The blade efficiency for a turbine cascade is defined as:

$$\eta_b = \frac{\text{Ideal static pressure drop } (\Delta p)_s \text{ to obtain a certain change in kinetic energy}}{\text{Actual static pressure drop to produce the same change in kinetic energy}}$$

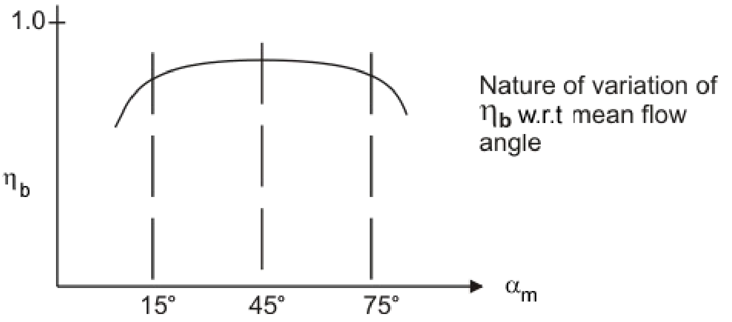
$$= \frac{\frac{\rho}{2}(V_2^2 - V_1^2)}{\frac{\rho}{2}(V_2^2 - V_1^2) + \varpi} = \frac{1}{1 + \frac{\varpi}{\frac{\rho}{2}(V_{w2} + V_{w1})(V_{w2} - V_{w1})}}$$

$$(\eta_b)_{\text{turbine}} = \frac{1}{1 + \frac{2C_D}{C_L \sin 2\alpha_m}}$$

For very small ratio of C_D / C_L

$$(\eta_b)_{\text{turbine}} = \left(1 + 2\frac{C_D}{C_L} * \frac{1}{\sin 2\alpha_m}\right)^{-1}$$

$(\eta_b)_{\text{turbine}} = 1 - 2\dfrac{C_D}{C_L \sin 2\alpha_m}$ which is same as the compressor cascade



Nature of variation of η_b wrt mean flow angle

Note: η_b does not vary much in the range $15° \le \alpha_m \le 75°$ provides flexibility in design.

In the above derivation for blade efficiency of both the compressor and turbine cascade, the lift is assumed as $\rho \Gamma V_m$, neglecting the effect of drag. With the corrected expression of lift, actual blade efficiencies are as follows:

$$(\eta_b)_{\text{comp cascade}} = \frac{1 - \frac{C_D}{C_L}\cot \alpha_m}{1 + \frac{C_D}{C_L}\tan \alpha_m}$$

$$(\eta_b)_{\text{turb cascade}} = \frac{1 - \frac{C_D}{C_L}\tan \alpha_m}{1 + \frac{C_D}{C_L}\cot \alpha_m}$$