Overall Efficiency (η) for a cyclone Separator

$$\eta = \frac{\text{mass of solid particles removed from feed (as underflow)}}{\text{mass of solid particles present in the feed}}$$

$$\boxed{\eta = \frac{\sum m_{dpi,U}}{\sum m_{dpi,F}}} \quad \text{—— (a)}$$

U for underflow
F for feed

fractional Efficiency $= \eta_i = \frac{\text{mass of a given particle size in underflow}}{\text{mass of a given particle size in feed}}$

$$\eta_i = \frac{m_{dpi,U}}{m_{dpi,F}} \Rightarrow \boxed{m_{dpi,U} = \eta_i \, m_{dpi,F}} \quad \text{(b)}$$

$$\eta = \frac{m_{dp_1,U}}{\sum m_{dpi,F}} + \frac{m_{dp_2,U}}{\sum m_{dpi,F}} + \cdots + \frac{m_{dpi,U}}{\sum m_{dpi,F}} \cdots + \frac{m_{dp_n,U}}{\sum m_{dpi,F}}$$

from eqn (b)

$$\eta = \frac{(\eta_1) m_{dp_1,F}}{\sum m_{dpi,F}} + \frac{(\eta_2) m_{dp_2,F}}{\sum m_{dpi,F}} \cdots + \frac{(\eta_i) m_{dpi,F}}{\sum m_{dpi,F}} \cdots + \frac{(\eta_n) m_{dp_n,F}}{\sum m_{dpi,F}}$$

$$\eta = \eta_1 \omega_1 + \eta_2 \omega_2 \cdots + \eta_i \omega_i \cdots + \eta_n \omega_n$$

$$\boxed{\eta = \sum \eta_i \omega_i}$$

where (ω_i) = mass fraction of particle having diameter d_{pi}, in Feed