ECP Pump Cuts Energy, Maintenance Costs With No Shear Lockup in Paper Applications

Unit is highly effective for pumping polymers, starch, specialty chemicals, and mineral fillers/coating ingredients, especially under shear sensitive, near-dilatent conditions. — BY DAVE HUNGERFORD

During the past few years, a new type of pump has been used by paper mills in applications from starch to fillers to coating pigments. Unique from most other pumps commonly used in these applications, the Waukesha SP-series ECP (external circumferential piston) positive displacement unit is proving to be a highly efficient and cost-effective alternative to lobe and progressive cavity pumps in the papermaking process. Today, some 250 of the units are operating in the paper industry.

Waukesha Cherry-Burrell, manufacturer of the pump, is one of several companies owned by SPX Corp. that manufacture equipment used in the paper industry. Their counterparts include DeZurick Valves, Lightnin Mixers, and Bran+Luebbe pumps. Four years ago, at Waukesha's request, ProFlow Inc., North Haven, CT, introduced the Waukesha pump to the paper industry. ProFlow, has been building fluid process and chemical feed systems for the paper industry for 25 years.

Smooth Fluid Flow

Although there is some similarity between an ECP pump and a rotary lobe pump, there are many critical differences. The shape of the rotors in an ECP pump is such that for every degree of rotation, the fluid displacement is the same as the last and the next degree of rotation. This makes for a very smooth fluid flow.

The Waukesha ECP design incorporates a very long slip path so that above approximately 300 cps, the pump is 100% volumetrically efficient. In a lobe pump, the position of the lobes in their mesh creates a constant change in displacement. The result is pulsation in the output.

The slip path is the route the fluid must take to migrate from the high pressure discharge port to the low pressure suction port. The slip path across the face of the lobe rotor is a straight line, while the slip path of an ECP rotor is a torturous path. When the fluid is able to migrate from the discharge to the suction, the flow through the pump will not be smooth and therefore will introduce pulsation to the fluid. The greater the slip, the faster the pump must run to maintain capacity.

Shear, Synchronization

Many fluids are shear sensitive and their characteristics change after being subjected to shear. Due to the low slip characteristics of the ECP pump, less fluid is exposed to shear within the pump. Examples of fluids changed by shear are many retention aid polymers and coating pigments.

Synchronization of the ECP rotors is not particularly critical. The ECP pump has adequate room between the rotor wings as they rotate. Alternately, if a lobe pump is slightly out of synchronization, the lobes hit each other, increasing vibration and requiring the pump to be shut down and re-synchronized. Lobe pumps have a torque-locking device to adjust the timing between the two rotors. The ECP pump has two gears keyed to the shaft and no adjustment is required.

Pumping Settled Slurry

Another important feature of the rather odd shaped ECP rotor is the ability to start pumping when near-dilatent fluids have settled in the pump. A dilatent fluid is shear thickening, i.e., the particles bind together when shear is applied. Everyone who has pumped a high concentration of a single component slurry that has settled in a progressing cavity or lobe pump has had the experience of a pump locking up. The pump won't start as the fluid under compression has bound up the pump. A locked rotor can seriously damage a pump.

The ECP rotor shape does not compress the settled slurry as a lobe pump or progressive cavity pump does. It lifts the slurry much like a snow shovel and re-suspends it in the carrier liquid. We have done numerous experiments measuring the horsepower required to start lobe pumps, progressing cavity pumps, and the ECP pump when filled with a settled slurry. The differences are impressive.

If a near-dilatent fluid is compressed, it will lock up and prevent a pump from turning. Rather than compressing a fluid, the ECP pump lifts it and assures that it is not be compressed. Thus the ECP unit turns freely under circumstances that would immediately lock up lobe and progressing cavity pumps.

Less Horsepower, Higher Temps

For a progressing cavity pump to work, the rotor must rub on the stator, requiring horsepower to overcome the drag. The ECP does not have to overcome internal pump drag, as the rotors and body do not touch each other. In general, the ECP pump requires less horsepower to start and run, resulting in significant cost savings.

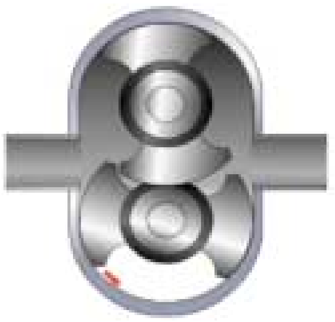

Fig. 1: With every degree of rotation, fluid displacement in the ECP pump is the same as the last and the next degree of rotation, resulting in a very smooth fluid flow. Since the body and rotor do not touch each other, there is no pump drag to overcome as with lobe and progressive cavity units.

Figures 1, 2, and 3 depict operating differences between an ECP pump and progressive cavity and lobe types of pumps.

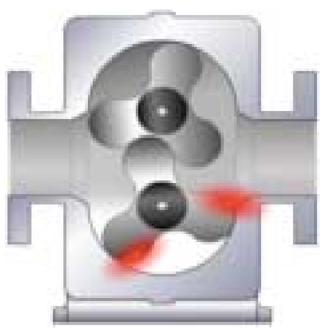

Fig. 2: A lobe pump, as well as a progressive cavity pump, can compress a settled slurry, resulting in lockup when pumping a near-dilatent fluid. Also, with the lobe pump, the position of lobes in their mesh creates a constant change in displacement, resulting in pulsations of the output.

Another important feature of the ECP pump is the metallurgy. If two pieces of 316 SS are rubbed together under pressure, the metal tends to gall (transfer of metal from one surface to the other). Severe galling damage can occur with a 316 SS rotor in close clearance with a 316 SS body.

To counter this effect, Waukesha developed a non-galling stainless for use with the ECP pump.

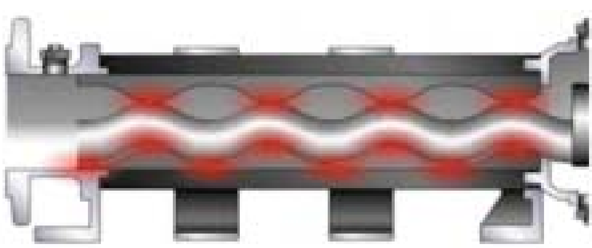

Figure 3. In a progressive cavity pump, the rotor rubs on the stator, requiring considerable horsepower to overcome the drag.

This metal allows the ECP pump to have very close clearances. Rotors constructed of 316 SS are available, but the clearances must be increased.

Many mills run starch at 200°F or higher. Because the ECP pump does not have an elastomeric stator sensitive to high temperatures, it can run at 300° F.

Applications

The ECP unit offers a superior alternative for pumping of polymer, starch slurry, hot cooked starch, sheet filler and coating ingredients such as GCC, PCC, clay, and TiO_2, as well as certain specialty chemicals.

For 13 years, ProFlow Inc.'s system business has been using the ECP pumps to pump polymer. During that time, the required maintenance has been little more than replacement of a mechanical seal.

Pumps were run on starch slurries and then on 205°F cooked starch. Units were also installed in each of the targeted applications. None of the pumps failed, and few parts sales resulted. Typically, parts sales for pumps used in the paper industry are a significant cost to mills.

Dry Running, Low Abrasive Wear

Fundamentally, the ECP pump can continuously run dry if the mechanical seals are kept lubricated. If seal water is a problem, a seal pot can be used. As stated earlier, the rotors do not touch each other or the body. Unlike a progressing cavity pump, the ECP pump is not dependent on a rotor rubbing on a stator.

Waukesha's long experience has shown that abrasive wear rapidly drops off when pump clearances are about three times the particle size. Fillers and coating pigments typically have a particle size of 3-15 microns, which is much smaller than the 0.004- 0.005 in. clearances in the pump. Wear, therefore, is held to a minimum. For example, one pump ran 15 months on 30% PCC, and the rotor diameter had worn only 0.001 in.

Of course, with time, ECP pumps will wear. Waukesha has thus initiated a pump remanufacture program, allowing pumps to be remanufactured twice. The service is done on an exchange basis at a cost of about 2/3 that of a new pump. Conversely, due to the geometry of a lobe pump, it is impossible to successfully install oversized rotors in a rebuilt pump. ■

About the Author

***Dave Hungerford** is the pulp & paper specialist for Pro Flow Inc., North Haven, CT. For more information about SPX Process Equipment and its product offerings, visit www.spxprocessequipment.com. To learn more about ProFlow, visit www.proflow-inc.com.*