Slip factor definition

The slip factor measures the difference between the ideal and the actual tang. velocity component at the exit of the impeller:

$$\sigma = 1 - \frac{W_{slip}}{U_2} \qquad \text{where} \qquad W_{slip} = W_{\theta 2, ideal} - W_{\theta 2, real}$$

$$W_{slip} = W_{m2} \cdot \left[\tan(\theta_2) - \tan(\beta_2)\right]$$

$$\boxed{\sigma = 1 - \left(\frac{W_{m2}}{U_2}\right)\left[\tan(\theta_2) - \tan(\beta_2)\right]}$$

Since we have the relation $\tan(\alpha) = \tan(\beta) + \frac{U}{V_m}$ we can also express the slip factor definition as

$$\sigma = 1 - \left(\frac{W_{m2}}{U_2}\right)\left(\tan(\theta_2) - \tan(\alpha_2) + \frac{U_2}{W_{m2}}\right)$$

$$\boxed{\sigma = \left(\frac{V_{m2}}{U_2}\right) \cdot \left(\tan(\alpha_2) - \tan(\theta_2)\right)}$$

The slip factor can be used to estimate the exit flow angles as:

$$\boxed{\begin{aligned} \tan(\beta_2) &= -\frac{(1-\sigma)}{\phi} + \tan\theta_2 \\ \tan(\alpha_2) &= \left(\frac{\sigma}{\phi}\right) + \tan\theta_2 \end{aligned}}$$

When $\sigma = 1$ corresponds to the zero-deviation condition

The slip factor is usually estimated with semi-empirical eqns:

Wiesner correlation $\qquad \sigma = 1 - \frac{\sqrt{\cos(\theta_2)}}{Z_b^{0.7}}$

Stanitz correlation $\qquad \sigma = 1 - \frac{0.63\pi}{Z_b}$

(Aungier proposes a more sophisticated model with r_1/r_2)

Eckert slip (1961)