Tubular Diaphragm Pumps Handle Ceramic Slurry

PROBLEM

The Allied Signal Company near Tulsa, OK had a problem moving a corrosive, abrasive slurry. Their process involves a vibrating media wet mill circulating fine alumina slurry in a nitric acid solution. The circulating pumps operate 24 hours a day, pumping 15 gpm at 30 psig.

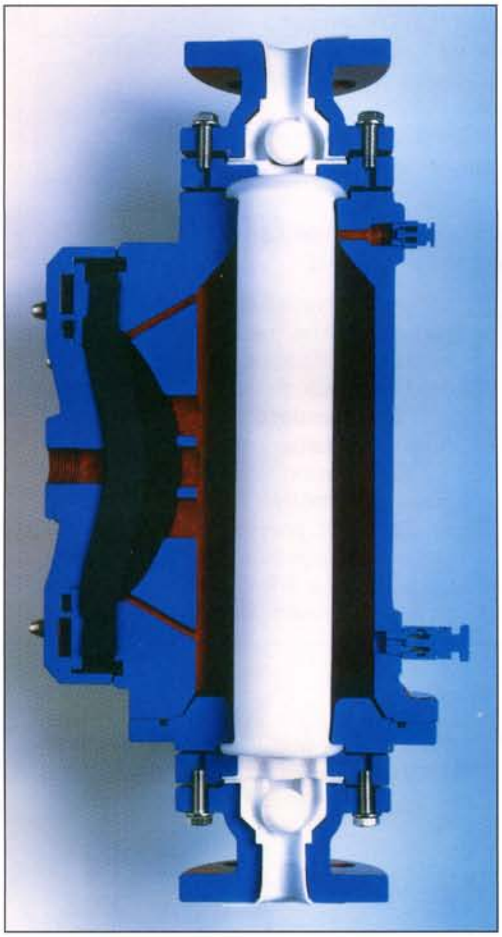
The plant unsuccessfully tried a variety of pumps in an attempt to find one that could stand up to this application. The pumps that contributed the most running time, and received the most attention, were progressive cavity and peristaltic pumps. But because the solution being pumped sometimes sets up due to system upsets, line blockages often occurred. In this event, packing glands would blow out on PC pumps, while hoses on peristaltic pumps would rupture.

In this particular service, maintaining the packing, stator, rotor, and linkage components on three PC pumps cost an estimated $1,500/month. Each pump also required a complete overhaul every two to three months at $2,000/pump. Peristaltic pumps proved easier to maintain and less costly overall, but experienced failures once every two to three days. Other pumps that failed to meet the challenge of this service included conventional double diaphragm and rotary lobe pumps.

Process engineers at the plant were so frustrated they tried to design their own pump. They purchased a tubular diaphragm and designed a chamber for it. A major obstacle was to arrange a hydraulic system to actuate the unit. Meanwhile, the plant manager was beginning to wonder if the pump they were designing wasn't already available.

SOLUTION

A chance meeting between a process engineer and a salesman revealed that plant personnel were re-inventing the wheel to solve their pumping problem. The pump that they were designing already existed, the Codip RP tubular diaphragm pump from Warrender, Ltd.



Cutaway of the Codip RP air-operated tubular diaphragm pump.

Plant engineers were attempting to eliminate seals and packing glands from their pump to reduce costly leakage of an expensive product. Mechanical linkages or actuators led to rapid wear of diaphragms, stators, or tubes, resulting in costly downtime and maintenance. The engineers needed a sealless, double-containment configuration. They realized that hydraulically balancing the tubular diaphragm would eliminate concentrated areas of stress and the resulting accelerated wear and chemical attack.

The RP design has no hydraulic systems that require oil for lubrication, and can use any process-compatible liquid as hydraulic fluid, preventing product contamination in the event of diaphragm failure. To resist corrosion and abrasion, process fluid only contacts the tube and check valve assemblies. All wetted parts are constructed of pure, hydrostatically pressed PTFE or various elastomers, including Hypalon, Viton, or EPDM. A 1-in. thick rubber membrane provides secondary containment and prevents process fluid from entering the air exhaust stream during a diaphragm failure. A conductivity probe with an electronic signal and/or acoustic alarm is available.

The pumps are simple and reliable. Many process requirements fall in the range below 150 psi, making these a cost-effective alternative to conventional, high-capacity metering pumps.

An advantage of the RP design is the ability to dead-head without damage. Air actuation allows it to stall or pump on demand without overpressurizing the system, eliminating the need for relief valves. The air distribution valve operates on a time sequence, regardless of air or discharge pressure, and will continue pumping down to even a trickle.

The plant ordered a Codip RP unit to test and evaluate. The pumps tested had Hypalon liners and an air valve equipped with a remote electronic frequency control for precise flow adjustment. The Codip pumps provided a dramatic improvement in maintenance and repair time and costs over the pumps previously used.

Maintenance involves replacement of the check valve liners every six months and the tubular diaphragm every three to six

TABLE 1. PUMP REPAIR ESTIMATES

Pumps	MTBF	Parts Cost	Annual Repair Cost (for 3 units)
Progressive Cavity (PC)	1-2 months	$500 per pump/month plus complete overhaul every 2-3 months at $2,000 per pump	$40,000+*
Peristaltic	2-3 days	$106/pump	$30,000+**
Codip RP	3-6 months	$1,000/pump every 6 months for check valve liners $284/pump every 3-6 months for tubular diaphragm***	$9,000

* Based on complete overhauls every 3 months.
** Based on operation 350 days per year and tube replacement every 3 days.
*** Labor costs, downtime, and lost production also reduced.

months, depending on the operating conditions. Most maintenance time is spent draining the process and dismantling the pump casings. Checking the tubular diaphragm clearance requires air to be connected directly into the air chamber after removing the air distributor. A small amount of excess fluid is then released from the vent valve until the proper clearance for the diaphragm is indicated. The air distribution valve is fully external and can be accessed by two socket head bolts without disturbing piping, process fluid, hydraulic fluid, or pump housing.

The standard design features a fully pneumatic, manually adjustable air distribution valve with separate frequency control, independent of air or discharge pressure. Other metering controls include a 4-20 mA converter with a UL-EXP air valve or a fully pneumatic 3-15 psi controller. Metering accuracies have been field tested to ±0.5%, requiring appropriate air pressure and flow.

The pumps can run dry and lift prime 8 to 16 feet, depending on their size. Standard RP pumps with pneumatic controllers are also inherently explosion proof.

Codip pumps are built in five sizes: 1 in. x 1 in. (0–5 gpm), 2 in. x 2 in. (0–15 gpm), 2 in. x 2 in. Duplex (0–30 gpm), 3 in. x 3 in. (0–40 gpm), and 3 in. x 3 in. Duplex (0–80 gpm). Maximum operating pressure is 150 psi. Maximum operating temperature is 350°F.

Recent contact with maintenance personnel at Allied Signal confirms that their RP pumps are still running, and the prototype housing and diaphragm from the engineers' design experiment are on the scrap heap. ■

Warrender Ltd., Northbrook, IL

CODIP's Range of Designs
Model Selection & Specifications

Model	Wetted Materials	*Max Flow (gpm)	Ports (150 Lb. ANSI)	Suction lift (Feet H20)	Max Frequency (Cycles/Min)
RP20-T	PTFE	5	1" x 1"	13'	120
RP20-T-AS	PTFE	5	1" x 1"	8'	120
RP20-H	Hypalon	5	1" x 1"	8'	120
RP20-E	EPDM	5	1" x 1"	8'	120
RP20-V	Viton	5	1" x 1"	8'	120
RP60-T	PTFE	15	2" x 2"	13'	120
RP60-T-AS	PTFE	15	2" x 2"	8'	120
RP60-H	Hypalon	15	2" x 2"	8'	120
RP60-E	EPDM	15	2" x 2"	8'	120
RP60-V	Viton	15	2" x 2"	8'	120
RP60D-T	PTFE	30	2" x 2" + 2" x 2"	16'	100
RP60D-T-AS	PTFE	30	2" x 2" + 2" x 2"	10'	100
RP60D-H	Hypalon	30	2" x 2" + 2" x 2"	10'	100
RP60D-E	EPDM	30	2" x 2" + 2" x 2"	10'	100
RP60D-V	Viton	30	2" x 2" + 2" x 2"	10'	100
RP150-T	PTFE	40	3" x 3"	13'	100
RP150-T-AS	PTFE	40	3" x 3"	8'	100
RP150-H	Hypalon	40	3" x 3"	8'	100
RP150-E	EPDM	40	3" x 3"	8'	100
RP150-V	Viton	40	3" x 3"	8'	100
RP150D-T	PTFE	80	3" x 3" + 3" x 3"	16'	100
RP150D-T-AS	PTFE	80	3" x 3" + 3" x 3"	10'	100
RP150D-H	Hypalon	80	3" x 3" + 3" x 3"	10'	100
RP150D-E	EPDM	80	3" x 3" + 3" x 3"	10'	100
RP150D-V	Viton	80	3" x 3" + 3" x 3"	10'	100

* The stated capabilities are based upon pumping water-like fluids (1.0 s.g. and 1.0 c.p.), 30' discharge head, 3' suction head, and driving air pressure of 40 psi.
Maximum Head Capability: 300'
Maximum Air Pressure: 150 PSI
Maximum Temperature: 350°F (Depending on design)