MECHANICAL OPERATIONS LAB REPORT

Experiment 4: Raymond Classifier

S.S.S.Vardhan

19CH30018

AIM

- Study the classification operation and understand the difference in operation with respect to Screening Equipment
- Calculate the effectiveness of the classifier for a given output

APPARATUS

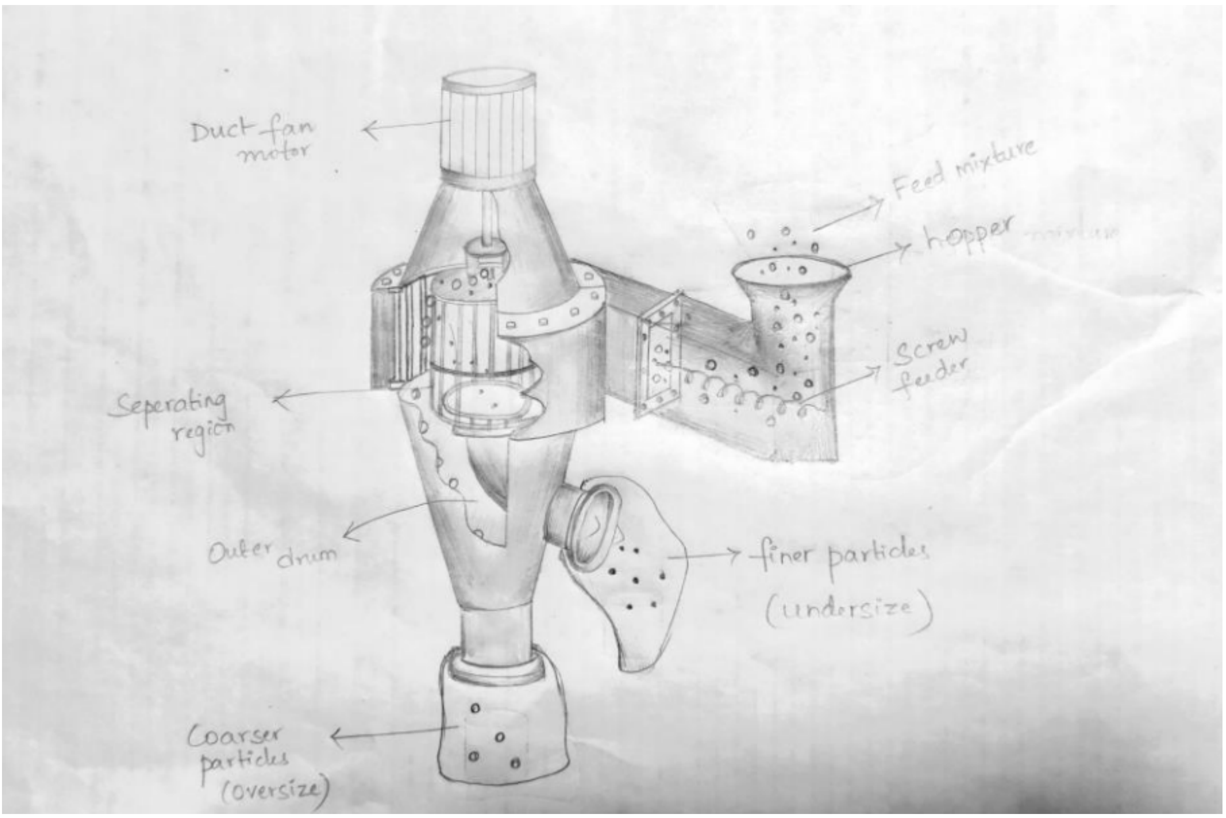
1) Raymond Classifier 2)Two Collecting Bags – each for an output channel 3)Sieve Shaker Machine 4)British Standard Sieve – 72 size mesh and Pan 5)Feed Particles for separation - Limestone 6)Weighing Machine 7)Stopwatch

THEORY

The Raymond Classifier separates particles on the basis of their size and density unlike a sieve or a screen that separates particles only on the basis of their size. That's why it's called "Classification", not "Sieving or Screening". We cannot separate a mixture of particles that have similar sizes but different densities or masses using the Screening experiment because it is dependent on the flow-through pores of the screen. Whereas the classifier uses Settling techniques which helps us to separate particles based on their size, density, shape, weight differences. In Raymond Classifier which we use, we want to separate the mixture of particles having different masses using the Centrifugal forces. The cause of separation in a Raymond Classifier is centrifugal force. The feed enters the machine through a screw feeder. A fan rotates at the top of the classifier to put the air inside in a state of rotatory motion.The air in turn will make the feed particles rotate. The particles will experience a centrifugal force proportional to the mass of the particle. Particles with higher mass (i.e higher density X size) will move into the outer drum and will be discharged through the respective pipe at the bottom. The finer particles on the other hand will remain in the inner drum and will be discharged through the other pipe. From the centrifugation, heavier particles experience higher centrifugal force and are pushed onto the wall surface of the outer drum. Which when gets hit, loses Kinetic Energy and falls down into the central output pore. Lighter particles will remain in a lesser radius and hence captured into the bounds of the Inner drum which will fell down into the side output pore. Coarser particles are collected from the central channel and Finer particles are collected in the side channel.

We would expect the machine to give 100% pure products and residues i.e the product contains only heavier particles and the reject contains only finer particles. However, this is not the case and here we are going to discuss the effectiveness of the Classifier.

EXPERIMENTAL SET-UP



Hand drawn schematic of Raymond's Classifier

EXPERIMENTAL SET-UP

Feed specification			
Material	**Particle size**	**Wt in gm(feed analysis)**	**wt in gm(Product analysis)**
Lime Stone	< 44 mesh	100	400

Feed Analysis		
Sieve No	**Wt of Material (gm)**	**Mass fraction (Xf)**
72	23.5	0.2293
Pan	76	

Product Analysis		
Sieve No	**Wt of Material (gm)**	**Mass fraction (Xf)**
72	99.6	0.476
Pan	109.4	

Reject Analysis		
Sieve No	**Wt of Material (gm)**	**Mass fraction (Xf)**
72	2.5	0.014
Pan	174.5	

CALCULATIONS

Our desired Product is oversize, we majorly obtain it in the Central output channel. The effectiveness or Efficiency of our device is based on how well the separation is made. So, how good the Oversize is present in the Central Output channel (and) how good the Undersize is rejected into the Side Output channel. Hence, Efficiency can be formulated as,

$$\text{Efficiency} = \text{Recovery} \times \text{Rejection}$$

$$\text{Recovery} = \frac{\text{Oversize in Product}}{\text{Oversize in Feed}} = \frac{0.476\,(99.6 + 109.4)}{0.2293\,(94 + 304)}$$

$$\therefore \text{Recovery} = 1.0901$$

$$\text{Rejection} = \frac{\text{Undersize in Reject}}{\text{Undersize in Feed}} = \frac{0.986\,(2.5 + 174.5)}{0.7707\,(94 + 304)}$$

$$\therefore \text{Rejection} = 0.56896$$

$$\therefore \text{Efficiency} = 1.0901 \times 0.56896$$

$$= 0.62022$$

$$\%\ \text{Efficiency} = 62.022\%$$

RESULTS

Actual Efficiency = 62.022% (The recovery is very high but the rejection could have been better. Ideally, the value should be one, but due to the poor rejection value, the overall efficiency has fallen down.)

DISCUSSION

Raymond classifier is one of the machines that can carry out the classification process. It uses centrifugal force to separate particles. It is mainly used to separate particles based on size, shape and density. As the particles revolve in a circular path, the particles of higher mass travel at a radius far more than the lighter particles. We use this difference of radii to trap only the heavier particles by a tapering truncated outer drum while the lighter particles flow out of the inner drum. Our desired product range is chosen as oversize of 210 microns (oversize of Mesh number-72), which means it is fine dust. So, there are a lot of chances to lose the potential mass while giving the feed input, collection, transferring, measuring. Bags are used instead of Bucket to encapsulate the fine dust without letting it expose into the Air gap and lose the mass. This error is visibly inculcated in all the calculations as the Total mass of Feed (398g) is not equal to the total mass of product + reject (209g + 177g = 386g). Duration of the Sieve shaking machine plays an important role, we operate for normal durations of 5-10min. As time increases, refinement of separation increases in general, however, as our mixture content has minute particles, the cohesive surface effects of those small particles come into play for longer runs of the sieve machine. So, to prevent clogging in the pores of sieve plates, optimum duration of 10min is chosen. We can control the airflow and velocity driving the centrifugation, using the Fan motor; by this way, we can set the cut off diameter to our choice according to the separation needed. A precise cut-off diameter increases the efficiency because we can further reduce the major presence of undersize mass (109g) in the product analysis