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Experimental Study and Performance Enhancement of Rotary Drum Filter

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ABSTRACT

In the Chemical Industry lot of Filters are frequently used for slurry separation that involves the separation of solid-liquid phase for continuous flow operations. One of the oldest and yet effective devices used still is the Rotary Drum Filter which can be called the workhorse of the chemical process industry.

In this paper, we have discussed various parameters for enhancing the performance of rotary drum filters which include various physical well as chemical properties. My main objective was concerned with changing the various parameters like reducing the moisture content, the agitation speed, the cloth used for filtration, ph., slurry age, viscosity, cycle time, pressure drop, temperature involved which will not affect the cost of the process making it economically beneficial and handling can be done easily.

Keywords : Rotary drum filter, Moisture content, speed, pressure drop, temperature

I. INTRODUCTION

In chemical industries, the separation and filtration of slurry become an important part of many processes. This means the solid-liquid separation in this type of separation the solid- liquid mixture forms a suspension which needs to be separated for this purpose the use of the Rotary Drum filter becomes an important part. Talking about the Rotary drum filter (RDF) it was one of the oldest pieces of equipment used for the industrial liquid-solid separation which is patented in 1872 and still is used due to its durability and reliability.

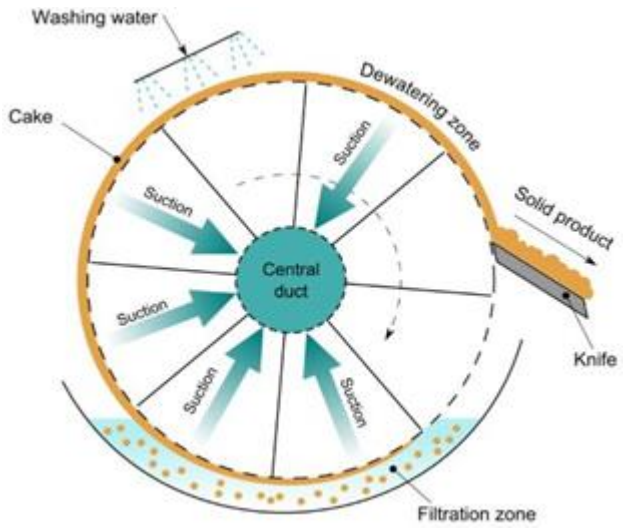
For processing the slurries and discharge cake formation during a process in the chemical industry.

We use a rotary drum filter. The vacuum filter is composed of a large rotating drum covered by a cloth. The drum is partially submerged in a fluid suspension, drives around 25% to 75% of the surface area of the screen. When running in and out of the gutter, and the liquid is sucked on the surface of a substance and is rotated by the liquid/solid base, as for a pie. When the dough is running, dehydration may occur in the drum. The cake is too dry because the vacuum drum

is constantly sucking in the cake, and remove the water from it. In the final stages of the separation, in, is dismissed, as a permanent product, and the drum rotates continuously at a different separation cycle

II. WORKING OF ROTARY DRUM FILTER

The working of rotary drum filter is split into various zones like pick-up zone, drainage zone, washing zone, drying zone, and cake removal zone. The drum is immersed to the required depth in the slurry, which is agitated with help of an agitator to prevent settling of the solids. A drum rotates, vacuum is applied to those sectors of the drum which is submerged. A cake of the specified thickness is produced by adjusting the speed of rotation of the drum. The filtrate is passed out to the receiver. The drum leaves the drainage zone and enters into the water wash zone. The cake is then washed with sprays. The cake is partially dried through a current of air and the cake enters into the drying zone. Finally, pressure is applied under the material to assist the removal of the cake. The washed and partially dried cake is removed using a doctor's knife. The cake is additionally discharged by string discharge and belt discharge filters. In the string discharge filter, numbers of endless strings are placed over the width of the drum. String discharge filters are used when the cake is sticky. The wear of filter cloth is a smaller amount during this case. In belt discharge filters short endless belts are used. Higher filtration rates could also be achieved using belt discharge. All these steps are completed in one cycle of a drum. Then drum again receive a fresh lot of slurry. When the solids of the slurry are an excessive amount of that the filter cloth becomes blocked with the particles, a pre-coat filter could also be used.



The Rotary Vacuum Drum filter is in the lower supply category and is one of the oldest filters used in the chemical process industry. Rotary drum filters are therefore used in the best part of the solid-liquid separation process. Figure 1, shows the basic components of the rotary vacuum drum filters and their components and the parameters for their operation. A valve with a bridge controls the flow of circulation so that each sector is exposed to vacuum, impact, and dead areas [3]. When the sector enters the first immersion phase and continues to wash, if necessary, to the point that it is cut off and strikes occur to aid in the use of the cake. The valve has some filters on flexible blocks and other fixed bridge rings. Flexible block blocks enable form formation to dry the scale within the filter cycle and the "active immersion" of the drum when the tender level of the tank is very high. Most drum filters have a three-dimensional valve and one line plate as shown below and to the right.

The function of the bridges is cleaning areas and fittings that separate the bridge: This bridge cuts the space and is therefore slightly wider than the inner hole of the pipe.

Dead Zone Bridge: This Bridge is open to strike just as you enter the room. Getting started helps bridge. In starting the open space is open-air and the cake can

only be built when the valve that controls the area closes. When the cake starts to appear in the tank the valve is slowly opened and completely opened when the surface of the drum is wrapped around the cake. As in continuous operation, both the lower and upper areas are under the closure this bridge is slightly smaller than the inner pipe of the pipe so that the vacuum can continue and the cake is held in a cylinder. The rotating drum filter is a highly separate liquid / solid device. It is used when further separation is a strong desire from the liquid distribution. It can be used in applications where the solid is the product or where the liquid is the product (and sometimes when both phases are the product). In the case of a wastewater application, it can be used to divert various sewage or to determine the wastewater.

III. Washing the cake

The effects of cake washing can affect the success of the process in a variety of ways. If a product, or other useful items, gets stuck in a filter, such as damp material, this could affect the cost of production or product. . It is easy to calculate product losses, as well as potential savings or product increases that may result from an improved cake washing process. To find the best cake washing effect may not be enough, the consistency of the washing effect should also be considered. It is not good to produce a delicious and healthy food ingredient that can be bought 99% of the time, but in the remaining 1%, it contains a combination cake filter that can cause stomach upset.

IV. Factors to be considered in performance enhancement

• The Drum speed vs performance,

The drum speed, in the case of any other constant, filter, modes of operation, the increase of the rotary speed will increase filter throughput. The speed of the accelerator pedal, drum to the left of the filter. With The Increase of The Speed of The Drum ↑

A) Filter Transit Increases

B) The thickness of the cake decreases

C) The moisture content on particles I formed Increases

D) The rate of filter drum per revolution decreases

E) The efficiency of the filter aid [precoat] decreases

The fine is the process of increasing the filtration capacity, i.e., the increase of the rotary speed, the high moisture content of the cargo to the unloading of cake solids. This may result in:

(1) the loss of the product, i.e., the restoration of the original solution, or [2]to higher disposal costs, that is to say, liquid, solids, and the filtered cake. With a pre-low-power high-speed of the drum, means to lower the filtration efficiency (and therefore higher production costs). The drum speed and the TAX levels are usually adjusted to optimize the filter's performance. In all of the discharge structures, except for the pre-coat, and a different way of training and a dry cake is the adjustment of the vacuum and the air stream. Outputs the devices of the airflow, the better to be made, whether within or outside of the dryland areas of the drum. Reduced vacuum in the inlet, which leads to more tender dough of the formation, so it will be a discount for the ordering of large amounts of air to flow into the dry-room for the dryer to the mixture. And if all of the terms and conditions for the filter's action is constant, the filter capacity will vary depending on the drum speed

• Temperature of Feed

Feeding slurry feed is another important factor in producing a high-quality filter cake. An increase in feed temperature increases the filtering rate (although not as much as it does feed concentration) and also results in a low moisture content filter. Second gain for the high temperature of the feed that the vapor passing through the vacuum pump is also high temperature. Reducing evaporation works to heat the

water in a vacuum pump, which can later be used as a cake washing machine.

• Wash Water Temperature

The filter cake needs to be washed to reduce the soluble chloride to an acceptable level wallboard maker, in most cases 100 ppm. This bath takes place in the back filter the cake formation step using fresh water to remove the remaining alcohol from the cake filter. Generally, the amount of bathwater required is about 0.3 to 0.33 pounds of water per pound.

solid dry cake. The use of recycled bulk water from a liquid ring vacuum pump is an easy method of providing high-temperature bathwater. This increasing temperature of the cake wash and reduces moisture remaining in the filter after washing.

• Pressure Drop

The filtering rate is proportional to the pressure difference in both the filter and the filter cake. Decreased pressure can be achieved in several ways: -

A) Gravity: The pressure difference can be achieved by keeping the slide head above the filter area. The pressure generated depends on the slide hardness.

B) Machine: The pressure below the filter area can be reduced under atmospheric pressure by connecting a filtrate receiver to a vacuum pump and creating a pressure difference across the filter.

C) Pressure: An easy way to pump slurry into a filter under high pressure.

D) Centrifugal Power: Gravity can be replaced by centrifugal force in particle separation

V. Filtering viscosity

It can be expected that increasing the viscosity of the filtrate will increase the flow resistance so that the filtering level is proportional to the viscosity of the fluid. This problem can be overcome in two ways:

a- The filtration rate can be increased by increasing the temperature of the liquid, which reduces its viscosity. However, it is not possible if thermolabile materials are involved or if the filtrate fluctuates.

b- Burning is an alternative but the rate should be doubled.

• Filter Cloth

All types of extensions, except for the pre- coating fabric, require the measurement of the first 5 fabric design parameters to maximize filter performance. The "fine-tuning" of the belt or the texture of the fabric is usually done with changes in the type of thread and the availability of the fabric. The fabric design of the pre- release filters, however, should be connected to the type of media filter [help filter] used in the process. For this reason, the use of many fabric design options has been greatly reduced. The sophisticated fabric design offers little or nothing to the best performance, without the high cost!

Best cloth aspects

1) Fabric Design: Polypropylene [fibre-based process]

2) Thread: mono or multifilament; not twisted

3) Weaving: bearing penetration: 50-150 cm / ft² width; depending on the weight of the filter aid:

4) 6 - 10 oz, standard

5) Thread Count: by Micron fabric manufacturer measured by woven fabric does not provide profit. No weaving, no needle dropping, and cloth weaving. Empty media can be standard Dutch twill [24 x 110] or binding cloth

• The Permeability coefficient,

which is The constant (K) represents the resistance of the filter medium, as well as to filter the sediment. As well as the thickness of the dough increases, the filtration rate will decrease. In addition, the surface of the particles, and the porosity of the paste, and the stiffness or compressibility of the particles can affect the permeability of the paste.

• Filter's media area

The total volume of the filtrate then flows from the filter, it will be in proportion to the filter surface. You can improve the environment by using more than one filter. In a rotor, drum filter, the continuous removal of the dough, the filter gives you an endless process of filtration area

• Vacuum-pump capacity

performance of the pre-pairing mode, the pump should be at least 2.5-3.5 CFM per square foot of filter area. In the process, the mode of 2.0 to 3.0 cubic feet. / min per square meter is more than enough. As a rule, it is sufficient to use a vacuum pump for the little ones. The power consumption can be reduced by the use of two pumps for medium-sized and large ones. Vacuum pumps for many of the filters can not be combined in the same system, vacuum bags, and all filters. The pumps must be able to be in a vacuum of 28 "Hg), and have dimensions that correspond to the desired CFM performance at a level of 20" Hg.

• Filter Pump Capacity

performance of the pump in most applications, the primary coating, the filters have a filtration process which is considerably lower than in the pre-alert mode. A standard centrifugal pump (ANSI type only) is used as the sample, and the pump, then you can expect problems with the operation of the pump, that is, to make the pump curve for the pre-alluvial mode, the filtration process. As a rule, two pumps of different sizes and can be used to move the sample from the vacuum receiver is a great pump for the pre-coating of a pump that is the right size for the technological process. Centrifugal pumps should not be run faster than that on 1 to 750 revolutions per minute. / min), and a non-return valve, on the pressure side. They will need to be changed to work in a vacuum on the suction side and has a capacity of TDH, and in compliance with the introduction of the system. The gasket should seal (mechanical or electronic).

• Vacuum receiver,

The application of a vacuum, the receiver, presses to separate it from the two-phase mixture, which consists of the filter, i.e., air/liquid (s). In the case of the foam, the receiver must also be able to prevent the foam from the relocation of the pump The diameter of the dish, is a critical size for the implementation of the separation of the two phases, and the height of the fifth wheel is designed for the use of the current site.

• Cycle Time

The duration of the leaf test cycle is the same as the speed of the filter drum, which is usually expressed in seconds or minutes per change. The speed of the drum is usually faster, the effect is much higher. However, under these conditions, the cake is thin and sometimes wet, so the output can be damaged. At all times, a removable cake should be produced. Any final choice of cycle or drum speed is a relaxation of these conditions.

• Surface Tension

Reducing facial friction with high temperatures or with surfactants can greatly improve the cake moisture content of some items. Its benefits are non-predictable and have no significant impact on filtering quality. Where surfactants are active, vacuum capacity can be greatly reduced.

• Cake compression

Cake congestion is often found in conjunction with the filtration step to reduce the moisture content of the cake under pressure.

• Feed Concentration

In general, the higher the percentage of solid matter in a given slide, the greater the filtering rate at Kg / m2 / h, and the filter rate in m3 / m2 / h decreases. Where a large amount of solid material is required it is advisable to consider the strength of the slide by gravity. In some applications involving solidity with sludge recycle, the particle size increases, and the cake and filtrate levels may increase.

• Slurry pH

Since slurry pH and particle distribution are closely related, changes in pH can be one of the most effective ways to achieve improved slope and filtration, if the process can be tolerated.

• Dispersion of good durability solid

Dehydration is usually preferable to solid slurries in a dispersed state and is usually poorly filtered. A variety of polyelectrolyte flocculants provide a place for significant improvement in filtering levels. The effective use of flocculants, especially polyelectrolytes, in the supply of a moderately high concentration filter requires strong agitation to obtain good solids-flocculant solids. Minimum continuous development and slow aging are important.

Some slurries can be so sweet to create filtration problems and dispersal may be a better way to get liquid than diluted.

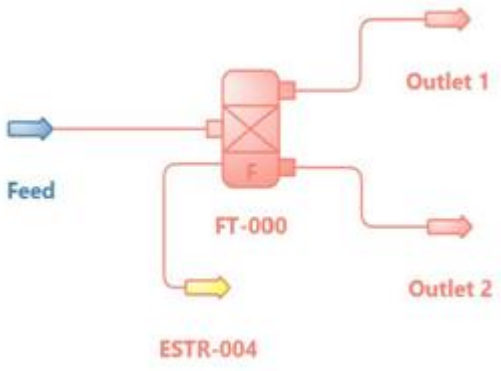
• Slurry Age

Sometimes procedures include arrest periods whether international or not, which provides a corrective effect, which adjusts the operation of the filter. Samples submitted for testing pose a risk that excessive aging may contribute to the diagnosis.

Example

I have tried to explain the problem of McCabe with the help of DWSIM software

A rotary drum filter with 30 percent submergence is to be used to filter a concentrated aqueous slurry of CaCO3 containing 14.7 lb of solids per cubic foot of water (236 kg/m³). The pressure drop is to be 20 in. Hg. If the filter cake contains 50 percent moisture (wet basis), calculate the filter area required to filter 10 gals/min of slurry when the filter cycle time is 5 min. Assume that the specific cake resistance is the same as in Example 30.2 and that the filter-medium resistance R is negligible. The temperature is 20°C.



Filter - Material Stream Results				
Object	Outlet 2	Outlet 1	Feed	
Temperature	68	68	68	F
Pressure	702.213	702.213	2116.21	lbf/ft2
Mass Flow	1484.32	4229.76	5714.08	lbm/h
Volumetric Flow	0.00391425	0.0183661	0.25239	ft3/s

Filter - Results		
Object	FT-000	
Energy Balance	141.777	BTU/h
Total Filter Area	35.186	ft2
Cake Relative Humidity (%)	50	%
Cycle Time	0.0833333	h
Filter Medium Resistance	0	ft-1
Specific Cake Resistance	4.08919E+09	ft/lbm
Submerged Area Fraction	0.3	
Total Pressure Drop	1414	lbf/ft2

Simulation Report

DWSIM 6.4

Details

Title: MySimulation_7

Comments:

Object: Outlet 2

Type: Material Stream

Property	Value	
Temperature	68	F
Pressure	702.213	lbf/ft2
Mass Flow	1484.32	lbm/h
Molar Flow	58.8182	lbmol/h
Volumetric Flow	0.00391425	ft3/s
Density (Mixture)	105.336	lbm/ft3
Molecular Weight (Mixture)	25.2358	lbm/lbmol
Specific Enthalpy (Mixture)	-744.282	BTU/lbm
Specific Entropy (Mixture)	-1.30876	BTU/[lbm.R]
Molar Enthalpy (Mixture)	-41.4082	BTU/lbmol
Molar Entropy (Mixture)	-0.131064	BTU/[lbmol.R]
Thermal Conductivity (Mixture)	0.213419	BTU/[ft.h.R]

Object: Feed
Type: Material Stream

Property	Value	
Temperature	68	F
Pressure	2116.21	lbf/ft2
Mass Flow	5714.08	lbm/h
Molar Flow	267.529	lbmol/h
Volumetric Flow	0.25239	ft3/s
Density (Mixture)	6.28886	lbm/ft3
Molecular Weight (Mixture)	21.3588	lbm/lbmol
Specific Enthalpy (Mixture)	-863.61	BTU/lbm
Specific Entropy (Mixture)	-1.63061	BTU/[lbm.R]
Molar Enthalpy (Mixture)	-40.6655	BTU/lbmol
Molar Entropy (Mixture)	-0.138207	BTU/[lbmol.R]
Thermal Conductivity (Mixture)	0.350834	BTU/[ft.h.R]

Object: Outlet 1
Type: Material Stream

Property	Value
Temperature	
Pressure	
Mass Flow	
Molar Flow	
Volumetric Flow	
Density (Mixture)	
Molecular Weight (Mixture)	
Specific Enthalpy (Mixture)	
Specific Entropy (Mixture)	
Molar Enthalpy (Mixture)	
Molar Entropy (Mixture)	
Thermal Conductivity (Mixture)	

Object: ESTR-004
Type: Energy Stream

Property
Energy Flow

VI. Benefits

1- the rotary filter is automated and is non- stop in operation so that the labor prices are very low.
2- the clear-out has a large capability, so it's miles appropriate for the filtration of surprisingly concentrated answers.
3- version of the rate of rotation allows the cake thickness to be managed.
4- pre-coat of filter out useful resource may want to use to accelerate the filtration charge.

VII. Disadvantage

1- the rotary clear out is a complex piece of device, with many moving components and may be very expensive.
2- Similar to the filter out itself, some add-ons are connected, e.g., a vacuum pump, vacuum receivers, slurry pumps, and agitators are required.
3- the cake tends to crack due to the air drawn thru by using the vacuum machine so that washing and drying aren't green.
4- it's far appropriate only for immediately- forward slurries

VIII. Conclusion

The experimental study and optimization have been studied. We conclude that by optimizing certain parameter in the RDF the performance can be increased with considerable cost reduction also is understood the machine usually need less attention the cloth increases the performance in RDF. Filtration efficiencies can also be improved in terms of the dryness of filter cake by significantly preventing filtrate liquid from getting stuck in the filter drum during the filtration phase.

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