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ECP Pump Design, Operations Solve Paper Mill Starch Handling Problems

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With no contact between rotors and pump casing, external circumferential piston pumps avoid extensive, costly damage when pumping dilatent starch slurries

Movement of starch slurries and cooked starch is one of the more difficult pumping applications in the papermaking process. Traditionally used in these applications, progressive cavity (PC) pumps have become less reliable as changes in the way starch is used have compounded operating and maintenance problems with these types of units. As an alternative to the PC pump in starch applications, the external circumferential piston (ECP) pump is providing long service life and minimal maintenance under these difficult and demanding conditions.

Starch slurries have the propensity to become dilatent, the phenomenon of materials becoming solid-like when subject to shear forces. Starch granules settle out of suspension very quickly once the slurry is no longer in motion, such as when the pump is stopped or the mixer is turned off.

To better understand how dilatency affects operations of PC and ECP pumps, this article examines how each specifically works. The lobe pump, which is often confused with the ECP, is also reviewed.

PROGRESSIVE CAVITY PUMP

In the progressive cavity pump (see Figure 1), there is direct contact between the rotor, usually constructed of stainless steel, and the stator, which is typically made of an elastomeric material. As the rotor turns, material is "pinched" between the two parts, subjecting the pumpage to compressive forces. As long as the slurry remains uniform or unsettled, the pump will continue to operate.

First, the rotor can be jammed into the stator, creating excessive wear on the elastomeric lining. Pump efficiency falls and in some cases pieces of the stator actually break off. Secondly, the forces can be transmitted back into the seals, causing them to prematurely fail, resulting in leakage problems. Leaking seals cause a number of serious problems such as high repair costs to rebuild the pumps, loss of material, housekeeping issues, variations in product quality, and lost production time.

In one paper mill in New York State, for example, PC pumps were being rebuilt at the rate of seven to eight times per year. An ECP pump was installed as a replacement for the PC pump in this mill's application, and with the exception of routine lubrication, has run maintenance free some 30 months.

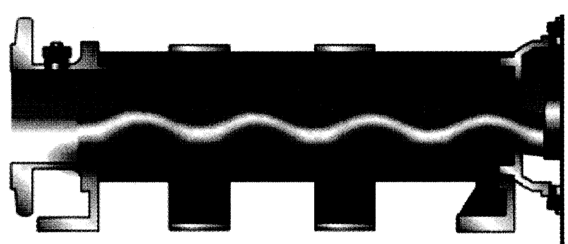

Figure 1. The progressive cavity pump works on the same principle as a screw pump. Rotor and stator are in continuous contact, therefore constantly wearing, as material is carried along through the pump. If the pump is shut off while pumping a dilatent slurry, material settles to the bottom of the cavity and begins to stiffen. When the pump is started, because the dilatent slurry is compressed by the rotor, the slurry stiffens and jams the rotor. Putting more horsepower on the shaft may tear the stator, resulting in a costly repair job. It is also possible for the connecting rod, knuckles, and seals to be damaged.

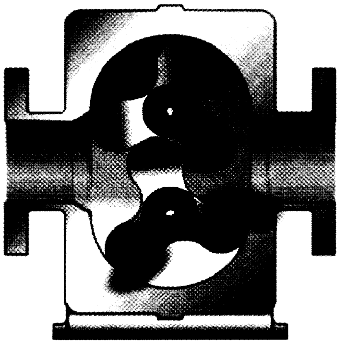

Figure 2. **Most slurry systems are designed to flush before they are shut down. But inevitably, a shut down will occur unexpectedly. As the flow ceases, heavier particles begin to settle at the bottom, stiffening around the lobes. When the pump restarts, the partially solidified materials binds the lobe, jamming the pump. The accompanying stress can pull the lobe out of sync and possibly cause severe damage, downtime, and costly repairs.**

LOBE PUMP DESIGN

Although they appear somewhat similar in size and configuration and are often referred to interchangeably, a lobe pump is not an ECP pump. The lobe pump (see Figure 2) has two tri-lobed impellers, rotating in opposite directions. The timing of the two impellers is critical. They must be very accurately indexed to ensure that they mesh properly.

When a lobe pump is started, product in front of the leading edge of the lobe is extruded forward, subjecting it to very high shear forces as the material compresses. Dilatent material such as settled starch will set up instantaneously into a near solid mass. Forces created as the impellers attempt to make their way through this solid mass are transmitted back to the gear box, resulting in slippage and damage to the gear train. Once the impellers are out of sync, pump efficiency falls and further damage to the unit can occur.

ECP OPERATION

Design and operation of the external circumferential piston pump (see Figure 3) eliminate the problems of dilatency. The two unique arc-shaped alloy rotors never contact each other or the body of the pump itself. A long sealing path is created between the leading edge of the rotor and the body of the pump. Material is picked up on the suction side of the pump, moving continuously through it to the discharge side as discrete "packets."

The ECP pump provides a constant displacement per each degree of revolution, resulting in a pulse-free flow. More importantly, these packets are never subjected to compressive forces. With no compressive forces on the material, the issue of dilatency is avoided.

The ECP pump is one of few pumps that can start even if partially filled with settled starch. Starting horsepower requirements for the ECP pump are typically much lower than with the PC pump, since the only resistance is in moving the rotor through the very thin film of material in the sealing path. Horsepower requirements can be as much as 75% lower, thus allowing for smaller drive components.

The ECP pump is ideal in addressing the most recent changes in high solids coatings. As mills attempt to run with higher starch concentrations, temperatures have been increased to compensate for higher viscosity. As a result, some starch pumps are now being run in the 200° F-plus range. The ECP pump has been designed to handle temperatures as high as 300° F. There are no wearing elastomeric materials in the wet end of the pump that could potentially fail at these high temperatures.

In PC pumps, these temperatures soften and weaken the elastomeric stator, accelerating the rate of failure. As the stator fails, pieces of elastomer can block valve seats and orifices in downstream equipment.

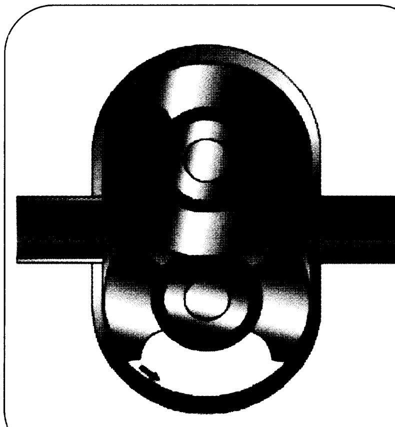

Figure 3. **With the ECP pump, there is no contact between the rotors and the pump casing. This becomes extremely important when pumping a dilatent slurry. As with any pump, when the pump is stopped, the material settles to the bottom of the cavity and begins to stiffen. When the pump is restarted, the slurry is scooped up by the ECP rotor, much like a snow shovel. The material is then moved into the collapsing cavity where fluid from the two rotors meet from the discharge side of the pump. There the slurry material is again mixed, and re-suspended, without stress or damage to the pump.**

For more information on specific ECP pump applications, contact ProFlow at (203) 230-4700.

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