14.4 Flow Over Weirs

Flow over weirs is complicated because of sharp curvilinear streamlines besides consisting of eddy regions, accelerating and retarding flow zones. The existing solution are semi-empirical in nature.

Discharge Coefficient:

For assessing the discharge passing over a weir, many semi-empirical formulae are in use. Among them, the formulae developed by Rehbock, Bazin, Von Mises, and Weisback and Francis are popular.

Factors Affecting Flow over Weirs

The several factors affecting the flow are

- The head
- Fluid properties and Temperature Effects
- Approach and tail water conditions
- Weir Geometry
- Measurement inaccuracies

Fluid Properties and Temperature Effects

The fluid properties which influence the discharge over the weir are viscosity and surface tension. In case of water flowing over the weir these effects are negligible at heads higher than 3 cm.

Temperature variations influence the fluid properties like viscosity and surface tension. The variations in these fluid properties in turn will influence the discharge over the weir. This type of problem is of importance to chemical Engineers and Sanitary Engineers.

Another closely associated problem is the influence of temperature variations on the aeration at weirs. In many weirs in industrial processes substantial aeration takes place when water falls over the weirs. The rate of absorption of atmospheric oxygen by the water flowing over the weir increases with increasing temperature.

However, the effect of small temperature variations on the water flow over weirs is negligible.

Approach Flow Conditions

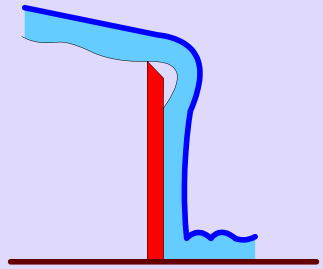
The distribution of velocities in the approach flow has a definite influence on the discharge over the weir. Kinetic energy correction factor can account for the variation in the approach velocity. The value of this coefficient depends on the degree of non uniformity of the approach velocity distribution.

A weir not normal to the approach flow is called a 'skew Weir'. In skew weirs there is a discharge concentration towards one side. The discharge was found to be greater than that over a normal weir.

Tail Water Conditions

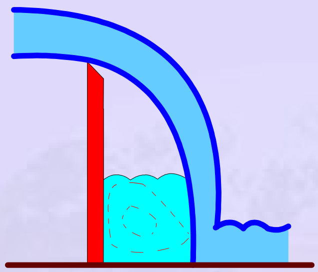
At high tail water levels, the flow over the weir passes in a sub critical state. In this case, the discharge is dependent on both the upstream and the downstream water levels. The Weir, in this case, is said to be submerged and the flow is non-modular. "The ratio of the downstream and the upstream water depths above the weir crest is defined as the submergence ratio, σ ". The limiting value of σ where the tail water also begins to influence the rate of flow is called the submergence limit. Beyond submergence limit, the discharge reduces.

The shape of the nappe may affect the discharge. The modification of the nappe conditions result in small variations of the order of 1 to 2% in the discharge.

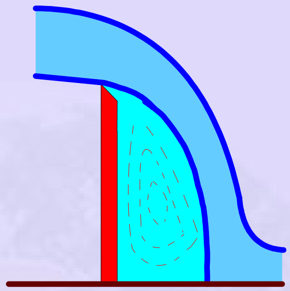


CLINGING NAPPE

Adhering to the crest and downstream face of the weir

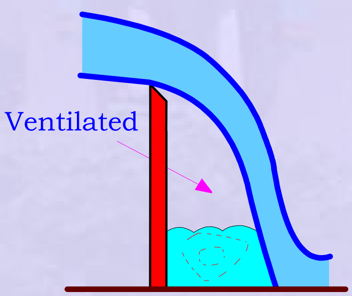


DEPRESSED NAPPE



NAPPE WETTED UNDERNEATH

The coefficient of discharge is generally above the free discharge coefficient upto $H/L \lesssim 0.8$



VENTILATED (FREE) NAPPE

The ventilated nappe springs clear of the crest

DIFFERENT NAPPE SHAPES

The weir geometry influences the coefficient of discharge. It depends upon the pressure distribution along the geometric profile, boundary layer growth and separation zones.