CAVITATION

The formation, growth, and collapse of vapour filled cavities or bubbles in a flowing liquid due to local fall in fluid pressure is called **cavitation**. When the pressure at any point in a flow field equals the vapour pressure of the liquid at that temperature vapour cavities (bubbles of vapour)

begin to appear. It is presumed that a vapour cavity is formed around a dust nuclei which is in the liquid (The vapour pressure values of water at 15° and 20° C are 1.74 m and 2.38 m of water column absolute). The cavities thus formed, due to motion of liquid, are carried to high pressure regions where the vapour condenses and they *suddenly collapse*. The adjoining liquid rushes with a very great velocity (and hence with very great force) to occupy the empty spaces thus created, *causes series of violent, irregular, spherical shock waves*. When these irregular implosions occur on the metallic surface, they produce *noise* and *vibration*.

Cavitation factor. Prof. Dietrich Thoma of Munich (Germany) suggested a cavitation factor (sigma) to *determine the zone* where turbine can work without being affected from cavitation. The *critical* value of cavitation factor (σ_c) is given

by,

$$\sigma_c = \frac{(H_a - H_v) - H_s}{H} \qquad \text{...(2.48)}$$

where, H_a = Atmospheric pressure head in metres of water,

H_v = Vapour pressure in metres of water corresponding to the water temperature,

H = Working head of turbine (difference between head race and tail race level in metres), and

H_s = Suction pressure head (or height of turbine outlet above tail race level in metres).

The values of critical factor *depends upon the specific speed of the turbine.*

The value for σ_c for different materials may be determined with the help of the following empirical relations :

For Francis turbine : $$\sigma_c = 0.625\left(\frac{N_s}{380.78}\right)^2 \quad \text{...(2.49)}$$

For propeller turbine : $$\sigma_c = 0.28 + \left[\frac{1}{7.5}\left(\frac{N_s}{380.78}\right)^3\right] \quad \text{...(2.50)}$$

For Kaplan turbines, values of σ_c obtained by eqn. (2.50) should be *increased by* 10%.

(In the above expressions N_s is in (r.p.m., kW, m) units.

Methods to avoid cavitation :

The following methods may be used to *avoid cavitation* :

1. Runner/turbine may be *kept under water*. But it is not advisable as the inspection and repair of the turbine is difficult. The other method to avoid cavitation zone without keeping the runner under water is *to use the runner of low specific speed.*
2. The *cavitation free runner* may be designed to fulfil the given conditions with extensive research.
3. It is possible to reduce the cavitation effect by *selecting materials which resist better the cavitation effect*. The cast steel is better than cast iron and stainless steel or alloy steel is still better than cast steel.
4. The cavitation effect can be reduced by *polishing* the surface. That is why the cast steel runners and blades are coated with stainless steel.
5. The cavitation may be avoided by selecting a runner of proper specific speed for given head.