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Chemical Processing

Curing cavitation saves money; cuts vibration, erosion damage

Vane straightener lowers pump maintenance and improves performance

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Three pump installations at DuPont Chemical's Beaumont, TX, acrylonitrile plant were set up with close-coupled long radius elbow intakes—without the customary eight diameters of straight pipe run ahead of the inlets.

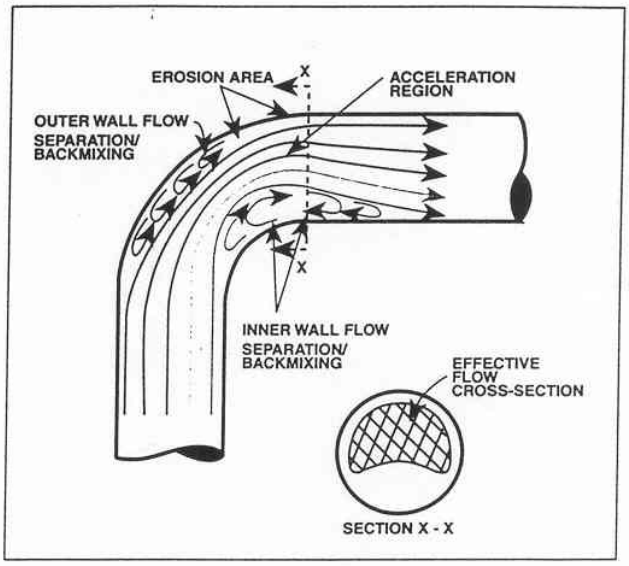
When fluid passes through an elbow, two flow regions occur (Fig. 1). Because of the separation, the fluid is forced through a reduced cross-sectional area and local velocity increases. Backmixing, separation and low pressure may even cause the liquid to vaporize if conditions are right. Such a disturbance can carry as far as 20 pipe diameters downstream. Unsuccessful attempts to correct the problem included a special suction elbow and a suction diffuser installed just upstream of the pump.

A patented flow conditioner consisting of a set of stationary vanes introduces a rotational effect into the fluid as it passes through the elbow. When installed upstream of an elbow, the straightener enables the fluid to negotiate the turn with all stream elements traveling the same distance from the entrance to the exit (Fig. 2).

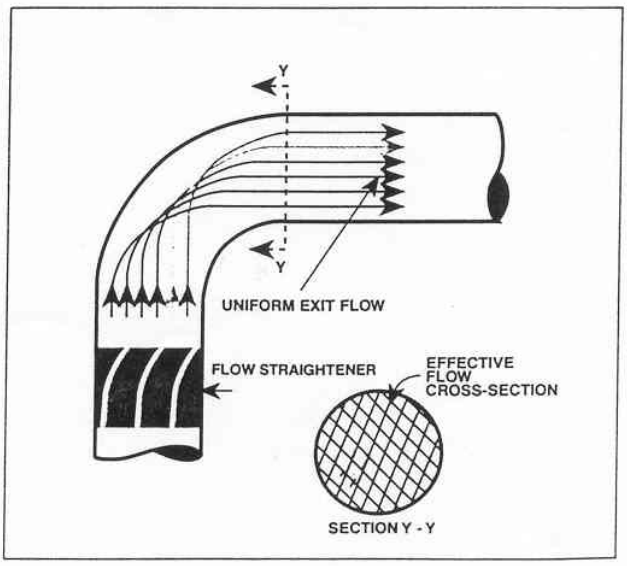
Reducing mag-drive vibration

In one case at the Beaumont plant, two magnetic-drive pumps in acetone cyanohydrin recirculation service were vibrating excessively because of cavitation created by turbulence through the elbow. If the condition was not corrected, there would be about 10 failures per year. Installation of the recommended straight run of 8-in suction pipe for the two pumps was estimated at $0.32X (X is the cost of a new pump.)

A normal failure would cost about $0.08X for repaired shaft, impeller, bushings, thrust washers and labor. A severe failure, which might include replacement of the containment shell and



Above: Fig. 1. Without flow straightener, uncontrolled flow through an elbow separates fluid into two stream regions creating local high velocities and turbulence.



Below: Fig. 2. Vane flow straightener imparts rotation to the fluid, allowing it to make the elbow turn with all stream elements traveling the same distance.

inner magnetic ring, could cost $0.32X. In addition to the maintenance costs, production losses represent a significant cost. An 8-in flow straightener could be installed for less than $0.08X, including labor, so the payout was attractive if the straightener would do the job.

Straighteners were installed upstream of both inlet elbows, and results were excellent, as demonstrated by before and after vibration measurements:

Vibration (in/sec)

		Before	After
Upstream of elbow		0.1645	0.0387
Downstream of elbow		0.2550	0.0619
Pump volute	-axial	0.1475	0.0347
	-radial	0.1848	0.0435

In addition to the reduction in vibration, flow studies around one of the pumps showed that volume rate had increased from 1,086 gpm to 1,135 gpm with about 7.46-ft H_2O head increase.

Reducing impeller wear

In the second case, boiler feed water is moved by two four-stage pumps rated for 900 gpm at 1,750-ft head. One of the pumps is driven by an electric motor, the other by steam turbine. Both have long radius elbows bolted to their suction flanges.

The motor drive pump outboard thrust bearing failed in September 1992 and the same bearing failed in the other pump two months later.

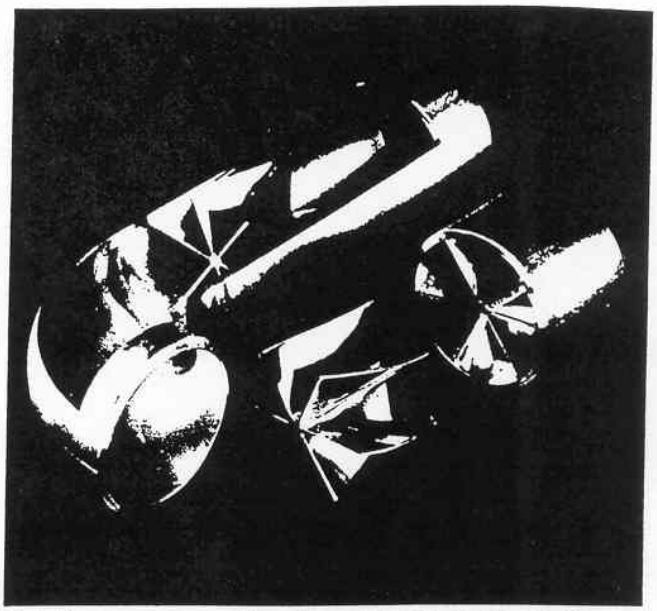
During repairs, inspection showed severe first-stage double-suction impeller wear. The second- and third-stage single-suction impellers showed similar but less severe wear. The damage was attributed to cavitation resulting from turbulence created in the long radius elbows.

While the pumps were down for repair, the mechanics installed an 8-in flow straightener in each inlet pipe just upstream of the elbow. Average vibration had been measured before shutdown and was checked again after start-up with the flow straightener installed. It had dropped from 0.25 in/sec to 0.08 in/sec. Noise level, also measured, had dropped from 98 dB to 86 dB. It is estimated that the flow straightener will save $14,000 per year in impeller repairs in the two boiler feed water pumps.

Internal casing wear

An eight-stage centrifugal pump moving organic slurry at the plant is rated for 600 gpm at 2,200-ft head. In January 1992, vibration had started moving upward from 0.1032 in/sec. By June of the following year, it had increased to more than 0.2500 in/sec, and the vibration spectrum analysis demonstrated severe cavitation. Noise level was also too high.

When the pump was shut down for repairs, an inspection showed there was severe erosion on the internal casing and on the impeller. In addition, the wear rings were loose. A 6-in flow straightener was installed just upstream of the pump suction long radius elbow.



Rotation vane assembly, shown in various stages of installation.

As in the previous two cases, the results were impressive. Average vibration dropped from 0.2751 in/sec to 0.0610 in/sec, and noise from 99 dB to 90 dB. Mean time between repairs was 25 months before the flow straightener was installed. The pump is still performing well after 20 months with the straightener, showing no signs of vibration or cavitation. Annual savings in this installation are estimated at $0.33X.

■ CRV® Flow Straightener —

References: Garay, P.N., "Pump Application Desk Book," page 391, The Fairmont Press Inc.

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