DEPOSIT VELOCITY OF SLURRY FLOW IN OPEN CHANNELS

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In relation to channel flow, assuming a steady and persistent runoff and with a fixed channel geometry, it is possible to select the following independent variables to explain the phenomenon :

$(\rho_s-\rho_m)$	=	apparent specific mass of solids
g	=	gravity acceleration
d_{85}	=	typical diameter of coarse particles
R_h	=	typical hydraulic radius of the channel dimension
ν_m	=	mixture viscosity
τ_{oc}	=	critical mean bed shear stress.

Since 3 magnitudes intervene in these 6 variables, it is possible to obtain 3 adimensional parameters. Based on the Buckingham method, these parameters have the following expressions :

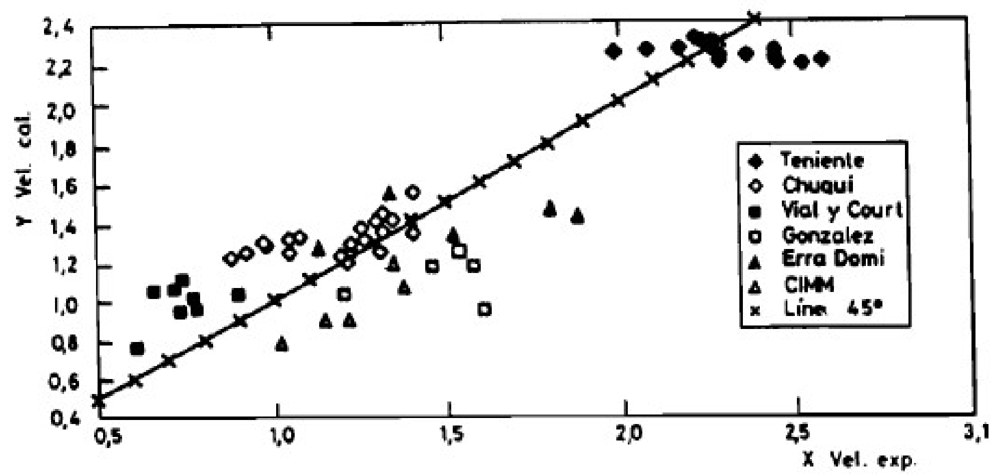
The experimental results allowed to obtain the following values for the Froude number F_{rcr*} and for the constant A* :
F_{rcr*}=1,833
A* = 0,158
with a correlation coefficient of 0,92.

Finally the equation for the limiting deposit velocity remains :

$$V_D = 1{,}833\left[8gR_h(\rho_s - \rho_m)/\rho_m\right]^{0,5}(d_{85}/R_h)^{0,158} \tag{14}$$

Figure 1 presents a chart with the experimental values and the values calculated through the proposed formula.

Figure 1. **Experimental velocity vs calculated velocity**



4.3 Correlation of the data considering the viscosity effect separately

In some industrial applications, where the solid-liquid flow has a strong alkaline condition (pH 10) an important increase in the viscosity has been observed. The experiences of Vega (1988) allowed the introduction of this effect and also to obtain an expression for equation (10).

$$V_D = 1{,}833\left[8gR_h(\rho_s - \rho_m)/\rho_m\right]^{0,5}(d_{85}/R_H)^{0,158}\,1{,}2^{\left(\frac{3100}{Re^*}\right)^3} \tag{15}$$

where Re* is the adimensional parameter which considers the viscosity according to :

$$Re^* = \frac{R_h(gR_H)^{0,5}}{\nu_m} \tag{16}$$

Figure 2 shows a comparison of the experimental results of both methods, the first one considers the viscosity separately (eq.15) and the second one includes the viscosity (eq. 14).

$$V_D = 1.833\left[8gR_h\frac{\rho_s-\rho_m}{\rho_m}\right]^{0.5}\left[\frac{d_{85}}{R_h}\right]^{0.158}1.2^{\left(\frac{3100}{\mathrm{Re}^*}\right)^3}$$

$$\mathrm{Re}^* = \frac{\rho_m R_h (gR_h)^{0.5}}{\mu}$$

Density ρ – kg/m^3

Hydraulic Radius Rh – metres

d_{85} – metres

Dynamic Viscosity μ – Pa.S

Gravity constant g – 9.81 m/s

Dominguez et al. (1996) developed the empirical equation to predict deposition velocity in open channel flows. Experiments were performed over a wide range of conditions but little experimental control existed with respect to fluid properties since industrial mixtures were used in the analysis. The correlation is applicable for Newtonian carrier fluids and channel shape is accounted for by the use of the hydraulic radius

The equation above is empirical. Since the equation was developed using Newtonian carrier fluids, it may not be appropriate for use with non-Newtonian slurries. It is also worth noting that the correlation is dependent on the particle size distribution as the d_{85} (the particle diameter in which 85% of the distribution is finer than) is required to represent the coarse phase of the solids particles.

One aspect of the correlation is that no apparent link is given between the inclination of the channel (driving force) and the critical deposition velocity.