Willard Says……

The Fixed-Speed Pump

dredge usually fails to produce at anywhere near its potential.

Why?

Because fixed-speed-pump operators fail to deal effectively with varying variables.

Industrial slurry pumping.

Countless industrial processes require that slurry be moved via pipeline from one point in the plant to another. System designers strive to eliminate all the variables and arrive at a specific set of conditions under which the pump must function. They determine the specific gravity and particle sizes of the solids, the length and diameter of the transport pipe, the vertical lift and the flow velocity. Most importantly, they determine the rate (tons per hour) at which solids must be moved from point A to point B and they assume that the *solids will be moved at a uniform rate.* That is to say, the rate of production will be (must be) constant.

Given this information, pump manufacturers can quote a particular pump model and size to provide high efficiency. They will also specify pump speed and horsepower.

They can recommend fixed-speed drive pumps in these applications because the variables are not allowed to vary. The variables are turned into constants.

Dredge slurry pumping.

Compare the conditions in the industrial plant application with sand and gravel dredging. The pipeline diameter and lift are fixed. The pipeline length changes infrequently. The particle size distribution of the sand and gravel usually does not vary widely. The specific gravity of the solids is known and the dredge pump runs at a constant speed. The target velocity can be determined.

So what is the problem? Why can't a fixed-speed pump dredge operate with the same efficiency as an industrial pumping system? The answer is varying slurry density. Dredge system density (solids production) fluctuates for a number of reasons;

- Lack of a mechanical digger.
- Cavitation due to cave-ins.
- Ineffective digger i.e. a cutterhead in rock or clay.
- Lack of instruments.
- Lack of a CONVAC suction side stability system.
- Inadequate hoist and positioning winches.
- Failure to keep the suction inlet in contact with the solids.
- An insufficient supply of pumpable solids.

Goal: Successful dredging means moving a high-density mixture through the dredge system at target velocity without interruption.

This goal is best attained if all variables are held constant regardless of whether the pump speed is fixed or adjustable. Fixed-speed pumps make reaching the goal a little more challenging. A fixed speed pump eliminates one variable, so reaching the goal means controlling or adjusting the other variables to achieve the target velocity.

Holding variables constant.

1. Use the proper digging device. At a minimum this means a rotary cutter. Those who desire certainty will install a Linear Cutter for ease of operation, adaptability to automation and slam dunk productivity.

2. Install a magnetic velocity meter. A doppler-type will do if the budget is really tight, however, the accuracy and ability to indicate clear water flow makes the magnetic meter the better choice.

3. Install a CONVAC suction bypass valve system. This system operates full time to monitor vacuum and velocity to help assure a selected, uninterrupted rate of production (slurry density) and relieves cavitation due to cave-ins.

4. A discharge pressure, hydraulic and ampere gauge are necessary additions to the velocity and vacuum gauges that are part of the CONVAC display panel.

5. Hydraulic hoist and positioning winches should be adequate and their easy-to-operate controls must be located convenient to the operator's hand. Use a wire positioning system. No spuds!

6. Pump speed. Connect the pump to the drive motor by means of a belt drive.

7. Train and monitor the operator so he knows how to do his job and hold him accountable for his performance. "If he does not do it, it ain't going to get done."

All of the above applies to any dredge operation—fixed or variable speed pump—where there is an expectation of high production and high efficiency.

Fixed speed dredge pump owners must address two additional factors in order to overcome the lack of infinite speed control.

Fixed-Speed Dredge Factors.

Pump speed. If the drive is not variable then pump speed must be adjusted by changing the motor-to-pump speed reduction ratio to obtain the desired speed. Herein lies the reason for utilizing a belt drive as opposed to a gearbox or any device that prevents a change of ratio.

Consult the pump manufacturer for guidance in determining what the proper pump speed should be at startup. They will want to know all you can tell them about the application.

In general, pipeline dredge pumps run at some speed between 65 and 100 percent of full rated speed. The larger, driven (pump shaft) sheave should be large enough to pair up with all available driver (motor shaft) sheaves to develop speeds in that range. When the time comes to change speed only a new, less expensive driver sheave will be needed. Select and install the sheave combination required to run the pump at the speed recommended by the pump manufacturer.

If the speed is too slow, the dredge will not be able to produce to its maximum capability because the velocity will fall to a dangerously low rate. Speed the pump up by installing the next size larger driver (motor shaft) sheave whenever low velocity forces a reduction in production.

Discharge head. It may happen that the selected pump speed matches exactly the speed required to support full production. Enjoy that happenstance because as soon as the pipeline is extended, and as the pump wears, the speed will be too slow.

Usually an upward adjustment of pump speed will result in a discharge velocity that is higher than it should be. This situation can be easily remedied by installing an annular head adjuster in the discharge pipe near its discharge end.

An annular head adjuster assembly makes it convenient to install the proper annular restrictor washer in the discharge pipe. A crude but equally effective way to achieve the same results would be to weld a plate across the end of the discharge pipe and torch an increasingly larger hole in it until the desired head is achieved.

The head pressure on the pump is just right when pipeline velocity can be maintained at the target rate while the dredge system is in full production. Our goal as stated above is being met.

Head vs. Velocity.

I can see the head swinging and the doubts rising at the goofy idea of putting a restrictor in the discharge pipe to improve dredge production. And what about the efficiency I am always stressing?

Surely you have blown a pipeline at some point near the dredge while in full production. What happened? A large commotion? Noise? Vibration? Power unit overload? All perfectly normal because the dredge pump, relieved of the head (restriction) on its discharge port, tries to satisfy a new set of conditions. The pump demands more power than is available as it attempts to move thousands more gallons per minute. It vibrates and thumps because it cannot get as much water to pump as it needs and so is cavitating due to high vacuum. Power unit speed is sagging badly due to overload. The pump drive belts are slipping.

Breaking the pipeline vividly demonstrates how it takes a lot less power to develop head and move a controlled amount of slurry through the system when the pipeline is intact compared to the tremendous amount of power required to move gallons (tons) of excess water a very short distance with practically no head.

The lesson of the busted pipeline applies in small scale to the use of a restrictor in the discharge pipe to increase head and reduce velocity to the target rate when the pump speed is too fast. The energy conserved by not pumping excess water more than offsets the slight increase in energy required to increase the head pressure.

Efficiency.

While DC or AC variable-speed motors are very efficient they do require additional energy for support equipment such as cooling fans and air-conditioned/heated control enclosures.

If all energy costs associated with driving the dredge pump are considered, fixed-speed pump operation can be as efficient as a variable-speed drives. Fixed-speed pumps will be more efficient as long as the proper pump speed/discharge head relationship is maintained and a regulated, continuous stream of solids is fed into the dredge system.

As noted above, the idea of intentionally installing an artificial restriction in the discharge pipe seems counter to the concept of energy efficiency. The fact is that restricting the full-production flow rate so that it does not exceed the target velocity results in a net saving of energy. Pumping at a higher pressure takes less power than pumping at a higher velocity.

“It takes more power to pump water than it does to pump solids.” I was very skeptical when “seasoned operators” of fixed-speed pump dredges first laid this concept on me. It did not make sense. It took some time to sort out the truth in that statement—to find the oats in the horsepucky. They showed me how amp draw decreased as solids were introduced into clear water flow and continued to decrease as the production rate was increased. You could not argue with the truth of the statement—only ask why.

A velocity meter told “the rest of the story.” The head on the constant-speed pump increased as slurry replaced clear water, which caused the velocity to fall.

The ammeter testifies to the fact that it requires less energy to pump solids (at a low velocity) than it does to pump water (at a relatively high velocity) with a fixed-speed pump. The key is to adjust the head (restrict the dredge pipe) so that the system moves a continuous, full-capacity load of solids to discharge at the target velocity. High-energy efficiency will result.

That is the concept presented in this paper.

Reliability.

DC or AC variable drives are regarded as being very reliable despite their relative complexity. When they do get a bellyache it is likely that the cure will require the services of an expert from some distant galaxy. Calling in the electron doctor means lost time accompanied by a bill for travel, expenses and service fees.

In contrast, a local commercial electrical contractor can troubleshoot and fix a common squirrel cage motor/soft starter drive system.

Conclusion.

This paper outlines ways to overcome inefficiencies commonly experienced on dredges with fixed speed pumps.

The ability to vary pump speed is always of benefit and comes standard on diesel powered dredges.

Variable speed electric dredge pump drives are readily available and highly recommended, however, the price and complexity is significantly higher be they DC or AC. It is hard to beat the price and simplicity of a standard squirrel cage motor with a soft-start starter.

Contact me and I will be glad to walk you through the particulars of how to achieve higher production, greater efficiency and increased profits with your fixed-speed dredge pump.

Comment, question, criticism, information on products mentioned? Contact willard@willardsays.com.