Sequential Operations and Discharge Mechanisms of Rotary Vacuum Drum Filter

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***Abstract*— The "Rotary Vacuum Drum Filter" is one of the simplest architectures for industrial mechanical applications and mechanical operations. It is the efficient practical approach for the separation of solid/liquid particle's from the mixture of slurry. Rotary Vacuum Drum Filter has an exclusive mechanism for supervision of formed solid cakes during the filtration operation with minimum labour operating cost. The operation performed with the help of "Rotary Vacuum Drum Filter" is considered as one of the energy efficient and clean method for filtration. The various parameters such as concentration of slurry, submerged depth, vacuum pressure, rate of rotation can affect the filtration rate and quality of filtrate. It has the capability of continuous flow processing during the phase of solid/liquid separation. The fact about rotary vacuum drum filter is that it is considered as the mother equipment and workhorse of various mechanical, chemical, food, agriculture industries.**

***Keywords*— Architectures, RVDF, Solid/liquid separation, Mother Equipment, Workhorse, Slurry, Submerged Depth, Vacuum Pressure, Rate of Rotation.**

I. INTRODUCTION

The process of solid and liquid particles separation from the slurry with the help of filtering equipment i.e., Rotary Vacuum Drum Filter in which solid cake is deposited on the surface of drum filter. The separation of solid and liquid consists of two phases. The operation in RVDF is carried out with the help of filtration cloth sizing in micron and vacuum pump. The operating speed should be very low i.e., 0.5 to 2 rpm. The approach to carry out this operation is mainly termed as "Mechanical Separation Process" the reason is it is mainly carried out with the help of physical means.

During the filtration operation various technical parameters are need to be considered for successful operation. Various technical parameters such as slurry composition, chemical formula of slurry, specific gravity, Ph value, total amount of slurry, temperature of slurry, vacuum pressure, dimensions of drum filter, material of filter cloth (mainly used of material Polypropylene), pore size in filter cloth (mainly in microns), holding arrangement (Grids).

II. ROTARY VACUUM DRUM FILTER

The most common type of filter for continuous filtration is "Rotary Vacuum Drum Filter". In which liquor is sucked through a moving septum to deposit a cake of solid. The cake is moved out of filter zone, washed, sucked, dry and dislodged from the septum. The Rotary Vacuum Drum Filter is one of the oldest filtration equipment applied in the process industries and it is considered as the equipment of bottom feeder group. Therefore, rotary vacuum drum filters are certainly used for the best part of solid liquid separation process.

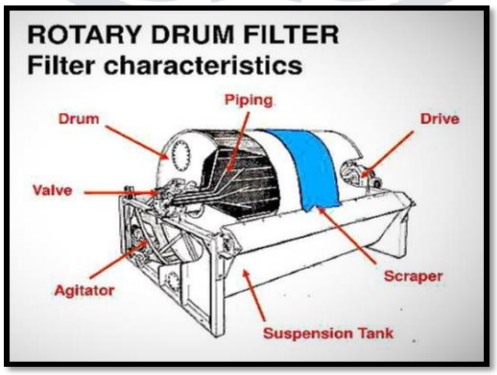

Fig. 1 RVDF filter characteristics

III. PRINCIPLE OF RVDF

RVDF is mainly used for the separation of fluid and solid particles or to perform the operation for solid and liquid separations.

IV. DESCRIPTION OF RVDF EQUIPMENT

1.Drum:

Drum is the main component which is mounted during the time of assembly with the help of bearing on the drive side and on the other side with the help of valve.

2.Support structure:

The drum will be mounted on self-aligning double row spherical roller bearing around the trunnion shaft Plummer block and tapper adapter sleeve with locking on drive side at non-drive end the trunnion pipe will be mounted with bronze bush bearing assembly and it will be link with rotary valve.

3.Scrapper assembly:

Scrapper blade will have PP as scraping edge sandwiched between top SS 316 pressure plate and SS 316 base plate. The blade will have manual arrangement to adjust pressure against the drum. For fine adjustment of blade, bolts will be provided on the top of pressure plate.

4.Valve:

The valve mainly used is Rotary valve. With the help of valve one can control the operational arrangement so that the operational cycle can cover the region which is subjected to the region of dead zone, vacuum zone, blow zone. The rotary valve is mainly provided for the suction of feed slurry from the tank.

5.Agitator:

An agitator keeps gently the slurry in suspension and reciprocates between the drum face and tank bottom for the proper mixture of slurry.

V. CONSTRUCTION OF RVDF

It consists of sheet metal drum. The diameter of drum ranges from 1 to 10 feet. A vacuum system is also attached to it so that, during filtration process the whole drum should performs operation under vacuum condition. The surface of the drum is divided into different sections by stripes.

These steps are parallel to the axis of drum and welded to the shell. In each section there are many pipes which open inside the cover plate. The side cover plate. There is also a stationary valve plate through which connection are made to the filtrate receiver tank. For compressed air and wash water connection valve are given.

After washing, to remove the formed cake, “Doctor Knife” is used for the removal of the cake. Its placed in such an angle that it should not damage the filter aid.

VI. WORKING OF RVDF

As the filtration operation starts the rotary vacuum drum filter is submerge for pre-coating purpose in tank of filter aid. After the drum is rotated in slurry tank at a speed of 0.5 to 2 rpm at that time 1/3 of the drum is dip in the slurry tank, and finally vacuum is applied through a valve and the filtration process is started.

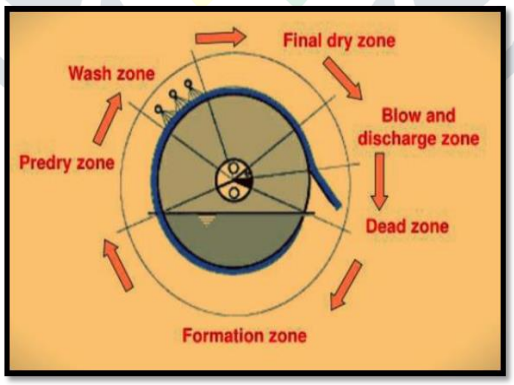

Fig. 1 working cycle

A layer of solid is built in the form of cake on the surface of panel in cake formation zone and filtrate get pass through the pipes and goes to vacuum receiver and get collected in the tank. As the panel leaves the cake formation zone it enters to washing zone and in which water is sprayed on the cake to extract all filtrate from cake and it is sent to wash vacuum receiver. And panel enters into the drying zone.

In these sections high vacuum is applied and all filtrate is sucked and cake is obtained in completely dried from. Now again with the help doctor knife removal dry cake from filter cloth carries out without damaging the filter aid. After that this panel again enters to the cake formation for continuous filtration and cycle is repeated.

VII. OPERATIONAL SEQUENCE

The entire filtration operation takes place on a rotary vacuum drum filter in a region of 360 degrees. The filtration operation covers each and every region during the operation is performed. Let's study the sequential cycle of filtration with the help of fig.3. According to the fig.3. the rotary vacuum drum filter is rotating in the clock wise direction as the viewer is viewing from the valve end.

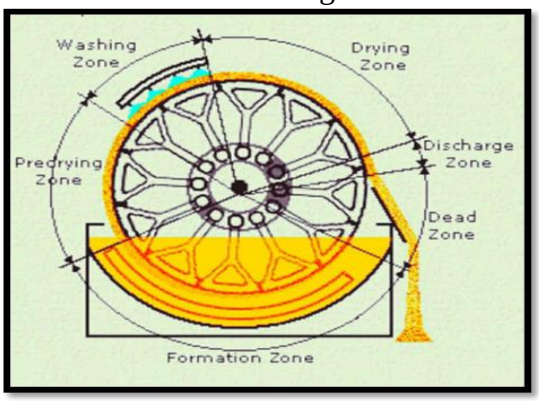

Fig. 3 operational sequence cycle

A. Operation sequence (rotation in clockwise direction as shown in fig. 3)

Cake formation zone, cake pre-drying zone, cake washing zone, cake final drying zone, cake discharge zone, dead zone.

1.Cake formation:

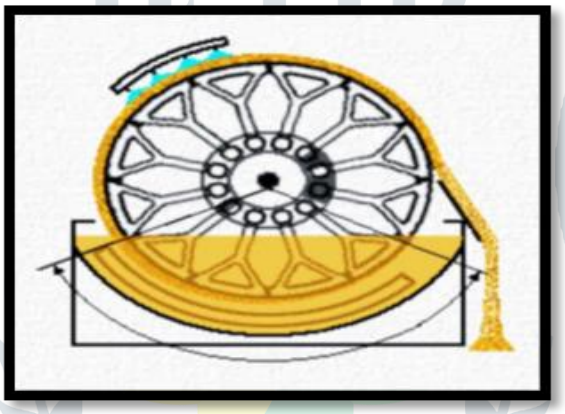

Fig. 4 Cake Formation zone

With the overflow weir set to a most the "apparent submergence" is normally 33-35% that the suspension levels between 04:00 and 08:00 hrs. Once a sector enters submersion vacuum is applied and a cake starts to make up to a degree where the sector emerges from the slurry. The portion of the cycle available for formation is that the "effective submergence" and its length depends on the quantity of sectors, the suspension level within the tank and also the bridge setting that controls the form to dry ratio.

2.Cake washing and drying:

After rising from submersion, the drying portion of the cycle commences and for non-wash applications continues to regarding 01:30 hrs wherever the vacuum is cut-off.

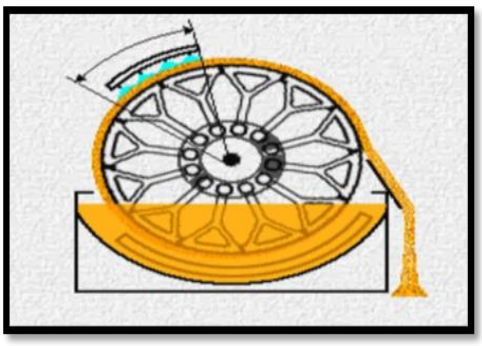

Fig. 4 Cake washing zone

If cake laundry is needed the wash manifolds are going to be located from regarding 10:30 to 11:30 hrs and therefore the remaining time to vacuum cut-off at 01:30 is that the portion allotted to final cake drying.

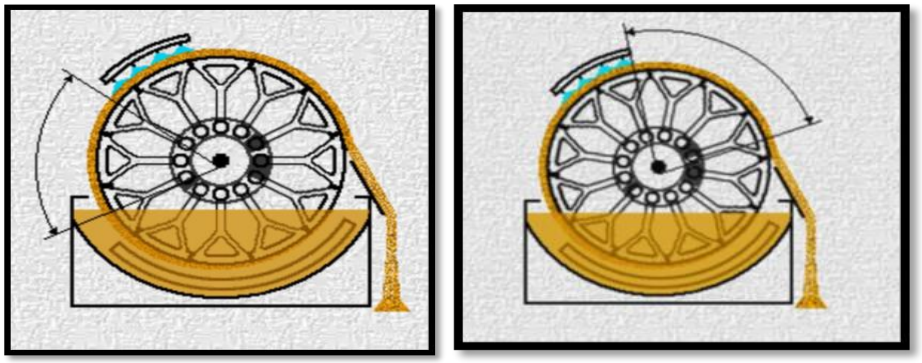

Fig. 5 Cake pre-drying and final drying zone

3.Cake discharge:

After vacuum for the complete sector is cut-off air blow commences at regarding 02:00 hrs so as to facilitate cake discharge. The blow, looking on the position of the tip of the hand tool blade, can cut-off at just about 03:00 hrs. Drum filters are normally operated with a low pressure blow but on certain applications a snap blow is applied and to avoid the snapping out of the caulking bars or ropes wire winding of the material is usually recommended. Blow is used on scraper and roll discharge mechanisms but on belt discharge filters vacuum cuts-off when the filter media leaves the drum.

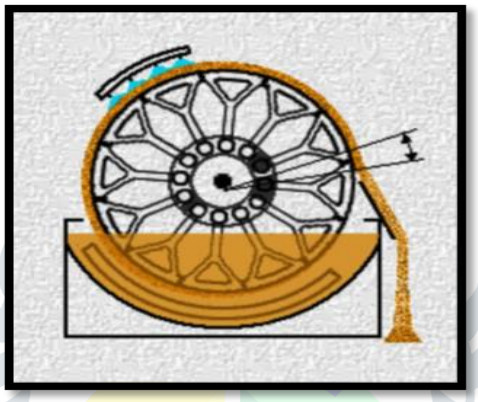

Fig. 6 Cake discharge zone

4.Dead zone:

Once the blow is cut-off the arena passes through a zone blocked with bridges in order that no air is drawn through the exposed filter media which could cause the loss of vacuum on the entire drum surface.

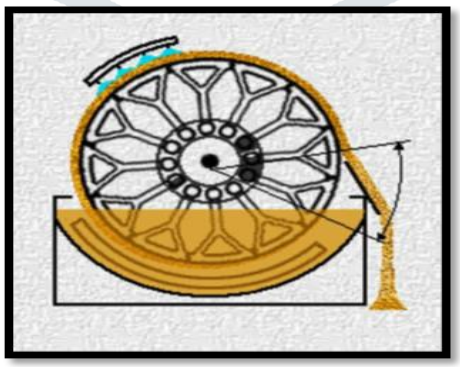

Fig. 7 Cake dead zone

VIII. DISCHARGE MECHANISM

Each is intended to be able to discharge specific varieties of fashioned cake solids. In essence, these five mechanisms enable the rotary vacuum filter to with efficiency handle [i.e. filter a solid-liquid slurry and discharge the formed solids] a complete spectrum of process slurries.

1.Endless belt discharge:

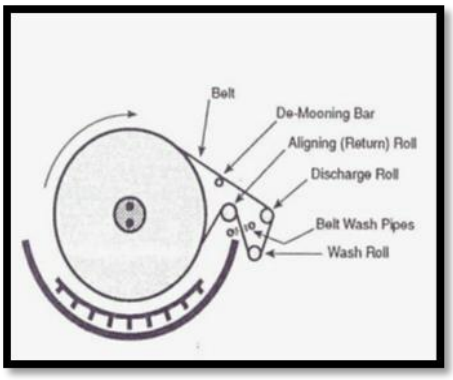

Fig. 8 Endless Belt Discharge Mechanism

Belt chase, cake unharness and media cleansing square measure of major importance for economical operation. The first task is to make sure that a septum (filter cloth) is chosen that provides [a sleek surface permanently cakes unharness, sensible wear resistance (suggest a weave variation), good dimensional stability (autoclaved material) and a yarn resistant to solids blinding (mono or multifilament). Belt tension, de-mooning bar height, wash water quantity and discharge roll speed are adjustments which must be carefully selected to maintain tracking and prevent excess wear.

Uniqueness:

1.Best for slurries with "moderate" solids content
2.Filter cloth critical for cake release & filtrate clarity
3.Most complicated discharge design
4.Cloth continually cleaned

2.Roller discharge:

Cloth choice should give permanently cake unharness and solids blazing resistance. Coated materials will be useful for enhancing each cake unharness and lengthening the lifetime of the media attributable to solids blazing. Valve body settings for vacuum emanation at the purpose of discharge is vital. Discharge roll speed should be matched to the drum speed and also the hand tool knife should leave a big "heal" on the discharge roll so cake transfer is continuous.

Uniqueness:

1.Solids must form a sticky, mud-like cake.
2.Slurry solid content usually high.
3.Filtration rate are typically very low.
4. Filter cloth design is critical

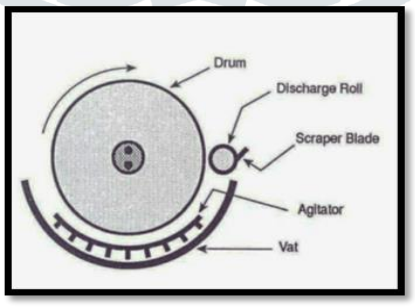

Fig. 9 Roller Discharge Mechanism

3.String discharge:

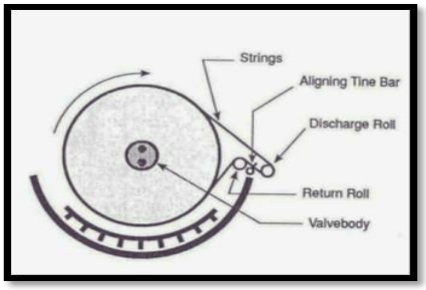

Fig. 9 Roller Discharge Mechanism

Besides the standard media choice demands, string following and alignment are vital. Aligning tines tend to get worn – in grooves from the strings. After a period of time these grooves will jam and cut the strings causing cake discharge and maintenance problems. Careful adjustment of the orienting prong bar to reduce lateral pressure on the strings is important. Placing a ceramic (glass, or any other suitable material) tube over each tine will act as a bearing surface for the string; the string rotates the tube around the tine as it passes by.

Uniqueness:

1.For slurries with high solids content.
2.Solids must be fibrous/string/pulpy.
3.Filter cloth design is critical.

4.Pre-coat discharge:

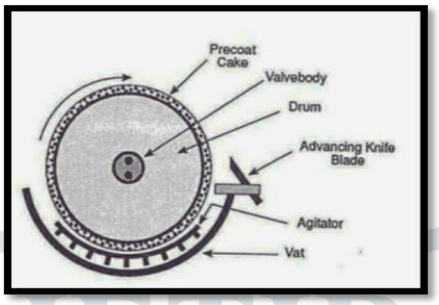

Fig. 10 Pre-coat Discharge Mechanism

Filter cloth should be selected in conjunction with the grade and type of filter aid (diatomaceous earth or perlite) being used in the process [please see "Filter Cloth/Septum Design"]. Adjusting the advancing knife for the optimum knife advance rate per drum revolution is totally imperative for economic filter performance and filter aid potency.

Uniqueness:

1.Well suited for very low solids concentration
2.Product is typically "liquid" phase
3.Designed for "difficult" to filter slurries
4.The filter medium is disposable & renewable
5.Typical filter medium is Diatomaceous Earth or Perlite
6.Filter aid selection is critical for clarity & economy
7.Economic operation sensitive to filter adjustments

5.Scrapper discharge:

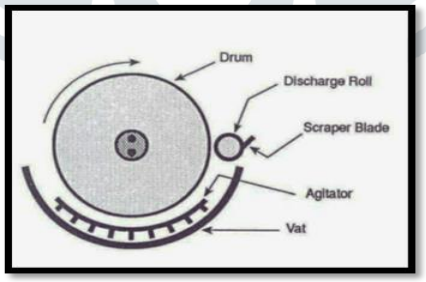

Fig. 11 Scrapper Discharge Mechanism

Filter textile choice should give smart wear and solids fulgent characteristics. Blowback pressure shouldn't be excessive (causes high go down the material and blows out the caulking), blowback ought to be for the shortest period potential (just enough to dislodge the cake) and therefore the hand tool blade shouldn't be set against the drum (unless the filter is wire wound). Valve body adjustments are critical for blowback so that excess filtrate is not forced back out of the pipes along with the released cake solids and to minimize wear and media maintenance.

Uniqueness:

1.Various mixtures of solid liquid slurry can be easily filter.
2."Air blow-back" for cake release.
3.Excellent for heavy solids.
4.Rate of filtration is high with great accuracy and good quality of cake.
5.Woven synthetic type of filter aid is used for great performance.

IX. CONCLUSIONS

Rotary Vacuum Drum Filter holds good for the filtration and solid liquid separation operations. Here we have discussed about the safety and unique ideas of operational sequence of rotary vacuum drum filter where we it seems that it requires very little operator attention as it rotates at very low rpm and it carries out a continuous filtration and cake discharging process.

We have briefly discussed about the various Cake discharging mechanism according to mixture of slurries, and uniqueness about each discharging mechanism. Therefore, the paper gives the clarified ideas about the sequential operational which is carried out by RVDF during operation and gives the clarification about the discharge mechanism where and why to use.

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