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THERMODYNAMICS

THERMODYNAMICS is the relationship between :
- heat and other form of energy

Temperature:
- is a factor that affects physical properties of fluids
- That is a concern when calculating state of gases

The poor temperature scales :
- Celsius
- And Fahrenheit
- And kelvin
- rankin

Degrees Fahrenheit = (1.8 × Degrees Celsius) + 32
Degrees Celsius = (Degrees Fahrenheit – 32) × 5/9
Degrees Kelvin = Degrees Celsius + 273
Degrees Rankine = Degrees Fahrenheit + 460

Or

$$\begin{tikzcd} R \arrow[r, shift left, "-460"] & F \arrow[l, shift left, "+460"] \arrow[r, shift left, "\frac{F^\circ - 32}{1.8}"] & C \arrow[l, shift left, "1.8 \times C^\circ + 32"] \arrow[r, shift left, "+273"] & K \arrow[l, shift left, "-273"] \end{tikzcd}$$

Heat energy unit : joule

THERMAL EXPANSION/CONTRACTION

Thermal expansion takes place in
1, solids
2, liquids
3, gases
- when they are heated

solids will
- expand when heated
- contract when cooled
- Because the molecules of solids are much closer together and are more strongly attracted to each other

Expansion = (coefficient) × (length) × (rise in temp.)

HEAT ENERGY UNITS

- joule
- calorie and the BTU.(One BTU of heat energy = 778 ft-lb of work)

THERMOMETERS

thermometer is a:

- temperature measuring instrument

NON-ELECTRIC TEMPERATURE INDICATORS

physical characteristics of most materials change when

- exposed to changes in temperature

The changes are consistent, such as the:

- expansion or contraction of solids, liquids, and gases

bimetallic thermometer:
The temperature sensing element of a bimetallic thermometer is made of :

- two dissimilar metals strips bonded together.
- Each metal expands and contracts at a different rate when temperature changes

One end of the bimetallic strip is

- fixed
- the other end is coiled

A pointer is attached to the coiled end which is

- set in the instrument housing.

When the bimetallic strip is heated:

- the two metals expand.

Bimetallic Temperature Gauge

ELECTRICAL TEMPERATURE INDICATION

Electrical Resistance Thermometers

Principle parts of the electrical resistance thermometer are the
- indicating instrument,
- the temperature sensitive element (or bulb),
- the connecting wires and plug connectors.

measure
- carburetor air,
- oil,
- free air temperatures,

They are used to measure
- low and medium temperatures in the –70 °C to 150 °C range.

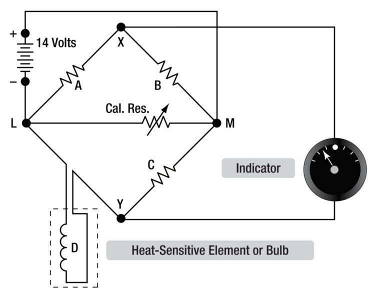


Figure 3-6. Internal structure of an electric resistance thermometer indicator features a bridge circuit, galvanometer, and variable resistor, which is outside the indicator in the form of the temperature sensor.

Ratiometer Electrical Resistance Thermometers

The ratiometer is more
- stable and can deliver higher accuracy

the ratiometer electrical resistance thermometer measures a :
- ratio of current flows.

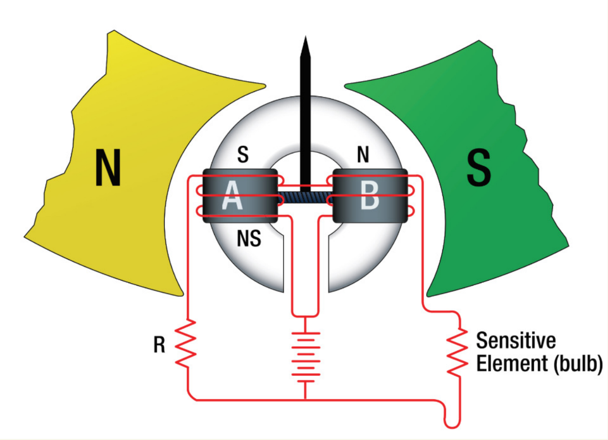
The circuit contains a
- variable resistance
- a fixed resistance to provide the indication.

It contains
- two branches for current flow.

Each has a
- coil mounted on either side of the pointer assembly that is mounted within the magnetic field of a large permanent magnet.

Varying current flow through the coils causes
- different magnetic fields to form,
- which react with the larger magnetic field of the permanent magnet.

This interaction rotates
- the pointer against the dial face that is calibrated in degrees Fahrenheit or Celsius, giving a temperature indication.



Thermocouple Temperature Indicators

A thermocouple is a circuit or connection of
- two unlike metals.

The metals are touching at :
- two separate junctions.

If one of the junctions is heated to a higher temperature than the other,
- an electromotive force is produced in the circuit.

This voltage is directly proportional to the temperature
- So, by measuring the amount of electromotive force, temperature can be determined.

A voltmeter is placed across the colder of the two junctions of the thermocouple
- It is calibrated in degrees Fahrenheit or Celsius, as needed.

The hotter the high temperature junction (hot junction) becomes,
- the greater the electromotive force produced,
- and the higher the temperature indication on the meter.

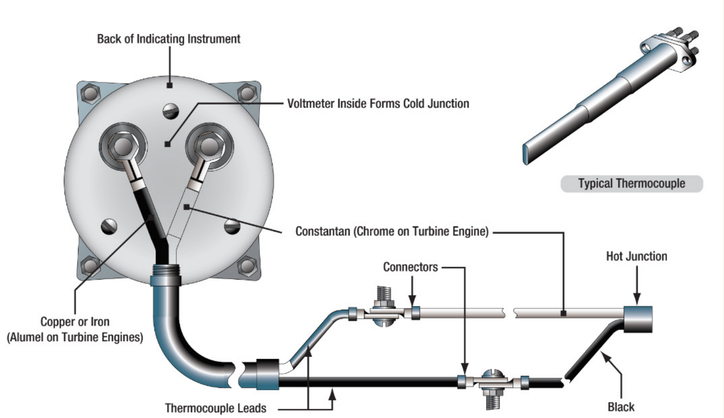


Figure 3-8. Thermocouples combine two unlike metals that cause current flow when heated.

HEAT DEFINITION

Heat is a form of energy.

It is produced only by the
- conversion of one of the other forms of energy.

Heat may also be defined as the
- total kinetic energy of the molecules of any substance.

Some forms of energy which can be converted into heat energy are as follows;
- Mechanical Energy
- Chemical Energy
- Radiant Energy
- Nuclear Energy
- The Sun

SPECIFIC HEAT

Each substance requires a quantity of heat, called its specific heat capacity
- to increase the temperature of a unit of its mass 1 °C.

The specific heat of a substance is the :
- ratio of its specific heat capacity to the specific heat capacity of water

HEAT TRANSFER

There are three methods by which heat is transferred from one location to another or from one substance to anotherThese three methods are:
- conduction,
- convection
- radiation.

CONDUCTION Heat transfer

Heat transfer always takes place by areas of

- high heat energy migrating to areas of low heat energy.

Heat transfer by conduction requires that there be

- physical contact between
- an object that has a large amount of heat energy
- and one that has a smaller amount of heat energy

CONVECTION

Convection is the process by which heat is transferred by :

- movement of a heated fluid (gas or liquid)

A convection process may take place in a:

- liquid as well as in a gas.

RADIATION

- Electro magnitec transfer

THERMODYNAMIC LAWS

FIRST LAW

The first law of thermodynamics is an application of the fact that

- energy cannot be created or destroyed.

this can be thought of as:

- the total energy in an isolated system remains constant

It states that the

- change in internal energy of a system is equal to the heat added to the system minus the work done.

In other words,

- there is a finite amount of heat (energy) in any closed system.
- If it increases, it is because it was added from outside the system.
- If it appears to decrease such as when the temperature decreases, that energy is accounted for by the work that is done by the system

SECOND LAW

The second law of thermodynamics states:

- heat always flows from hot objects to cold objects,
- that is, from high energy toward low energy.

Actually, this law is universal and included all types of energy.

BOYLE'S LAW

Boyle's law is normally stated:

- The volume of an enclosed dry gas varies inversely with its absolute pressure, provided the temperature remains constant

Volume 1 × Pressure 1 = Volume 2 × Pressure 2

Or

$$V_1P_1 = V_2P_2$$

CHARLES' LAW

Charles law states:

- gases expand and contract in direct proportion to the change in the absolute temperature, provided the pressure is held constant.

As a formula, this law is shown as follows:

Volume 1 × Absolute Temperature 2 =
Volume 2 × Absolute Temperature 1

Or

$$V_1T_2 = V_2T_1$$

Charles' law also works if the volume is held constant, and pressure and temperature are the variables. In this case, the formula would be as follows:

$$P_1T_2 = P_2T_1$$

GENERAL GAS LAW

By combining Boyle's and Charles' laws, a single expression can be derived which states

- all the information contained in both.

$$\frac{\text{Pressure (Volume 1)}}{\text{Temperature 1}} = \frac{\text{Pressure (Volume 2)}}{\text{Temperature 2}}$$

When using the general gas law formula, temperature and pressure must be in the absolute.

DALTON'S LAW

Dalton's law:
- "A mixture of several gases which do not react chemically exerts a pressure equal to the sum of the pressures which the several gases would exert separately if each were allowed to occupy the entire space alone at the given temperature."

IDEAL GAS LAW

The ideal gas law is used to
- describe the state of a gas under a given set of conditions such as temperature, pressure, and volume.

The law assumes that
- gases are ideal,
- that is that the molecules are perfectly uniform and simply collide with each other but do not interact.

WORK AND EXPANDING GASES

In an adiabatic, or isolated system, when work is performed by expanding gases, the volume that the gases occupy increases but there is a corresponding decrease in temperature and pressure

Adiabatic
In adiabatic:
- no energy added to the system (no heat)

since it is adiabatic, the values of pressure, temperature and volume could be calculated using the
- general gas formula

If the gases are compressed instead of expanded,
- the phenomenon would reverse.
- A smaller volume would increase the pressure of the gas and increase the temperature of the gas.

Isothermal

An isothermal system is one in which :

- temperature remains the same

THERMAL EFFICIENCY

The heat produced by the burning of gasoline in the cylinders causes a rapid expansion of the gases in the cylinder, and this, in turn, moves the pistons and creates mechanical energy

LATENT HEAT:

- Adding heat to a substance does not always raise its temperature.
- such as when a liquid changes into a vapor

heat energy is absorbed. This heat energy absorbed to change state is called

- latent heat

The temperature of a substance remains constant during its change of state

When a liquid changes state and becomes a vapor, the process is known as

- evaporation

THERMAL ENERGY

All matter not existing at absolute zero temperature has thermal energy. The extent of vibration or internal movement of the molecules of a substance is actually what is referred to as :

- thermal energy

HEAT OF COMBUSTION

- the energy released as heat when the fuel air mixture is burned in an internal combustion engine