Willard Says……

The Velocity Meter As a Scale

Velocity Wisdom I

The dredge pump must run fast enough to create pressure sufficient to cause slurry (mixture of water and solids) to flow through the discharge pipeline to the discharge point.

The slurry must flow fast enough so that solids do not settle out of the flow, but the flow should not be too fast. There are significant rewards for keeping pipeline velocity as slow as practical. Minimizing pipeline velocity conserves energy, contributes to excellent system operating efficiency and makes it possible to obtain the maximum rate of production. All these achievements contribute to increased profit.

Velocity Wisdom Denied

Operating a dredge that is not equipped with a velocity meter is like:

- Driving a Lamborghini without a speedometer.
- Trying to make love in a hammock—standing up.
- Jumping out of a plane without a parachute.
- Driving at night with the lights off.
- Expecting a politician to honor his campaign promises.
- Dumb.

Results in all cases will be poor.

Buy and install a velocity meter on your dredge!

Dredge Operation Without a Velocity Meter

Typically, lacking a velocity meter, the operator maneuvers the suction inlet in an effort to cause a continuous flow of solids to enter the suction inlet. He tries to maintain a satisfactory rate of production by maintaining the vacuum at or near some value that experience has taught him will result in a comfortable rate of production. Often his main concern is to not plug the discharge pipe, which may happen if he is too adventurous in trying to maximize production. If he is concerned about plugging the discharge pipe he will always err on the side of discretion and pump clean water whenever the discharge pressure rises or a "slug" of solids enters the suction inlet. Production goes to hell whenever he does that but pipeline plugging is avoided so all ends well as far as he is concerned.

The moral of this sad story is that the operator is doing the best he can with the information he has. What he lacks the most important information of all—an indication of the rate at which slurry is flowing in the discharge pipe.

Velocity Wisdom II

We call the ideal velocity, the slowest practical rate of flow—one that is neither too slow nor too fast—the target velocity. See **WillardSays**...*Using the Velocity Meter* for more information about how to determine the target velocity for a particular dredge system.

Pipeline velocity changes whenever:

- The pump speed changes. An increase in pump speed will cause the velocity to increase. A decrease in pump speed will cause the velocity to slow down.

- The total weight of solids flowing in the discharge pipeline changes. A decrease in the amount of solids will cause the velocity to increase. An increase in the total solids flowing in the system will cause the velocity to decrease.

Velocity Principles—Constant-Speed Pump

Consider a dredge system consisting of a constant-speed pump and a pipeline through which slurry is flowing at a constant velocity. For purposes of illustration assume that the slurry in this system contains five tons of solids.

Principle #1. The velocity will remain constant as long as the total amount of solids flowing in the pipeline remains a constant five tons. To maintain constant velocity requires that solids be taken into the suction inlet at the same rate that they flow out of the discharge end of the pipeline.

–pump speed– & –solids- = –velocity–

Principle #2. The velocity will increase if the rate at which solids enter the system decreases to a rate that is less than they are being discharged. If this happens the total weight of solids flowing in the system will decrease to something less than five tons.

–pump speed– & ↓solids↓ = ↑velocity↑

Principle #3. The velocity will slow down if the rate at which solids enter the system increases to a rate greater than they are being discharged. If this happens the amount of solids flowing in the system will increase to something more than five tons.

–pump speed– & ↑solids↑ = ↓velocity↓

Using Constant-Speed Pump Velocity Principles

The operator now has a mighty new tool at his disposal—a velocity meter! We can start educating him in how to use this powerful instrument by coaching him to see for himself how the first three principles of velocity work.

One way to better understand how these principles work is for him to think of the velocity meter as a scale. Imagine that the velocity meter reading is an indication of the weight of the solids flowing in the system. If the velocity remains constant it means that the rate of solids intake matches the rate of discharge and the weight of the solids flowing in the system remains constant (**Principle #1**). If the amount of solids flowing in the system decreases it means that the "load" the pump has to move is getting lighter and easier to move so the velocity increases (**Principle #2**). The opposite reaction would take place if the load of solids increases—the velocity will slow as the "load" of solids gets heavier (**Principle #3**).

The velocity meter is indeed a very sensitive scale! This indicator can be used to great advantage.

Running the Dredge

First, the operator should run the dredge as he did before he had a velocity meter and note the velocity when he has a "good" load in the system. We will call that velocity the target velocity for now.

Next, the operator should be given to understand that now the goal is not to maintain a vacuum but to maintain the velocity at a constant rate—the target velocity.

Now the operator can begin to apply the principles of velocity. If the velocity does not change it indicates that he is having success in his attempt to keep a uniform flow of solids moving to discharge and that solids are coming into the suction at the same rate as they are being discharged (**Principle #1**). Soon, however, **Principle #2** or **#3** will come into play as the velocity gradually changes to signify that the quantity of solids flowing in the slurry is changing.

Principle #2 is at work if the velocity increases to indicate that the load of solids is decreasing. The operator needs to bring the velocity back down to the target rate by increasing the vacuum and cause the rate of solids intake to increase and restore the flowing "load" to five tons. The operator may have to increase the vacuum to a value that is higher than he normally did before he had a velocity meter to regain the target velocity.

Principle #3 is at work if the velocity decreases and signals that the load of solids is increasing. The operator needs to bring the velocity back up to the target rate by reducing the vacuum to cause a decrease in the rate of solids intake and restore the flowing "load" to five tons.

From now on the operator's unvarying task is to adjust the vacuum as required to maintain a target velocity by applying **Principles #1, #2** & **#3.**

A Note About Vacuum

Vacuum is only a general indicator of the rate at which solids enter the suction inlet. Vacuum cannot be used as an absolute indication of the rate of solids intake because there are several other undetectable variables that affect the suction pressure reading that we call vacuum. Ignorance is on display whenever you see attempts made to control the rate of production by maintaining vacuum at some fixed value. The **only** real time indicator that can be used to closely regulate production is velocity.

Increase Pump Speed to Increase Production

To this point we have instructed the operator to run the pump at the speed at which he previously ran it. Now we will explore ways to increase production by incrementally increasing pump speed.

We instruct the operator to increase the pump speed about 25 rpm and impress on him that the goal is same as before: maintain the target velocity by adjusting the vacuum as required.

As the pump speed increases the velocity also increases and the operator maneuvers the suction to increase the vacuum enough to cause the velocity to slow to the target velocity. The operator continues to use the same procedure of adjusting the vacuum as necessary to maintain target velocity. The vacuum values will be somewhat higher than they were when the pump was running at a lower speed. The "load" of flowing solids will have increased to perhaps six tons and the discharge pressure will have increased as well.

Before going too far in the effort to increase production it would be well to determine the true target velocity for this particular dredge system. In this example we have assumed that the velocity that was being maintained before the velocity meter was installed was OK and designated it as our target velocity. It may actually be too fast for efficient production or it may be too slow to support a significant increase in production with the result that the discharge pipeline will plug.

Determine the Target Velocity

See **WillardSays**…*Use a Velocity Meter* to find out how to determine the target velocity for your dredge system.

Once found the operator should always adjust the vacuum as required to maintain the target velocity and increase the pump speed in small increments until one of two limits to production are found:

1. Cavitation limits the amount of vacuum that can be developed.
2. The pump is running at maximum speed.

Either of these conditions indicates that the maximum production capability of that particular dredge system has been reached. This is where we want to be—producing at the max.

Pipeline Plugging No More

Not only does the velocity meter enable the operator to increase production and efficiency, it enables him relax and concentrate on maintaining production free of the fear of plugging the pipeline. His job is to maintain a certain velocity so he no longer has to lift the suction and pump water just to be sure the line is not plugging—production can and should be continuous.

Process Plant Benefits

Pumping sand and gravel to a process plant, particularly one that has a settling tank classifier, at a constant velocity pays big dividends in terms of increased yield of specification product. Settling tanks depend on a steady flow of slurry to accomplish particle sizing and yield suffers when the inflow fluctuates.

Automatic Velocity Control

We have described how to maintain target velocity by adjusting the vacuum as necessary. Pit conditions or other factors may frustrate attempts to obtain the required vacuum with the result that the velocity cannot be controlled. If this situation persists it may be well to install an automatic pump speed controller that will maintain target velocity under all conditions. With automatic velocity control the operator continues to try to control production by adjusting the vacuum, however, instead of attempting to maintain target velocity, he now tries to maintain a constant pump speed.

Automatic Production Control

In this paper we have assumed that the operator can readily control vacuum and thus regulate the rate of solids production. Accomplishing this may require the operator to concentrate to a degree that is not realistically possible to achieve on a continuous basis. Often conditions such as cave-ins force the operator to take action that unavoidably results in interruptions to production. Shear boredom often causes an operator's attention to wander.

Production can be maintained at a high rate with fewer interruptions if the dredge is equipped with a modulating suction bypass system such as the Twinkle Co ***CONVAC S^4*** Suction Side Stability System. Operator input is greatly reduced because now he need only keep the suction immersed in solids so that CONVAC can automatically assure continuous production.

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