Variable	Effect
Pressure drop increases.	Cut size (diameter of particles of which 50% are collected) decreases; flow rate increases; sharpness increases.
Solids content of feed increases	Cut size increases (large effect above 15-20% v/v).
$(\rho_p - \rho_l)$ increases.	Cut size decreases.
Viscosity of liquid	Little effect below 10 mPa.
Cyclone diameter (D_c)	Cut size increases; pressure drop increases.usually decreases.
Cyclone inlet (a) diameter increases.	Gravitational force in cyclone decreases; cut size increases; capacity falls; pressure drop decreases.
Overflow diameter increases.	Cut size increases; risk of coarse sizes appearing.
Underflow diameter increases.	Brings excess fines from liquid phase into underflow.
Cyclone shape becomes longer	Decrease cut size; sharpens separation.

Table 1. Effects of variable on cyclone performance.

Saltation velocity

Koch and Licht *(7)* expressed the saltation velocity as:

- The minimum fluid velocity necessary to prevent the settling out of solid particles carried in the stream.
- The necessary velocity that picks up deposited particles and transports them without settling.

Zenz *(8)* has shown that the velocity given by the latter differs from the former by a factor of 2 to 2.5. Kalen and Zenz *(9)* have applied the saltation concept to cyclone design by assuming:

- There is no slippage between fluid and particles. The cyclone inlet width is the effective pipe diameter for calculating saltation effects.
- Grain loading (dust concentration) is less than 10 grains/ft^3.
- The diameter effect on the saltation velocity is proportional to the 0.4 power of the inlet width.

The saltation velocity, v_s is dependent on cyclone dimensions, as well as particle and fluid properties; v_s is expressed as:

$$v_s = 2.055\omega\left\{\frac{b/D_c}{(1-b/D_c)^{1/3}}\right\}D_c^{0.067}v_i^{2/3},\ ft/s \quad (13)$$

where

$$\omega = \left\{\frac{4g\mu(\rho_p - \rho_r)}{3\rho_f^2}\right\}^{1/3} \quad (14)$$

Inlet velocity, v_i, ft/s

$$v_i = \frac{Q}{(ab)} \quad (15)$$

Kalen and Zenz have shown that maximum cyclone collection efficiency occurs at v_i/v_s = 1.25, and Zenz has found experimentally that fluid reentrainment occurs at v_i/v_s = 1.36.

Pressure drop

Several attempts have been made to calculate the frictional loss of ΔP of a cyclone, although none has been very satisfactory. Assumptions made have not considered entrance compression, wall friction, and exit contraction, all of which have a major effect. Consequently, no general correlation of cyclone ΔP has been adopted. Pressure drop in a cyclone with collection efficiency is important in evaluating its cost. Correlations for the pressure drop have been empirical, and are acceptable up to ΔP = 10 in. H_2O. The pressure drop, ΔP, or the frictional loss is expressed in terms of the velocity head based on the cyclone inlet area. The frictional loss through cyclones is from 1 to 20 inlet velocity heads, and depends on the geometric ratios; ΔP through a cyclone is given by

$$\Delta P = 0.003\rho_f v_i^2 N_H \quad (16)$$

where

$$N_H = K\left(\frac{ab}{D_e^2}\right) \quad (17)$$