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DEWATERED CAKE TRANSFER: A SYSTEMATIC APPROACH TO SELECTING THE BEST TECHNOLOGY

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Moving dewatered cake can be extremely challenging and quite frustrating over time. Progressive Cavity (PC) pumps have been pumping dewatered cake for over 70 years, but how do PC pumps stack up against other methods used today? We will research this topic focusing on the advantages and disadvantages given a particular installation.

BACKGROUND

Most processes ending with dewatering sludge require a method to move the dewatered material to an awaiting truck, a drying bed, incinerator, or dryer. To accomplish this, a system must be utilized to move cake from point A to point B, and this is typically broken down into two groups: pumps and conveyors. The two groups can be further dissected into the main products that reside in each category:

PUMPS

- Progressive cavity pumps
- Piston pumps

CONVEYORS

- Shafted and shaft-less screw conveyors
- Belt conveyors

Now let us look at what differentiates the two groups, looking at who has the advantage starting with the general pump group versus conveyors group, the advantages between PC pumps over Piston pumps, and finally what differentiates PC manufactures from one another.

SEEPEX Inc.
511 Speedway Drive
Enon, OH 45323 USA
+1 937 864-7150
www.seepex.com

PUMPS VS. CONVEYORS

When we look at the two groups, there are distinct differences in cost and space requirements. The products within each group are vastly different, but there are several key features from a group perspective that standout.

FLOOR SPACE:

The most common conveyor systems in cake installations require low angles for elevation change, or at a minimum, uninterrupted runs to get to their destination. This results in considerable floor space either for the conveyor itself or the support structure to get the device off the floor. If there is a need for a large elevation change, conveyors require great distances to accomplish this. Pumps conversely, utilize piping that is capable of leaving the end of the pump and being routed completely vertical if necessary. Because of this, pipe can be installed overhead leaving floor space open for other equipment or movement in the area. Pumps require only enough space for the pump footprint.

ODOR CONTROL AND HOUSEKEEPING:

Based on design, conveyors feature completely open or partially open areas that allow odors to escape. This openness often results in increased housekeeping requirements as well. Cake in an overstuffed auger system can push out from under thin covers. Even worse, belt conveyors, by design, require the belt to turn upside down the complete length of travel, spilling any contents that did not drop off at the discharge. Pumps, on the other hand, use sealed piping systems, eliminating all odor and housekeeping issues.

COST:

The cost of the system can vary greatly based on overall distance of travel, elevation changes, and product type selected. Simple short runs with no turns (less than 20 feet) are sometimes more economical with conveyors. For larger systems, a pump system becomes more economical, especially with elevation and turns, as a conveyor system requires a new drive system anytime a change in direction is necessary. Pump pricing is somewhat basic with the ability to develop a price per gallon, whereas a conveyor increases price with length. The longer the run, the higher the cost.

MULTIPLE DROP POINTS:

For customers having a need for multiple drop points, both systems can accommodate this with varying degrees of difficulty and cost. With a pump, valves in conjunction with piping are used to allow for selectable discharge points. With a conveyor, either multiple conveyors are used or a reversible conveyor with drop points can be utilized. Each option should be evaluated for the given situation to determine the most economical installation.

CHANGING VISCOSITIES:

Some dewatering equipment can output lower solid concentrations of product at times, or even have cleaning cycles that discharge a high amount of liquid. If this scenario is part of the operation, a conveyor cannot move this type of product and must have provisions to drain away from the device. Conversely, pumps used to convey cake can move these lower viscosity fluids without issue. This makes them ideal for systems that are setup to discharge cake as well as lower viscosity media.

EFFICIENCY:

This topic is completely dependent on what distance needs to be covered, and in the case of conveyors, how many changes of direction. In general, a short single run of a conveyor is going to be more efficient than either pump type. If a longer run or additional motors are necessary, then the PC pump becomes at least as efficient, if not more efficient. We will discuss piston pumps next.

PROGRESSIVE CAVITY PUMPS VS. PISTON PUMPS

Just like the pumps vs. conveyors, when we look at the different pump types there are some distinct differences. Both types of pumps are positive displacement, meaning for each revolution or stroke, a set amount of product is discharged. This is the only real similarity these two pumps share.

FLOOR SPACE:

The typical piston pump is setup with a twin screw feed hopper (TSF) that feeds the pump dewatered material. Both pieces of equipment run off of hydraulics. A power pack or hydraulic unit is therefore required and needs to be in close proximity to the pump/TSF unit. Together, there are three pieces of equipment taking up floor space. In contrast, the PC pump uses a feed hopper integrated with the pump elements, increasing simplicity and saving on floor space.

COST:

Cost is where the two types of pumps vary the most. When pressure requirements increase, a piston pump may only require a larger motor. A PC pump will need to increase the length of the pumping element (stages) to accommodate an increase in pressure. This may seem like a disadvantage for the PC pump, but in reality, even the highest pressure PC pumps are 3-5 times less expensive than the equivalent flow piston pumps. It is often possible to install a PC pump with integrated hopper for less cost than just the power pack on a piston pump.

PRESSURE CAPABILITY:

Piston pumps have always been known for their high pressure capabilities, exceeding that of standard PC pumps. In the past, if the discharge pressure was over 600 psi, a piston pump was the only choice. PC pumps were able to combat this considerably by using a Boundary Layer Injection (BLI) setup. This involved injecting polymer (or other lubricant) around the inside of the pipe to reduce the friction, therefore reducing the pressure requirement. This was effective in many cases, but for extremely long runs of piping, not practical. To level the pressure playing field, SEEPEX developed and patented the use of Smart Air Injection (SAI). This system injects air into the discharge line by pushing plugs of cake at much lower pressures, but at much greater distances. The combination of BLI and SAI allows for pumping distances of 3280 feet with greatly reduced pressure at the pump as well as in the pipework. This reduction in power allows for the use of smaller pumps, lowers power consumption, and in some cases allows plastic piping to be utilized.

EFFICIENCY:

As eluded to earlier, piston pumps are not very efficient compared to PC pumps. The piston pump's hydraulic system takes electrical energy (motor), develops hydraulic pressure via a pump, then delivers the pressurized hydraulic fluid to the pump to do mechanical work. The PC pump takes electrical energy either directly to mechanical work, or through a gearbox which acts as a torque multiplier to do mechanical work. Just simply looking at this one component that is not part of the PC pump, the hydraulic motor, there is a power loss of 15%, mostly due to heat.

PULSING/PRESSURE SPIKES:

Most modern day piston pumps in dewatered applications use two pistons. Two pistons help to minimize pulsing and pressure spikes, but are not able to eliminate it completely. The pistons do not run in a continuous feed situation, leaving one piston pushing into the pipe as the other is filling. This scenario results in momentary pressure spikes every time a piston evacuates. This can be upwards of 75 psi resulting in pipe movement and just general fatigue to piping and accessories. PC pumps form cavities in which the material is moved. As one cavity is closing, another one is opening, giving a nice linear discharge with no pressure spikes or pipe shake.

MAINTENANCE:

Piston pumps require ongoing maintenance to keep seals clean and operating without damage or leakage. Hydraulic lines develop leaks and need tightened or changed. Hydraulic fluid and filters have to be changed at regular intervals as well. The PC pump is electrically driven with the only regular maintenance task of gearbox oil checks every 6-12 months.

ENVIRONMENTAL CONCERNS:

Hydraulic Power Packs contain large amounts of hydraulic oil that must be changed on a regular basis and disposed of properly. Oil leaks develop typically around fittings and can cause environmental issues in normal operation. PC pumps are electrically driven and do not have any of the issues common to piston pumps.

OPERATIONAL NOISE:

Piston pumps are inherently loud as the piston cycle and hydraulic power units deliver pressurized fluid. In some cases, depending on the installation, hearing protection is required. PC pumps are very quiet, with just a low decibel whine to the motor if a VFD is being used to control it. No pops or bangs, just smooth, quiet cake delivery.

PROGRESSIVE CAVITY PUMP VS. PROGRESSIVE CAVITY PUMP

While it is true that Progressive Cavity pumps may look similar on the surface, there are in some cases dramatic differences in how the dewatered cake is delivered to the pumping elements. First, we will explore what styles are similar between the large manufacturers. Then we will discuss the innovative engineering designs of one manufacturer that sets it apart from the others.

DESIGNS:

All of the mainstream PC pump manufactures have an open hopper design with an auger feeding the pumping elements. This design, in general, is not considered a standalone cake pump unless it is mounted under a live bottom hopper, allowing cake to be delivered to the pumping elements without bridging. To combat bridging in a situation where cake freely drops into the pump hopper, manufacturers set pumps up with near vertical sidewalls, larger augers, and in some cases, a bridge breaking device. A larger auger and near vertical sidewalls allow for low solids cake pumping, but really is not ideal for cake with a solids concentration greater than 20-22%. When dealing with higher concentrations, all of the manufacturers have a bridge breaker device that resides in the inlet of the hopper, keeping product from bridging over the auger. This design works well, but does require another one or two drives, adding cost and lowering efficiency.

Other designs have been engineered over the years with one manufacturer developing a twin screw feeder (TSF) to feed the pump. The downsides of this design will be discussed below. SEEPEX developed the first concentrically rotating integrated auger, which is a big departure from all of the other eccentrically driven auger systems. Running the auger concentrically with vertical sidewalls effectively eliminates the area along the side of the auger where cake can build and eventually bridge over the auger.

FLOOR SPACE:

Pumps with integrated hoppers are very similar in floor space requirements, with the exception of units that have a separate twin screw feeder (TSF). If the TSF is used, more floor space is required, unless the unit can be mounted above the pump.

COST:

Just like floor space, pumps with integrated hoppers are going to be within a certain percentage of each other in cost. There are slight variances in design which can drive costs, but no large jumps. The exception again is the twin screw feeder pump which tends to be double the cost of a standard hopper pump as there are two pieces of equipment rather than one.

PRESSURE CAPABILITY:

The maximum pressure a PC pump can handle with no aides is typically 600 psi, which equates to roughly 300 feet of pipe. By using a Boundary Layer Injection (BLI) setup, injecting polymer (or other lubricant) around the inside of the pipe to reduce the friction, the effective length of pipe can be doubled or the pressure cut in half. The use of SEEPEX patented Smart Air Injection (SAI) takes this to the next level. The combination of BLI and SAI allows for pumping distances of 3280 feet with greatly reduced pressure at the pump as well as in the pipework. This reduction in power allows for the use of smaller pumps, lowers power consumption, and in some cases allows plastic piping to be utilized. This keeps installation cost low as well as ongoing maintenance.

LEVEL CONTROL:

Level control is typically done via load cells or a single measuring device in the hopper. These methods have been problematic as load cells measure just a small fraction of weight vs. the total weight of the unit, require complex base plates, and complex setups. Single level devices require an amount of product above the pump to allow even for speed control, which can result in bridging. They are also prone to blinding from moisture and product build-up as they are positioned in or over the feed hopper. SEEPEX developed a Laser Level System that uses three lasers, two for sensing absence and presence of product and the third for level measurement. The level measurement sensor is positioned on the outside of the hopper. This allows for measurement from the side to avoid build-up and moisture, increases accuracy and provides redundancy.

CONCLUSION

When looking for a product to move dewatered cake, PC pumps have a clear advantage over other methods typically used. SEEPEX is the clear leader in progressive cavity pumps when comparing all aspects.

	SEEPEX PC PUMPS	OTHER PC PUMPS	PISTON PUMPS	SCREW CONVEYOR	BELT CONVEYOR
UNIT COST	✓	✓	✗	✗	✗
FLOOR SPACE	✓	✓	✗	✗	✗
ODOR CONTROL	✓	✓	✓	✗	✗
HOUSEKEEPING	✓	✓	✓	✗	✗
LOW VISCOSITY FLUIDS	✓	✓	✓	✗	✗
EFFICIENCY	✓	✓	✗	✓	✓
PRESSURE CAPABILITY / DISTANCE OF DISCHARGE	✓	✗	✓	✓	✓
ENVIRONMENTAL CONCERNS	✓	✓	✗	✓	✓
OPERATIONAL NOISE	✓	✓	✗	✓	✓
MAINTENANCE	✓	✓	✗	✓	✗
LEVEL CONTROL	✓	✗	✗	N/A	N/A

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