$Q'' = \frac{Q}{A}$$

where:

$Q''$  = heat flux (Btu/hr-ft<sup>2</sup>)

$Q$  = heat transfer rate (Btu/hr)  
 $A$  = area (ft<sup>2</sup>)

#### Thermal Conductivity

The heat transfer characteristics of a solid material are measured by a property called the *thermal conductivity* ( $k$ ) measured in Btu/hr-ft<sup>2</sup>-°F. It is a measure of a substance's ability to transfer heat through a solid

by conduction. The thermal conductivity of most liquids and solids varies with temperature. For vapors, it depends upon pressure.

**Convective Heat Transfer Coefficient**

The convective heat transfer coefficient (h), defines, in part, the heat transfer due to convection. The *convective heat transfer coefficient* is sometimes referred to as a film coefficient and represents the thermal resistance of a relatively stagnant layer of fluid between a heat transfer surface and the fluid medium. Common units used to measure the convective heat transfer coefficient are Btu/hr - ft<sup>2</sup> - °F.

**Overall Heat Transfer Coefficient**

In the case of combined heat transfer, it is common practice to relate the total rate of heat

transfer ( Q ), the overall cross-sectional area for heat transfer (A<sub>o</sub>), and the overall temperature difference (Δ T<sub>o</sub>) using the overall heat transfer coefficient (U<sub>o</sub>). The *overall heat transfer coefficient* combines the heat transfer coefficient of the two heat exchanger fluids and the thermal conductivity of the heat exchanger tubes. U<sub>o</sub> is specific to the heat exchanger and the fluids that are used in the heat exchanger.

$$Q = U_o A_o \Delta T_o \tag{2-3}$$

where:

- Q = the rate heat of transfer (Btu/hr)
- U<sub>o</sub> = the overall heat transfer coefficient (Btu/hr - ft<sup>2</sup> - °F)
- A<sub>o</sub> = the overall cross-sectional area for heat transfer (ft<sup>2</sup>)
- ΔT<sub>o</sub> = the overall temperature difference (°F)

**Bulk Temperature**

The fluid temperature (T<sub>b</sub>), referred to as the *bulk temperature*, varies according to the details of the situation. For flow adjacent to a hot or cold surface, T<sub>b</sub> is the temperature of the fluid that is "far" from the surface, for instance, the center of the flow channel. For boiling or condensation, T<sub>b</sub> is equal to the saturation temperature.

**III. Thermodynamics**

**Thermodynamic Definitions & Relationships**

Specific enthalpy, h=u+pv

Specific heat capacity at constant volume, Cv=(∂u/ ∂T)<sub>v</sub>

Specific heat capacity at constant pressure, Cp=( ∂h/ ∂T)<sub>p</sub>

Ratio of specific heat capacities γ=Cp/Cv

**Ideal Gas Relationships**

Equation of state: pV=nRT

pV=mRT

pv=RT

Relationship between Cp, Cv and R: Cp-Cv=R

Perfect Gas Relationships

Change in specific internal energy: u<sub>2</sub>-u<sub>1</sub>= c<sub>v</sub> (T<sub>2</sub>-T<sub>1</sub>)

Change in specific enthalpy: h<sub>2</sub>-h<sub>1</sub>= c<sub>p</sub> (T<sub>2</sub>-T<sub>1</sub>)

Change in specific entropy:  $s_2 - s_1 = c_v \ln(T_2/T_1) + R \ln(v_2/v_1)$   
 $= c_p \ln(T_2/T_1) + R \ln(p_2/p_1)$   
 $= c_v \ln(p_2/p_1) + c_p \ln(v_2/v_1)$

**Mixtures of Perfect Gases**

For a mixture of  $N$  perfect gases where, for component  $-i$ ,  $m_i =$  mass,  $p_i =$  partial pressure,  $h_i = h_i(T) =$  partial specific enthalpy,  $s_i = s_i(T, p_i) =$  partial specific entropy,  $n_i =$  number of mols and the overbar signifies a partial molar quantity:

$$p_{mixture} = \sum_{i=1}^N p_i$$

$$H_{mixture} = \sum_{i=1}^N m_i h_i = \sum_{i=1}^N n_i \bar{h}_i$$

$$S_{mixture} = \sum_{i=1}^N m_i \bar{s}_i = \sum_{i=1}^N n_i \bar{s}_i$$

**Non-Dimensional Groups**

Reynolds Number	$Re = \frac{\rho V d}{\mu} = \frac{V d}{\nu}$
Mach Number	$M = \frac{V}{a}$
Froude Number	$Fr = \frac{V}{\sqrt{g z}}$
Prandtl Number	$Pr = \frac{\mu c_p}{\lambda} = \frac{\nu}{\alpha}$
Drag Coefficient	$C_D = \frac{D}{\frac{1}{2} \rho V^2 A}$
Lift Coefficient	$C_L = \frac{L}{\frac{1}{2} \rho V^2 A}$
Skin Friction Coefficient	$c_f = \frac{\tau_w}{\frac{1}{2} \rho V^2}$
Friction Factor	$f = 4 c_f$
Discharge Coefficient	$C_d = \frac{m_{actual}}{m_{ideal}}$
Nusselt Number	$Nu = \frac{h d}{\lambda}$
Grashof Number	$Gr = \frac{\rho g \beta \Delta T d^3}{\nu^2}$
Stanton Number	$St = \frac{Nu}{Re Pr} = \frac{h}{\rho V c_p}$

**Molar (universal) gas constant**

$$\bar{R} = MR = 8.3143 \text{ kJ/kmol K}$$

**Molar volume of a perfect gas**

1 kmol of any perfect gas occupies a volume of approximately 22.4 m<sup>3</sup> at s.t.p. (0 °C and 1 bar) and contains 6.022x10<sup>26</sup> particles.

**Thermochemical data for equilibrium Reactions**

The tables of equilibrium constants and standard enthalpy change on the next page relate to the reactions listed below:

Stoichiometric equations

$$\nu_i A_i = 0$$

$i$

where  $v_i$  is the stoichiometric coefficient of the substance whose chemical symbol is  $A_i$ .

- (1)  $-2H + H_2 = 0$       (4)  $-2NO + N_2 + O_2 = 0$       (7)  $-CO - \frac{1}{2} O_2 + CO_2 = 0$
- (2)  $-2N + N_2 = 0$       (5)  $-H_2 - \frac{1}{2} O_2 + H_2O = 0$       (8)  $-CO - H_2O + CO_2 + H_2 = 0$
- (3)  $-2O + O_2 = 0$       (6)  $-\frac{1}{2} H_2 - OH + H_2O = 0$       (9)  $-\frac{1}{2} N_2 - \frac{3}{2} H_2 + NH_3 = 0$

**Equilibrium constants**

The equilibrium constant  $K_p$  is given by

$$\ln(K_p) = \sum v_i \ln p_i^*$$

where  $p_i^* = p_i' / p_0$

$p_i'$  = partial pressure of species  $A_i$  in bars  $p_0$  = standard pressure = 1 bar

Thus  $p_i^*$  is numerically equal to  $p_i'$  but is dimensionless.

**Standard free Enthalpy of Reaction**

At a given temperature, the standard free enthalpy of reaction (or the *standard Gibbs function change*)  $\Delta G_T^0$  may be calculated from the listed value of  $\ln K_p$  by the following equation:

$$\Delta G_T^0 = -RT \ln K_p = -8.3145 T \ln K_p \text{ kJ}$$

**Equilibrium Constants & Standard Enthalpies of Reaction**

Reaction Number	1	2	3	4	5	6	7	8	9
$v_i$	-1	-1	-1	0	-1/2	-1/2	-1/2	0	-1
Temperature K	Equilibrium Constant $\ln(K_p)$								
200	250.149	354.472	285.471	105.592	139.972	161.789	159.692	19.719	15.433
298.15	163.986	367.479	186.975	69.865	92.207	106.228	103.762	11.554	6.593
400	119.150	270.329	135.715	51.311	67.321	77.284	74.669	7.348	1.778
600	75.217	175.356	85.523	33.203	42.897	48.905	46.245	3.348	-3.191
800	53.126	127.753	60.319	24.145	30.592	34.634	32.036	1.444	-5.822
1000	39.803	99.127	45.150	18.706	23.162	26.033	23.528	0.366	-7.457
1200	30.874	80.011	35.005	15.082	18.182	20.281	17.871	-0.311	-8.570
1400	24.463	66.329	27.742	12.489	14.608	16.160	13.841	-0.767	-9.371
1600	19.632	56.055	22.285	10.546	11.921	13.065	10.829	-1.091	-9.972
1800	15.865	48.051	18.030	9.035	9.825	10.657	8.497	-1.329	-10.439
2000	12.835	41.645	14.622	7.824	8.145	8.727	6.634	-1.510	-10.810
2200	10.353	36.391	11.827	6.834	6.768	7.148	5.119	-1.649	-11.109
2400	8.276	32.011	9.497	6.010	5.619	5.831	3.859	-1.759	-11.358
2600	6.512	28.304	7.521	5.314	4.647	4.718	2.800	-1.847	-11.563
2800	5.002	25.117	5.286	4.720	3.811	3.763	1.893	-1.918	-11.738
3000	3.685	22.359	4.357	4.205	3.086	2.936	1.110	-1.976	-11.885
Temperature K	Standard Enthalpy of Reaction $\Delta H_T^0$ MJ								
200	-434.7	-944.1	-496.9	-180.4	-240.9	-280.2	-282.1	-41.21	-43.71
298.15	-436.0	-945.3	-498.4	-180.6	-241.8	-281.3	-283.0	-41.17	-45.90
400	-437.3	-946.6	-499.8	-180.7	-242.8	-282.4	-283.5	-40.63	-48.04
600	-439.7	-948.9	-502.1	-180.7	-244.8	-284.1	-283.6	-38.88	-51.39
800	-442.1	-951.1	-503.9	-180.8	-246.5	-285.5	-283.3	-36.82	-53.66
1000	-444.5	-953.0	-505.4	-180.9	-247.9	-286.6	-282.6	-34.74	-55.07
1200	-446.7	-954.7	-506.7	-180.9	-249.0	-287.4	-281.8	-32.79	-55.83
1400	-448.7	-956.1	-507.8	-181.0	-249.9	-287.9	-280.9	-30.98	-56.07
1600	-450.6	-957.5	-508.9	-181.0	-250.6	-288.4	-279.9	-29.29	-55.99
1800	-452.3	-958.7	-509.8	-181.0	-251.2	-288.6	-278.9	-27.71	-55.66
2000	-453.8	-959.9	-510.6	-181.0	-251.7	-288.8	-277.9	-26.22	-55.19
2200	-455.2	-961.0	-511.4	-180.8	-252.1	-288.9	-276.8	-24.79	-54.61
2400	-456.4	-962.1	-512.0	-180.7	-252.4	-289.0	-275.8	-23.41	-53.92
2600	-457.6	-963.1	-512.5	-180.4	-252.7	-289.0	-274.8	-22.07	-53.12
2800	-458.6	-964.1	-513.0	-180.1	-253.0	-288.9	-273.7	-20.77	-52.22
3000	-459.6	-965.0	-513.4	-179.7	-253.3	-288.9	-272.7	-19.49	-51.20

**Warning:** These tables list *absolute* temperatures

**Properties of gases at sea level Conditions**

The following data are at  $p_{sl} = 1.01325 \text{ bar}$  and  $T_{sl} = 15 \text{ }^\circ\text{C}$ .

	<i>Air</i>	<i>CO<sub>2</sub></i>	<i>H<sub>2</sub></i>	<i>He</i>
Density $\rho \text{ kg/m}^3$	1.225	1.860	0.0852	0.1693
Viscosity $\mu \text{ kg/m s}$	$17.9 \times 10^{-6}$	$14.4 \times 10^{-6}$	$8.9 \times 10^{-6}$	$19.7 \times 10^{-6}$
Kinematic viscosity $\nu \text{ m}^2/\text{s}$	$14.64 \times 10^{-6}$	$7.7 \times 10^{-6}$	$104 \times 10^{-6}$	$116 \times 10^{-6}$
Speed of sound $\text{m/s}$	340	264	1292	988
Thermal conductivity $\lambda \text{ W/m K}$	0.0252	0.0153	0.180	0.150

**Fluid mechanics**

First, What is a *fluid*?

Three common states of matter are solid, liquid, and gas.

A fluid is either a liquid or a gas.

If surface effects are not present, flow behaves similarly in all common fluids, whether gases or liquids.

Example - The Penn State Sea Lion Students in the Penn State Mechanical Engineering Department have designed and built a human powered submarine, named the "Sea Lion" as part of a national contest. In the preliminary stages of the design, back in the early 1990's, some wind tunnel testing was done on various hull shapes and fin shapes. Since the submarine moves below any surface effects, it was perfectly valid to run these tests in a wind tunnel (using air as the working fluid) rather than in water (the actual fluid in which the submarine moves). As will be discussed in a later learning module, drag and lift measurements must, of course, be scaled properly according to the rules of dimensional analysis.

Example - PSU Harrier experiments Several years ago, Professor Cimbala had a research grant from NASA to study the interaction of the jet exhaust from a harrier aircraft with the ground, while the aircraft is in hover with a wind blowing. Model tests were conducted in both a wind tunnel and a water tunnel. It was perfectly valid to run these tests in either air or water, since there were no free surface effects to worry about. As will be discussed in a later learning module, the results in either case must be scaled properly according to the rules of dimensional analysis.

Formal definition of a fluid - A fluid is a substance which deforms continuously under the application of a shear stress.

Definition of stress - A *stress* is defined as a force per unit area, acting on an infinitesimal surface element.

Stresses have both *magnitude* (force per unit area) and *direction*, and the direction is relative to the surface on which the stress acts.

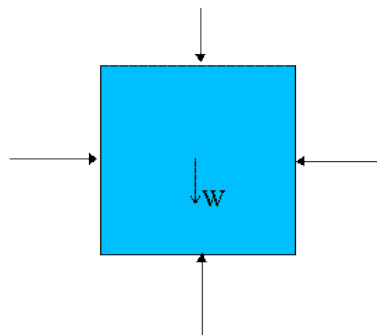
There are *normal* stresses and *tangential* stresses.

Pressure is an example of a normal stress, and acts inward, toward the surface, and perpendicular to the surface.

A shear stress is an example of a tangential stress, i.e. it acts along the surface, parallel to the surface. Friction due to fluid viscosity is the primary source of shear stresses in a fluid.

One can construct a free body diagram of a little fluid particle to visualize both the normal and shear stresses acting on the body:

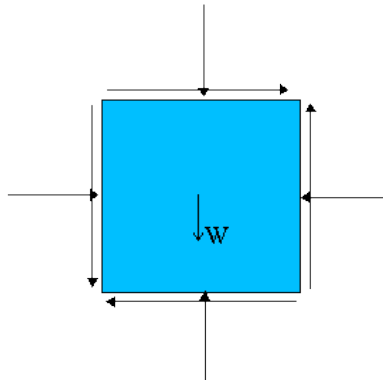
Free Body Diagram, Fluid Particle at Rest:



Consider a tiny fluid element (a very small chunk of the fluid) in a case where the fluid is at rest (or moving at constant speed in a straight line). A fluid at rest can have only *normal* stresses, since a fluid at rest cannot resist a shear stress. In this case, the sum of all the forces must balance the weight of the fluid element. This condition is known as *hydrostatics*. Here, pressure is the only normal stress which exists. Pressure always acts positively inward. Obviously, the pressure at the bottom of the fluid element must be slightly larger than that at the top, in order for the total pressure force to balance the weight of the element. Meanwhile, the pressure at the right face must be equal to that on the left face, so that the sum of forces in the horizontal direction is zero.

[Note: This diagram is two-dimensional, but an actual fluid element is three-dimensional. Hence, the pressure on the front face must also balance that on the back face.]

Free Body Diagram, Fluid Particle in Motion:



Consider a tiny fluid element (a very small chunk of the fluid) that is moving around in some flow field. Since the fluid is in motion, it can have both normal and shear stresses, as shown by the free body diagram. The vector sum of all forces acting on the fluid element must equal the mass of the element times its acceleration (Newton's second law).

Likewise, the net moment about the center of the body can be obtained by summing the forces due to each shear stress times its moment arm. As the size of the fluid element shrinks to "zero," i.e. negligibly small, the shear stress acting on one face of the element must be the same magnitude as those acting on the other faces. Otherwise, there would be a net moment, causing the fluid element to spin rapidly!

### Combustion

Combustion is the conversion of a substance called a fuel into chemical compounds known as products of combustion by combination with an oxidizer. The combustion process is an exothermic chemical reaction, i.e., a reaction that releases energy as it occurs. Thus combustion may be represented symbolically by:



Here the fuel and the oxidizer are reactants, i.e., the substances present before the reaction takes place. This relation indicates that the reactants produce combustion products and energy. Either the chemical energy released is transferred to the surroundings as it is produced, or it remains in the combustion products in the form of elevated internal energy (temperature), or some combination thereof.

Fuels are evaluated, in part, based on the amount of energy or heat that they release per unit mass or per mole during combustion of the fuel. Such a quantity is known as the fuel's heat of reaction or heating value.

Heats of reaction may be measured in a calorimeter, a device in which chemical energy release is determined by transferring the released heat to a surrounding fluid. The amount of heat transferred to the fluid in returning the products of combustion to their initial temperature yields the heat of reaction.

### Mass and Mole Fractions

The amount of a substance present in a sample may be indicated by its mass or by the number of moles of the substance. A mole is defined as the mass of a substance equal to its molecular mass or molecular weight. A few molecular weights commonly used in combustion analysis are tabulated below. For most combustion calculations, it is sufficiently accurate to use integer molecular weights. The error incurred may easily be evaluated for a given reaction and should usually not be of concern. Thus a gram-mole of water is 18 grams, a kg-mole of nitrogen is 28 kg, and a pound-mole of sulfur is 32 lb<sub>m</sub>.

Molecule	Molecular Weight
C	12
N <sub>2</sub>	28
O <sub>2</sub>	32
S	32
H <sub>2</sub>	2

The composition of a mixture may be given as a list of the fractions of each of the substances present. Thus we define the *mass fraction*, of a component  $i$ ,  $mf_i$ , as the ratio of the mass of the component,  $m_i$ , to the mass of the mixture,  $m$ :

$$mf_i = m_i / m$$

It is evident that the sum of the mass fractions of all the components must be 1. Thus

$$mf_1 + mf_2 + \dots = 1$$

Analogous to the mass fraction, we define the *mole fraction* of component  $i$ ,  $x_i$ , as the ratio of the number of moles of  $i$ ,  $n_i$ , to the total number of moles in the mixture,  $n$ :

$$x_i = n_i / n$$

The total number of moles,  $n$ , is the sum of the number of moles of all the components of the mixture:

$$n = n_1 + n_2 + \dots$$

It follows that the sum of all the mole fractions of the mixture must also equal 1.

$$x_1 + x_2 + \dots = 1$$

The mass of component  $i$  in a mixture is the product of the number of moles of  $i$  and its molecular weight,  $M_i$ . The mass of the mixture is therefore the sum,  $m = n_1M_1 + n_2M_2 + \dots$ , over all components of the mixture. Substituting  $x_i n$  for  $n_i$ , the total mass becomes

$$m = (x_1M_1 + x_2M_2 + \dots)n$$

But the average molecular weight of the mixture is the ratio of the total mass to the total number of moles. Thus the average molecular weight is

$$M = m / n = x_1M_1 + x_2M_2 + \dots$$


### Professional Experience

At Novartis (Sandoz) Bangladesh we calibrate a thermolab stability chamber machine. The data as follows:

Date Time	CH-1		CH-2		CH-3		CH-4		CH-5		CH-6		CH-7		CH-8	
	Temp	Hum.	Temp	Hum.	Temp	Hum.	Temp	Hum.	Temp	Hum.	Temp	Hum.	Temp	Hum.	Temp	Hum.
	T1(°C)	H1(%)	T2(°C)	H2(%)	T3(°C)	H3(%)	T4(°C)	H4(%)	T5(°C)	H5(%)	T6(°C)	H6(%)	T7(°C)	H7(%)	T8(°C)	H8(%)
29/02/2016 12:58	24.9	59.1	25.0	59.5	25.0	59.2	25.1	60.4	25.1	59.2	25.2	59.3	25.0	60.6	25.3	59.6
29/02/2016 12:59	24.9	59.5	25.0	59.5	24.9	59.2	25.1	60.4	25.1	59.2	25.3	59.6	25.1	60.3	25.3	59.8
29/02/2016 1:00	24.9	59.2	25.0	59.5	25.0	59.5	25.0	60.4	25.1	59.6	25.3	59.5	25.1	60.3	25.3	59.6
Min Value :	24.9	59.1	24.8	59.1	24.9	59.1	24.8	59.2	25.0	59.2	25.2	59.2	25.0	59.4	25.0	59.4
Max Value :	25.2	60.2	25.2	59.6	25.2	60.0	25.2	60.5	25.2	59.6	25.3	59.6	25.1	60.6	25.5	59.8
Average :	25.04	59.44	24.96	59.40	25.00	24.96	24.97	60.36	25.10	59.46	25.24	59.43	25.04	60.36	25.33	59.63

Note: Reading with underline indicates 'Out of Range'. NA: Not Applicable

Here, we observe that max and minimum value has showed. Sometimes it rises and sometimes it down. Also temperature and humidity calibration have been done in the following way:



Format No: CALSC/FO-01  
 Rev: 04  
 Date: 01/06/2014

The Equipment is calibrated at different temperature and humidity as per the working temperature and humidity range specified by us.  
**TEMPERATURE CALIBRATION**

Cal. Points	Value read on UUC TSNS-WALKIN-S1									Measured Value on Standard
	°C	°C	°C	°C	°C	°C	°C	°C	°C	
-20	-19.8	-20.0	-20.1	-20.0	-20.0	-19.9	-20.1	-20.0	-20.0	-20.0
-10	-10.0	-10.1	-10.0	-10.1	-10.1	-10.0	-10.2	-10.1	-10.1	-10.1
0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0
5	5.1	5.0	5.1	5.0	5.0	5.1	5.0	5.0	5.0	5.0
25	25.0	24.9	25.0	25.1	25.0	25.0	25.1	25.2	25.0	25.0
30	30.1	30.1	30.0	30.0	30.1	30.2	30.1	30.2	30.1	30.1
40	40.2	40.1	40.2	40.1	40.2	40.1	40.2	40.1	40.1	40.1
60	60.2	60.1	60.1	60.2	60.1	60.2	60.1	60.2	60.1	60.1
80	80.2	79.9	80.1	80.1	80.2	80.0	80.1	80.2	80.1	80.1

**HUMIDITY CALIBRATION**

Cal. Points	Value read on UUC TSNS-WALKIN-S1									Measured Value on Standard
	%rh	%rh	%rh	%rh	%rh	%rh	%rh	%rh	%rh	
30	30.1	30.1	30.2	30.1	30.3	30.0	30.1	30.1	30.1	30.1
40	40.0	40.2	40.1	40.2	40.1	40.2	40.1	40.2	40.1	40.1
60	60.1	60.2	60.2	60.1	60.2	60.1	60.2	60.1	60.1	60.1
65	65.2	65.1	65.2	65.1	65.2	65.2	65.1	65.2	65.1	65.1
75	75.3	75.2	75.2	75.2	75.3	75.4	75.2	75.2	75.2	75.2

**Acceptance Criteria**  
 Temperature : +/- 0.2°C from the Reference Standard  
 Humidity : +/- 2% RH from the reference standard  
**Conclusion** : The above data shows that the difference of Temperature humidity of the UUC from the Reference Standard is within the limit of acceptance criteria

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### IV. Conclusion

It is described clearly from professional view that thermal and fluid work is very needful in modern era.

**Limitation:**

1. In case of heat transfer radiator measurement is difficult.
2. For combustion not every fact that efficiency is gotten higher.
3. Calibration & validation data logger must be appropriate otherwise it creates a discrepancy on measurement.

Though it has limitations but modern era is very dependable on these. Specially in pharmaceutical sector these are very effective. Hence, all kinds safety for human is possible by this system. So, this system is absolutely welcome for modern era.