Flushing Velocity and Netafim

The subject of dripline ‘flushing’ or ‘scouring’ velocity in mining is full of opinion and claims, due largely to a lack of published standards or independent field studies. In addition, conditions at every mine vary, so developing a single set of standards is illogical.

This paper presents Netafim USA Mining Division’s position regarding flushing velocity of dripline.

Background

The inside of a piping network can develop a build-up of unwanted material such as precipitation of solids from chemical or biological reactions that can degrade system performance and need to be removed. For this reason, developing an effective means of dislodging the build-up is important, and the first step is to design the piping network with an appropriate flushing capability.

What is ‘Flushing’?

The act of flushing refers to either the manual or automated opening of the ends of dripline laterals or the ends of headers at the downstream end of the dripline. Whether there is an automatic valve or a manual ball valve, this action is designing to increase the velocity of the solution through the piping to a speed that acts to dislodge debris from the walls of the pipe and vent the debris onto the heap. The velocity is measured in feet per second (fps).

Determining Flush Velocity

There is a direct relationship between the I.D. of the tubing and the amount of solution flowing through it to the velocity of the solution.

For the purpose of measuring and stating velocity, calculations and data presented are made at the distal (farthest) end of the dripline lateral. In addition, each dripline lateral will require the stated amount of additional flow, so the total requirement is cumulative to the number of laterals in a section.

Turbulence and the Reynolds Number

The success of a flushing action is dependent on velocity. Said another way, the greater the velocity, the greater the turbulence, and thus the more likely that debris will be dislodged. As such, some measure must be used to assign how much turbulence is desired based on design considerations. One method is to calculate the “Reynolds Number”.

The Reynolds Number is a dimensionless value linked to the smoothness of a fluid flowing through a pipe, and it ties its result to whether the flow is ‘laminar’, ‘transitional’ or ‘turbulent’.

Fluid flow is smooth, or ‘laminar’ at low velocities. During laminar flow, fluid moves in distinct and separate layers, and there is no mixing of adjacent layers. (While this flow is beneficial from the standpoint of reduced friction loss because of the slower movement of the fluid, it is an ingredient in allowing debris build-up on the walls of the pipe). A transition zone develops when increasing velocity begins to alter the flow from laminar to ‘transitional’ and ultimately to ‘turbulent’. When flow is turbulent, the fluid and its contents are moving in irregular, agitated patterns. The characteristic fluctuations and mixing that occur in turbulent flow give rise to the scouring action that takes place as the fluid moves across the pipe surface.

When the Reynolds Number is less than 2000, flow is described as laminar. From 2000 to 4000, it is considered transitional, and when greater than 4000, it is considered turbulent.

The accompanying charts show the Reynolds Number for 0.54” I.D., 0.62” and 0.69” I.D. pipe (16mm, 18mm and 20mm). These are the most common I.D.’s of Netafim dripline for mining. There are other variables that go into calculating a very precise Reynolds Number, among them temperature and fluid viscosity. (For the purposes of these data, the viscosity of water is being used at the benchmark of 70° F.) Changing these values can generate different values, so while these data are not static, they provide a baseline to better see the link of turbulent flow to velocity/GPM flow.

Since a flushing velocity of 4000 or greater is desired (turbulent), a flow rate at the end of **each lateral** at or above 0.65 GPM for 16mm, 0.75 GPM for 18mm or 0.88 GPM for 20mm is required. (Note - As mentioned earlier, the additional GPM flow required to achieve flushing is cumulative. If there are 50 laterals being flushed at the same time [50 x 0.65, or 0.75 or 0.88], this additional flow must be added to the normal GPM already occurring as the heap is being leached.) This then would equate to a flushing velocity of approximately 1 fps. While Netafim considers this to be a minimum velocity, and while we encourage flushing velocities of 1.5 fps or higher, site limitations are always in play, but since the intent behind flushing is to dislodge any debris that can cause lack of performance or dripline failure, targeting a higher velocity (in addition to flushing frequency) is a logical goal.

FPS Properties of 0.540” I.D. (16mm) Dripline

Reynolds Number	Type of Flow	Distal Flow (GPM @ 70° F)	Distal End Velocity (fps @ 70° F)
2000	Laminar	0.32 GPM	0.4 fps
2500	Transitional	0.41 GPM	0.6 fps
3000	Transitional	0.49 GPM	0.7 fps
4000	Turbulent	0.65 GPM	0.9 fps
5000	Turbulent	0.81 GPM	1.1 fps
6000	Turbulent	0.97 GPM	1.3 fps
7000	Turbulent	1.14 GPM	1.6 fps
8000	Turbulent	1.30 GPM	1.8 fps
9000	Turbulent	1.46 GPM	2.0 fps
10000	Turbulent	1.62 GPM	2.2 fps
11288	Turbulent	1.83 GPM	2.5 fps
13546	Turbulent	2.20 GPM	3.0 fps

FPS Properties of 0.620” I.D. (18mm) Dripline

Reynolds Number	Type of Flow	Distal Flow (GPM @ 70° F)	Distal End Velocity (fps @ 70° F)
2000	Laminar	0.37 GPM	0.4 fps
2500	Transitional	0.47 GPM	0.6 fps
3000	Transitional	0.56 GPM	0.7 fps
4000	Turbulent	0.75 GPM	0.9 fps
5000	Turbulent	0.93 GPM	1.1 fps
6000	Turbulent	1.12 GPM	1.3 fps

7000	**Turbulent**	**1.31 GPM**	**1.6 fps**
8000	**Turbulent**	**1.49 GPM**	**1.8 fps**
9000	**Turbulent**	**1.68 GPM**	**2.0 fps**
10000	**Turbulent**	**1.86 GPM**	**2.2 fps**
11288	**Turbulent**	**2.10 GPM**	**2.5 fps**
13546	**Turbulent**	**2.53 GPM**	**3.0 fps**

FPS Properties of 0.690” I.D. (20mm) Dripline			
Reynolds Number	**Type of Flow**	**Distal Flow (GPM @ 70° F)**	**Distal End Velocity (fps @ 70° F)**
2000	**Laminar**	**0.44 GPM**	**0.4 fps**
2500	**Transitional**	**0.55 GPM**	**0.6 fps**
3000	**Transitional**	**0.66 GPM**	**0.7 fps**
4000	**Turbulent**	**0.88 GPM**	**0.9 fps**
5000	**Turbulent**	**1.11 GPM**	**1.1 fps**
6000	**Turbulent**	**1.33 GPM**	**1.3 fps**
7000	**Turbulent**	**1.55 GPM**	**1.6 fps**
8000	**Turbulent**	**1.77 GPM**	**1.8 fps**
9000	**Turbulent**	**1.99 GPM**	**2.0 fps**
10000	**Turbulent**	**2.21 GPM**	**2.2 fps**
11288	**Turbulent**	**2.50 GPM**	**2.5 fps**
13546	**Turbulent**	**2.99 GPM**	**3.0 fps**

Flushing Frequency

There are several ways to design for flushing, among them automatically or manually as well as whether it is done intermittently or continuously. While there are no science-based facts regarding frequency, it may be logical to assume that the more frequent the flushing, the lower the velocity may need to be. While that can place less load on the pumping network, in a manual system this could require significant manpower if flushing is being done daily. For that reason, sites are increasingly looking to various forms of automated control to eliminate the need for personnel walking from location-to-location to open and close ball valves.

Types of Automated Control

When personnel walking the pad daily is not cost-effective, the use of automated flush valves could be a solution. In cases where large-scale automation is not feasible, flush valves with an IP-67, 9V battery-operated controller pre-wired to the valve are available. These can be set to open and close as needed to initiate a flushing cycle. Available in sizes from 1½” - 6”, they can be operated up to 3 times daily.

When even greater oversight or control is needed, Netafim offers scalable radio or cell-based packages that can manage flushing as well as monitor and report any number of other parameters. With this system, Netafim not only provides flushing control, it also provides real-time data that can be analyzed and acted on immediately. The most common data collected are flow, temperature and pressure. Limits can be set so alarms alert personnel if the flow/pressure is too high or too low. Because the dripline design is configured for certain inlet flows and pressures, if these parameters are above or below those limits pad performance could be compromised.

Monitoring the flow and pressure across the leach pad can alert personnel that plugging may be occurring in the dripline, meaning the lines need to be flushed. The flushing logic can be programmed into the software to flush on a time-based schedule or when the flow differential exceeds a set point.

Conclusion

Maintaining a clean dripline piping network can extend the life of the dripline and help deliver ***Maximum Recovery and Maximum Reliability***. For that reason a flushing protocol must be implemented and adhered to, whether it is manual or automatic. In addition, the effectiveness of the flushing is dependent on ensuring that the additional flow through the driplines is at a velocity adequate to scour the inside of the walls.

Netafim looks forward to supporting your efforts to maximize your performance while reducing maintenance and pipe replacement cost. Please feel free to contact us with any questions.

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