EFFECT OF SOLIDS ON A PINCHED SLUICE CONCENTRATOR

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by

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To my wife,

for her understanding love and support

ABSTRACT

The pinched sluice concentrator is a device for the separation of heavy minerals particularly beach sands. They come in a variety of sizes and shapes and have been extensively used in the beach sand industry, for over a century. But the basic mechanism involved in the separation has not been fully understood.

Most of the work upto 1982, had been empirical in nature. In 1983, an attempt was made to explain the behaviour of pinched sluice in terms of established theories of fluid mechanics and mineral processing.

However, their work was limited to particles of single size. In the present analysis, an attempt has been made to refine the existing model, taking the effects of particle size and density into account.

The relationship between the flow rate and depth of flow was confirmed and their variation with particle size and feed concentration has been studied.

A method has been developed to calculate the underflow flow rate of the sluice assuming logarithmic velocity distribution and the established relationship between Froude Number and the split height.

Assuming that Bagnolds Shearing Theory holds in pinched sluice operations, and also the dispersive pressure is some function of solid concentration, velocity gradient, specific gravity and diameter of the particles, a relationship was derived to predict the underflow pulp density. Above relationship was used to predict the grade of the underflow for a mixture of ilmenite and silica.

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B	Breadth of sluice
C	Volumetric concentration of solids
C_o	C at closest packing
C_u	C of underflow
C_f	C of feed
C_1	Linear concentration of solids
C_d	Drag co-efficient
d	Particle diameter = Median apperture particle size (d_{50})
Fr	Froude number of flow
F_{rs}	Fr at a section above the slot
g	Gravitational acceleration
G_u	Grade of under flow (volume fraction of heavies in the solids)
G_f	Grade of feed
K	Karman constant
L	Length of sluice
P	Bagnold dispersive pressure
Q	Total volumetric flow rate
Q_f	Q of the feed
Q_u	Q of the underflow
R	solid recovery
Re	Renolds number of flow
Re_p	Particle Renolds number
S	Specific gravity of solids
So	Slope of the sluice Sin α
I, α	Slope of the sluice
t	Time
V	velocity of flow at an elevation

u^*	Shear Velocity
$\bar{V}$	Mean velocity of flow
V_g	Velocity of stream line satisfying gravity fall requirement
$\bar{V}_u$	The average velocity of underflow stream
w	Width of discharge slot
y	Elevation above the deck
y_o	Depth of flow
y'	Split height
y''	Height above boundary at which velocity is zero according to logrithmic distribution
α	Inclination of the sluice to the horizontal
γ	Exponent in equation 4.1
β	Angle of shockwave with the direction of flow
δ	Nominal boundary layer thickness
δ'	Thickness of laminar sub-layer
η	Eddy viscosity
μ	Viscosity of pure fluid
ν	Kinematic viscosity of the fluid
ρ_f	Density of fluid
ρ_s	Density of solids
ρ_{sus}	Density of suspension
θ	Angle of pinch of the sluice
τ	Shear stress at an elevation y
τ_o	Shear stress at the boundary
$\tau\Sigma$	Total shear stress due to the presence of grains and intergranular fluid
τ_g	Shear stress due to the presence of grains
τ_f	Shear stress due to the intergranular fluid.