UNIQUE DESIGNS FOR HORIZONTAL BELT TYPE FILTERS

The use of horizontal belt filters has a fairly long history. It was first developed in the early 1930's by Nordengren at the Landskrona Phosphoric Acid Plant in Norway and was used for filtering gypsum in the phosphoric acid process. There have been several offshoots from that original design, many of which are still around today. There were some that were developed not as offshoots of the originator but were developed independently. However, all have the same general configuration and the same principle of operation.

There were others that were developed for special needs, and the most notable of these are the indexing type of horizontal filters. There is one type which uses a traveling pan, which indexes backwards and forwards with vacuum interruption and another type which has a stationary vacuum box but indexes the filter media only also with vacuum interruption.

There are also the horizontal rotary pan or rotary tray filters, but these will not be discussed here.

Dorr-Oliver's involvement with the horizontal belt filter dates from 1948 with the introduction of our traveling pan filter otherwise known as the Giorgini filter. The application of that filter was confined solely to phosphoric acid filtration and many were sold around the world, the last being some time in the early 1960's.

More recently Dorr-Oliver has developed a traveling horizontal belt filter with a rubber belt similar to others of that type but with some distinct differences. Even more recently a horizontal belt filter which replaces the rubber belt with a segmented metal belt for use where, for a variety of reasons, the rubber belt is not the best choice.

Some of the more obvious reasons for choosing a segmented metal belt over a rubber belt are: the rubber is attacked by the process liquor; process temperatures are too high; or the installation is in a remote part of the world where rapid replacement of a damaged rubber belt is not assured.

We call these two versions the Roller Belt, which is the filter having the rubber conveyor and the Rigid Belt which is the filter having the segmented metal conveyor.

Obviously there are going to be some major differences in these two types of filters, but there are also some similarities or even identical parts. These are the feed and wash boxes, cloth husbandry if you will, that is the cloth tracking, washing, control, tensioning. And the vacuum box. Although our treatment of the pivoting and

movement of the swing-away type vacuum box is slightly different for each type.

The major differences are of course in the conveyor, and we will discuss those separately and in detail.

First of all, the feed box is designed to accommodate all types of feeds, that is low concentration, high concentration, segregating flocculant, fine solids, coarse solids, etc. The feed box extends across the entire width of the filter. We provide a separate feed inlet for each meter of belt width. The feed is dropped down onto an impingement plate and then onto an impingement shelf where it reverses direction and hits a flexible rubber flap. The pressure of the flap against the impingement tray or shelf can be adjusted. The flexible rubber flap provides a slight back pressure so that we get a slight buildup of slurry behind the flap and thus even distribution. The slurry then flows out from between the rubber flap and the shelf onto the curved impingement plate on the bottom before being smoothly fed onto the filter media. This feed box is positioned so that the feed is introduced onto the belt in a non-vacuum zone, which gives segregating slurries a chance to place the coarser fraction next to the filter media.

The feed box is mounted on the side frame of the filter and can be easily positioned by loosening the hold-down clamps and moving the feed box into the desired location.

The wash box is somewhat different in that it has a single wash liquor entry except for very large width filters and there is a pool of liquor maintained behind the distribution weir. The wash liquor overflows the weir and down over a curved distribution plate and onto the filter. For very low flows the weir would be v-notched.

As part of the wash box, there is a flexible rubber flap on the backside which prevents stronger liquor upstream from intermingling with the wash liquor being applied.

Our continuous filter cloth control system starts just upstream of the feed box. On returning to the filtering surface, it first encounters the preforming roll. This is a roll about 8 to 10 inches in diameter with conical ends and which fits snugly into the contour of the rubber belt or trays. It serves the function of centering the filter media and assuring that the media fits smoothly against the traveling belt without creasing or wrinkling.

The cloth is held to the traveling belt by the weight of the feed slurry, filter cake and vacuum. It is carried along with the traveling belt by friction, which is typical of these kinds of filters.

On the discharge end the cloth wraps around a small diameter roll for cake discharge. Cake still clinging to the cloth is knocked off

by a doctor blade. The cloth then goes through a wash zone where cloth wash water is applied on both sides through high velocity sprays. It is in this zone too that wash water may be applied to the rubber or metal belt itself to remove any solids which go through the filter cloth. The belt/tray washing is caught in a shallow pan, which is in place to avoid splashing. The filter cloth washings are also caught in a tray and directed to an outlet at the lower end. This wash water is often recycled and used as cake wash.

The belt is returned over idler rolls to the front end of the filter where it encounters the optical sensor for tracking. The optical sensor senses the edge of the belt. There is one on either side. These sensors send a signal to the electrical screw jack which moves a tracking roll laterally from one end only, the other end being a pivot point. This tracking roll, by moving forward and backward, causes the cloth to move either to the right or to the left. On signal the screw jack moves a predetermined amount and stops. If there is still a signal from the optical sensor that the belt is off line, the screw jack moves another increment. It continues to do this until the belt is properly centered.

We have a unique tensioning device at the head end of the filter. This assembly automatically adjusts for belt stretch or shrinkage. The tension roll is mounted on a very heavy movable mounting bar. The mounting bar is supported by cables. The weight of the mounting bar and tensioning roll is partly balanced by filling the counterweight box with water. It is by this means that a precise and constant tension can be put on the cloth. By tensioning in this particular way, the tension on the cloth remains constant even as the cloth changes length.

Following the tension assembly there is the standard banana roll or curved roll, which of course serves to dewrinkle the cloth. Following that, there is another optical sensor, which is in place just ahead of the preforming roll. This optical sensor is in place to detect cloth misalignment that does not get corrected. If the cloth goes too far out of line, an alarm sounds first. If it continues to drift, an automatic shut-off will shut the machine down before cloth damage can occur.

The vacuum box has a fairly typical shape. It is narrow at the top end where the vacuum seal is, and it has a generally rectangular configuration. It includes the wear strips, seal strips, the vacuum box, and a removable bottom.

The vacuum box itself can be made out of several materials: carbon steel, stainless steels or even more exotic metals. Or it can be rubber lined or made of fiberglas reinforced plastic. The seal strips at the top of the box are made from high molecular weight polyethylene and are put in place in modular lengths. Several are used on each filter. Down the center of the seal is a deep channel with several longitudinal holes connecting the channel to the vacuum box. At the

upstream end of each of these seal strips, there is a port for introducing water between the seal and the wear strips. This water is used for lubricating and dissipating the heat.

The wear strips are narrow ribbons of two materials bonded together. They are rough on one side and very smooth on the other. The rough side meets the underside of the traveling belt and travels with it by friction. There is no movement between belt and wear strip. The very smooth side slides along the seal strip. This low cost wear strip wears preferentially, thus saving both belt and seal strip.

One of the more attractive optional features of our vacuum box is the removable bottom. The bottom is polyethylene and held onto the box by quick disconnect clamps. This enables an operator to quickly and easily inspect the inside of a box. He may also have easy access to the box for cleaning and descaling or relocating wash liquor partitions.

For inspection and maintenance the entire box swings away from its operating position on a pivot point.

The vacuum box with its support and the wear strip idler rolls are pivoted about the pipe carrying the seal strip lubrication water. This entire assembly is counterweighted by a box filled with water. Of course the amount of water can be precisely adjusted so that the entire vacuum box assembly can be tilted away by one person.

There is a second version of the swing-away vacuum box which places the water filled counterweight directly on the structural framework, and it does not act through the cables and pulleys.

The filter drive consists of a shaft mounted gear reducer, the gear reducer is connected by a flexible coupling with a standard AC motor. The speed of the drive can be controlled by frequency modulation.

For those special cases where washing is extremely important and therefore cake thickness should be controlled, we have a cake thickness control consisting of an ultrasonic device. This ultrasonic device gives a 4 to 10 milliamps signal and can be used to modulate the frequency of the filter drive, which in turn of course controls the speed of the filter.

This concludes the list of major parts that are the same for either the rubber or metal belt. As mentioned at the outset, the metal and rubber belts are distinctly different from others on the market and from each other. The rubber belt which supports the filter media and conveys has a fairly standard drainage groove and hole pattern.

There are two curb constructions. One has a thin curb with a thinner flex zone but which is reinforced throughout this critical area.

Furthermore, the reinforcing does not extend to the drainage holes and thus is protected from the process liquor. With this type of belt the edges lay flat as they wrap around the head and tail pulleys.

Through the feeding, filtering, washing, and drying zone, the edges are supported by edge rollers. In the feed zone, where the feed slurry is very fluid, there are many edge support rollers. Later on through the washing and drying zone, there are fewer rollers required. There are two types of rollers guiding the belt, one on an angle supporting the edge curve and another maintaining belt alignment.

The really unique feature about our rubber belt filter is the means of supporting the rubber belt and from which it gets its name. We have supplanted air or water lubricated slide bars with a series of very closely spaced rolls arranged along the full length of the filter. It is on these rolls that the belt rides and is supported. By incorporating these rolls instead of the air or water lubrication, we have eliminated the nuisance of having to deal with either air or water for supporting the belt. The roll bearings are sealed and self-lubricated. One axle is spring loaded so it can be pushed in and the roll removed in seconds even while the filter is operating.

The use of the belt support rollers and edge guard rollers results in a very low power demand. We judge on a calculated basis the power draw of filter using slide bars, either air or water lubricated, will require about twice the torque compared to filters using the rollers.

We have another belt design which is similarly supported and guided on rolls, but which has a heavier curb. This heavy curb does not need the angled side rollers for support. It is strong enough to contain the feed slurry by itself. Unlike some others, is not monolithic with the main belt so that when it wears, it can be separated at the bond and a new curb recemented to the belt.

Now for the truly unique machine. The Dorr-Oliver Rigid Belt, as previously mentioned, has a conveyor made of a segmented metal belt. The segments have raised sides for slurry containment; otherwise the segments form one flat continuous conveyor. A plastic drainage grid is fixed in the bottom of each segment to support the filter cloth and allow filtrate drainage. The trays are joined underneath by a thick but narrow rubber band, which functions as the sealing strip between the metal trays and the vacuum box.

This metal belt is driven by two cog wheels located at the discharge end of the filter. Each cog wheel engages a toothed heavy rubber belt, much like a timing belt. The trays are also supported at the outer edges by rollers. The use of rollers here again is advantageous in that it results in a lower power demand than comparably sized rubber belt filters with either water or air lubricated slide plates.

The filter drive consists of a shaft mounted gear reducer, the gear

reducer is connected by a flexible coupling with a standard AC motor. The speed of the drive can be controlled by frequency modulation.

In summation, Dorr-Oliver has drawn on its many years of experience with horizontal continuous filters both tray and belt to introduce to the process industries two unique machines. The first, a rubber belt filter, called the Roller Belt, which is supported by rollers with the belt being tracked by rollers. This provides for lower drive torque and the elimination of the peripheral system of air or water for belt support and lubrication.

For those situations where rubber is incompatible with the process requirements, we have a segmented metal belt filter called the Rigid Belt. This segmented metal belt eliminates the need or worry of rubber belt replacements. It is also a truly continuous filter without any vacuum interruption and/or reciprocating action. The elimination of the reciprocating action results in a higher unit capacity. It also results in a lower vacuum demand since there is no vacuum interruption. We have one and soon will have two 5 sq. ft. pilot plant Rigid Belt filters available for renting to those who are excited about the possibilities of horizontal belt filtration. In our opinion, it is the most versatile and adaptable vacuum filter available.

Thank you very much.