Al-Mustaqbal University College

Chemical Engineering and Petroleum Industries

Unit Operations Lap

Experiment (6)

ROTARY VACUM FILTER

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OBJECTIVE:

- To study the performance of a Rotary Drum Filter operating under Vacuum.

AIM:

- To determine the specific cake resistance for a given slurry of CaCO3

INTRODUCTION:

A most common type of continuous vacuum filter a rotary drum filter, which consists up a horizontal drum with a slotted face turns at a speed of 1.5 to 2 rev/min in an agitated slurry through a filter medium such as canvas covers the face of the drum., which is partly submersed in the liquid. Under cylindrical face of the main drum is a second smaller drum with a solid surface. Between two drums are radial partitions dividing the annular space into separate compartments. Due to vacuum applied inside the drum, the filtrate is drawn in through the filter medium and the cake is deposited on the outer surface of the drum.

THEORY:

In a continuous Rotary Drum Filter, the feed, filtrate and cake move at steady constant rates. For any particular element of the Filter surface, however, conditions are not steady but transient. The process of filtration consists of cake formation, washing, drying and discharging. The cake thickness is not allowed to increase to large values and therefore the filtration process can be conducted at a constant rate using a constant pressure difference.

A Rotary drum vacuum filter consists of a cylindrical drum partly submerged in the feed slurry. At any instant, a segment of the drum is in position and thus in contact with the slurry. Due to vacuum applied inside the drum, the filtrate is drawn in through the filter medium and the cake is deposited on the outer surface of the drum. As the drum rotates, this segment moves up where it is subjected to dewatering, to washing and finally the cake is removed by the scrapper or doctor

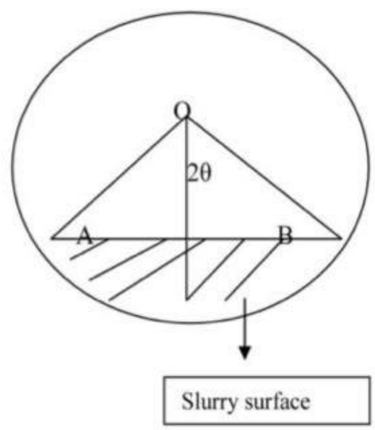
$$\frac{dt}{dv} = \frac{\mu f}{A(-\Delta P)}\left[\frac{\propto v}{A} + R_m\right] \qquad \text{------------ } 1$$

Ingrating:-

$$t = \frac{\mu f}{A(-\Delta P)}\left[\frac{\propto v}{A} \times \frac{v^2}{2} + R_m v\right] \qquad \text{------------ } 2$$

Then $t = f\, t_c$

$$f = \frac{2\theta}{360} \qquad \text{-------------- } 3$$



Rate Of filtration = $\frac{v}{t_c}$

Neglecting the filter medium resistance R_m compared to the specific cake resistance $\propto$, Eq 2 can be written as:

$$t = \frac{\mu f}{A(-\Delta P)}\left[\frac{\propto v V^2}{2A}\right] \qquad \text{----------------- } (4)$$

$$(-\Delta P) = \left[\frac{\mu f \propto v}{2t} \times \left(\frac{V}{A}\right)^2\right] \qquad \text{-----------------}(5)$$

$$V = \frac{x}{1-x} \times \frac{\rho_f}{\rho_s} \qquad \text{------------------}(6)$$

DESCRIPTION:

The set-up consists of stainless steel ram moving in gunmetal brackets. The drum is divided in 8 compartments, covered by a SS mesh. A canvas filter is used for filtration. The whole assembly is fitted with a SS trough in which an agitator is provided. To make the unit a self-contained a slurry mixing and feed arrangement, receiver tanks, vacuum pump, control panel are provided.

UTILITIES REQUIRED:

- Electricity Supply: Single phase, 220 V AC, 50 Hz, 5-15 amp socket with earth connection.
- Water Supply (Initial fill).
- Drain required.
- $CaCO_3$: 10 kg.

EXPERIMENTAL PROCEDURE:

- Prepare slurry of $CaCO_3$ in water of known concentration.
- Allow the Slurry to pass through the filter and start the vacuum pump. Fix the pressure gauge reading ($-\Delta P$) at one value and record the filtrate collected in the receiver for known amount of time. Record the volume of filtrate collected for the known amount of time at least 4 times at the same ($-\Delta P$) and take the average of the three concurrent readings.
- Increase the ($-\Delta P$)by slightly closing the air by pass line and repeat step 2.
- Repeat step 3 for at least 4 ($-\Delta P$).
- Allow air to enter the drum and stop the vacuum pump . Remove the cake deposited and wash the filter assembly.
- During steps 3-4-5, collect the wet cake deposited/ rev of the drum.

OBSERVATION & CALCULATION:
DATA:

$D = 0.25$ m

$L = 0.35$ m

$A = 0.275 m^2$

$D_F = 0.215$ m

$A_F = 0.0594\ m^2$

$\theta = 68.284$

ρ_F = ------------- kg/m^3 (From data book)

ρ_S = ------------- kg/m^3 (From data book)

μ_F = ------------- Ns/m^2 (From data book)

Plot (-ΔP) vs $(V/A)^2$ on a simple graph and measure the scope

Calculation:

$X = \frac{Kg\ of\ Solid}{Kg\ of\ water + Kg\ of\ solid} =$

$v = \frac{X}{1-X} \times \frac{\rho_F}{\rho_S} =$

$V_F = A_F \times h$, m^3 = -------------m^3

$V' = \frac{V_F}{T}$, m^3/sec = ------------- m^3/sec

$V = V' \times t_c$, m^3 = ------------- m^3

$f = \frac{2\theta}{360}$ = -------------------

$t = t_c \times f$, sec = --------------sec

$A = \pi DL$, m^2 = ---------------m^2

$L_c = \frac{V \times v}{A}$, m = --------------m

$\alpha = \frac{2 \times t \times slope}{v \times \rho_F \times \mu_F}$, m/kg = ----------------m/kg

NOMENCLATURE:

A = Area of drum,m^2

AF = Cross sectional area of filtrate tank, m^2

D = Drum diameter, m

DF = Diameter of filtrate tank, m

f = fractional submergence

h = Rise in water in filtrate tank, m

L = Drum length, m

Lc = Thickness of cake, m

$-\Delta P$ = Pressure drop (vacuum gauge reading), N/ m^2

T = Time of filtrate collection, sec

tc = Time for one revolution, sec

t = Time for cake formation, sec

v = Voidage or porosity of the bed.

V_F = Volume of the filtrate, m3

V' = Rate of filtration, m3/sec

V = Volume of filtrate in one revolution, m3

X = mass fraction of the solid in slurry

ρ_f = Density of the filtrate, kg/m3

ρ_S = Density of the solid, kg/m3

α = Specific cake resistance

μ_F = Viscosity of Filtrate, N.S/m^2