The degree of reaction

$$\Lambda = \frac{\Delta T_A}{\Delta T_A + \Delta T_B} \tag{10.3}$$

With the help of Eq. (10.2), it becomes

$$\Lambda = \frac{UV_f(\tan\alpha_2 - \tan\alpha_1) - \frac{1}{2}V_f^2(\tan^2\alpha_2 - \tan^2\alpha_1)}{UV_f(\tan\alpha_2 - \tan\alpha_1)}$$

and

$$\Lambda = 1 - \frac{V_f}{2U}(\tan\alpha_2 + \tan\alpha_1)$$

By adding up Eq. (9.1) and Eq. (9.2) we get

$$\frac{2U}{V_f} = \tan\alpha_1 + \tan\beta_1 + \tan\alpha_2 + \tan\beta_2$$

Replacing α_1 and α_2 in the expression for Λ with β_1 and β_2 ,

$$\Lambda = \frac{V_f}{2U}(\tan\beta_1 + \tan\beta_2) \tag{10.4}$$

As the case of 50% reaction blading is important in design, it is of interest to see the result for $\Lambda = 0.5$,

$$\tan\beta_1 + \tan\beta_2 = \frac{U}{V_f}$$

and it follows from Eqs. (9.1) and (9.2) that

$$\tan\alpha_1 = \tan\beta_2, \text{ i.e. } \alpha_1 = \beta_2 \tag{10.5a}$$

$$\tan\beta_1 = \tan\alpha_2, \text{ i.e. } \beta_1 = \alpha_2 \tag{10.5b}$$

Furthermore since V_f is constant through the stage.

$$V_f = V_1\cos\alpha_1 = V_3\cos\alpha_3$$

And since we have initially assumed that $V_3 = V_1$, it follows that $\alpha_1 = \alpha_3$. Because of this equality of angles, namely, $\alpha_1 = \beta_2 = \alpha_3$ and $\beta_1 = \alpha_2$, blading designed on this basis is sometimes referred to as *symmetrical blading* .The 50% reaction stage is called a repeating stage.

It is to be remembered that in deriving Eq. (10.4) for Λ , we have implicitly assumed a work done factor λ of unity in making use of Eq. (10.2). A stage designed with symmetrical blading is referred to as 50% reaction stage, although Λ will differ slightly for λ.