N E T A F I M   U S A

FLUSHING VELOCITY
and Netafim Bioline®

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Flushing Velocity and Netafim Bioline®

The subject of 'flushing' or 'scouring' velocity for onsite wastewater dripperline is full of opinion and sales claims, due in part to a lack of published standards or independent field studies.

This paper explains Netafim USA's Wastewater Division position regarding flushing velocity of onsite dripperline in general and Bioline® in particular. It also provides data to assist engineers, designers and consultants as they make independent decisions on the appropriate flushing velocity to design with.

Why Flush?

Flushing the piping network of water delivery networks, including onsite drip dispersal systems is an effective way to maintain design flow and system capacity. Flushing breaks loose accumulated bioslimes and purges sediments and deposits helping to extend the life expectancy of the system.

Ways Systems Can be Contaminated

It is well-accepted that the inside of an onsite piping network can develop a build-up of microbial slime that could degrade system performance. There is also the probability that inflow into the piping network from rainfall or normal on-off cycling of the system can occur. Further, precipitation of solids from chemical or biological reactions may be caused that need to be removed. For these reasons, developing an effective means of dislodging the build-up is important, and the first step is to design the drip dispersal network with an appropriate flushing capability.

Beside the normal build-up that can occur, the chance of the treatment system tank not being watertight also needs to be recognized. "The preponderance of septic tanks sold in the U.S. are structurally unsound and almost never watertight."[1] As such, "Because leaky tanks can exfiltrate… floatable solids, fats, soaps, oils and greases can be dosed or washed through the outlet assembly,"[1] looking only at the type of wastewater being used only looks at part of the problem.

The moral of the story - Protecting the system means that we must consider more than just the dripperline component. We must look at the entire system and consider all of the components that will benefit from forward flushing:

- Piping beside the dripperline
- Valves
- Fittings and other velocity-hindering junctions

Protecting Bioline Dripperline

Netafim incorporates an anti-microbial additive into the dripper. This additive acts to reduce the build-up of microbial slimes and has proven to be very effective. In addition to the anti-microbial additive, designing the drip dispersal system to flush effluent at an increased velocity is the norm. The speed and frequency of this action may be a topic of debate, whether it should be done is not.

Protecting the Rest of the System

The easiest and most common method for keeping the piping network and allied components operating in peak condition is to design the system so that a flushing action can take place. This flushing action focuses on opening the network up so that additional flow can move through the network at an increased velocity, creating turbulence and scouring off any build-up that may have occurred.

[1] "Design and Performance of Septic Tanks", T.R. Bounds, P.E.

Designing For Flush Velocity

The objective of a well-designed and properly maintained system is years of trouble-free operation. As such, falling prey to the claim that other products will work with lower velocities may not recognize the fact that higher flushing velocities would clean the piping network even better. Furthermore, such a claim is out of sync with the majority of regulations and fails to take into account that flushing velocity helps keep the entire system clean, not just the dripperline.

We have all heard the adage "An ounce of prevention is worth a pound of cure", and it is usually true. Cutting corners can ultimately translate to more money being spent. When all of the costs are analyzed, from installation, to the cost of the years of service performed, what may have seemed more expensive in the beginning is really less expensive over time. That is the principle behind *Total Cost of Ownership* and that is why Netafim encourages a conservative design approach and active professional maintenance of an onsite system.

Determining Flush Velocity

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

For the purposes of measuring and stating velocity, calculations are made at the distal (farthest) end of the dripperline lateral. For Netafim Bioline, the chart at the right shows the relationship of additional flow to velocity.

Velocity at the distal end of the lateral	Equates to an additional flow requirement per lateral
3 fps	2.3 GPM
2½ fps	2.0 GPM
2 fps	1.6 GPM
1½ fps	1.2 GPM
1 fps	0.8 GPM
½ fps	0.4 GPM

Turbulence and the Reynolds Number

Since the success of a flushing action is dependant on velocity, and the greater the velocity, the greater the turbulence, and thus the more likely that debris is going to be dislodged, some factor must be used to assign how much turbulence is desired based on design considerations.

One such method is to calculate the "Reynolds number". This dimensionless value is linked to the smoothness of a fluid flowing through a pipe and 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. A transition zone exists where 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 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 generally described to be laminar. From 2000 – 4000, it is considered transitional, and when greater than 4000, it is considered turbulent.

The chart below shows the Reynolds number for 0.57" I.D. pipe, the I.D. of Netafim Bioline. There are variables that go into calculating the Reynolds number, temperature and fluid viscosity among them. Changing these values can generate different values, so while the data below are not static, they provide a baseline for the designer to better see the link of turbulent flow to velocity/GPM flow.

If a flushing velocity of 4000 or greater is desired (turbulent), a flow rate at the end of each lateral at or above 0.69 GPM is required. This equates to a flushing velocity of approximately 1 fps. Designing a Bioline drip dispersal system based on a Reynolds number of 6000 would equate approximately to 1.3 fps and require distal end flow at each lateral of 1.05 GPM.

NOTE: This chart helps explain how Netafim's conservative design philosophy of 2 fps is portrayed. A Reynolds number of 9000 is well into the turbulent category and provides aggressive cleaning of the pipe.

FPS Properties of 0.57" I.D. Dripperline

Reynolds Number	Type of Flow	Distal Flow (GPM @ 70˚ F)	Distal End Velocity (fps @ 70˚ F)
2000	Laminar	0.35 GPM	0.4 fps
2500	Transitional	0.44 GPM	0.6 fps
3000	Transitional	0.52 GPM	0.7 fps
4000	Turbulent	0.69 GPM	0.9 fps
5000	Turbulent	0.87 GPM	1.1 fps
6000	Turbulent	1.05 GPM	1.3 fps
7000	Turbulent	1.25 GPM	1.6 fps
8000	Turbulent	1.40 GPM	1.8 fps
9000	Turbulent	1.58 GPM	2.0 fps
10000	Turbulent	1.74 GPM	2.2 fps
11288	Turbulent	1.96 GPM	2.5 fps
13546	Turbulent	2.32 GPM	3.0 fps

Netafim's Recommendations on Flush Velocity

Netafim recommends a flushing velocity of 2 fps.

Will a Netafim Bioline dripperline system work if the velocity is less than 2 fps? Sure. How much less? That gets back to the fact that science has not provided a precise answer.

Since entering the onsite market, Netafim has always promoted and recommended conservative design techniques, including designing with the conservative 2 fps value; we still do.

However, we also recognize that many elements go into an onsite design, and the ultimate decisions rest with regulations and the system designer, so it is important to provide all the necessary information to help make informed decisions. For dripperline, that includes tables that show lateral lengths as a function of various flushing velocities.

Flush Velocity vs. Effluent Quality

Some designers suggest that secondary effluent may only need a 0.5 - 1.0 fps scouring velocity while raw wastewater with grit and other debris should be anywhere from 2.5 - 3.5 fps, and effluent following primary settling may be in the 1.5 - 2.0 fps range. It is important to note that there is no specific science to prove or disprove these data.

2 fps Scouring Velocity

After years of working with distributors, engineers, regulators, universities, installers and other onsite experts, Netafim has concluded that systems designed with a 2 fps scouring velocity have the fewest problems and afford an excellent life expectancy for the system. We are not alone in that conclusion. A 2 fps velocity requirement is written into most regulations.

Incorporating Flushing with Lateral Length Data

There are several ways to design for flushing, among them automatic, manual, intermittent and continuous. Regardless of the flushing method used, the dripperline must have a minimum of 7 psi pressure at all times during dose cycles. This will ensure that each emitter is operating with pressure compensation.

Netafim's *Bioline Maximum Length of a Single Lateral* charts assume:

- There will be a minimum of 7 psi at the end of all stated lateral lengths, and
- The end of the lateral is closed

In addition to the pressure and flow required to perform a dose, the design must also provide enough additional pressure and flow to support the desired flush velocity.

The amount of additional flow required for flushing is incremental to the dose flow rate.

When designing for the desired flushing velocity, remember that the higher the velocity, the higher the GPM requirement. A 1 fps flush velocity requires an additional flow of 0.8 GPM per lateral whereas a 2 fps velocity requires 1.6 GPM. Note that the additional flow must be available to each lateral. The more laterals you have, the more additional flow you must add.

Ensure that the pump and the piping network are capable of providing the required increase in pressure and flow, and that all piping is capable of providing sufficient backpressure.

Lateral Lengths Based on Velocity

To make designing easy, Netafim has developed "Bioline Maximum Length of a Single Lateral" charts. These charts are design aids that allow the designer to determine how far a lateral can reach based on a specific flushing velocity. It is important to reaffirm that:

- There is a good chance for inflow into the piping network from rainfall or normal on-off cycling of the system. This can add to other constituents entering the piping network that need to be purged
- Precipitation of solids caused by chemical or biological reactions can occur
- Flushing velocities less than 2 fps may provide adequate protection for the system if effluent quality and outside considerations have been taken into consideration

The charts on the following pages provide designers with Bioline lateral length information based on various flushing velocities. After the desired flushing velocity, dripper flow rate and dripper interval are chosen, determine the pressure that will be available at the beginning of the drip lateral to see the effective lateral length of dripperline.

NOTE: *Publishing these charts does not constitute Netafim agreement that any type of wastewater can be used in a drip dispersal system and work properly with any of these lower velocities. Those decisions are left to regulations and the designer.*

Bioline Data - Maximum Length of a Single Lateral - 3.0 fps Flush Velocity

Additional Flow of 2.3 GPM Required Per Lateral to Achieve 3.0 fps

Dripper Spacing		12"			18"			24"		
Dripper Flow Rate (GPH)		0.4 GPH	0.6 GPH	0.9 GPH	0.4 GPH	0.6 GPH	0.9 GPH	0.4 GPH	0.6 GPH	0.9 GPH
Inlet Pressure (psi)	15	102	94	84	136	127	113	161	151	137
	25	151	136	118	203	184	161	245	223	197
	35	193	171	146	260	232	200	315	283	245
	40	211	186	158	286	254	218	347	311	267
	45	228	200	169	310	274	233	377	335	287
Flow per 100' (GPM / GPH)		0.67 / 40	1.02 / 61	1.53 / 92	0.44 / 26.67	0.68 / 41	1.02 / 61	0.34 / 20	0.51 / 31	0.77 / 46

Lateral lengths are based on flows allowing for a 3 fps flushing/scouring velocity

Bioline Data - Maximum Length of a Single Lateral - 2.5 fps Flush Velocity

Additional Flow of 2.0 GPM Required Per Lateral to Achieve 2.5 fps

Dripper Spacing		12"			18"			24"		
Dripper Flow Rate (GPH)		0.4 GPH	0.6 GPH	0.9 GPH	0.4 GPH	0.6 GPH	0.9 GPH	0.4 GPH	0.6 GPH	0.9 GPH
Inlet Pressure (psi)	15	128	115	100	172	155	136	205	187	165
	25	183	161	137	248	220	188	301	268	231
	35	228	198	166	310	272	229	379	333	283
	40	248	214	178	338	295	247	413	362	305
	45	266	229	190	364	316	263	447	389	327
Flow per 100' (GPM / GPH)		0.67 / 40	1.02 / 61	1.53 / 92	0.44 / 26.67	0.68 / 41	1.02 / 61	0.34 / 20	0.51 / 31	0.77 / 46

Lateral lengths are based on flows allowing for a 2.5 fps flushing/scouring velocity

Bioline Data - Maximum Length of a Single Lateral - 2.0 fps Flush Velocity

Additional Flow of 1.6 GPM Required Per Lateral to Achieve 2 fps

Dripper Spacing		12"			18"			24"		
Dripper Flow Rate (GPH)		0.4 GPH	0.6 GPH	0.9 GPH	0.4 GPH	0.6 GPH	0.9 GPH	0.4 GPH	0.6 GPH	0.9 GPH
Inlet Pressure (psi)	15	161	141	119	217	191	164	263	233	201
	25	221	190	157	302	261	218	369	321	270
	35	269	229	187	370	316	260	455	391	324
	40	290	246	200	399	340	278	493	421	347
	45	310	261	212	427	362	296	527	449	369
Flow per 100' (GPM / GPH)		0.67 / 40	1.02 / 61	1.53 / 92	0.44 / 26.67	0.68 / 41	1.02 / 61	0.34 / 20	0.51 / 31	0.77 / 46

Lateral lengths are based on flows allowing for a 2 fps flushing/scouring velocity

Bioline Data - Maximum Length of a Single Lateral - 1.5 fps Flush Velocity

Additional Flow of 1.2 GPM Required Per Lateral to Achieve 1.5 fps

Dripper Spacing		12"			18"			24"		
Dripper Flow Rate (GPH)		0.4 GPH	0.6 GPH	0.9 GPH	0.4 GPH	0.6 GPH	0.9 GPH	0.4 GPH	0.6 GPH	0.9 GPH
Inlet Pressure (psi)	15	201	171	140	275	235	194	337	289	241
	25	266	222	179	366	308	251	453	383	313
	35	316	262	210	437	365	295	543	455	369
	40	337	280	223	469	391	313	583	487	393
	45	358	296	235	497	413	331	619	517	415
Flow per 100' (GPM / GPH)		0.67 / 40	1.02 / 61	1.53 / 92	0.44 / 26.67	0.68 / 41	1.02 / 61	0.34 / 20	0.51 / 31	0.77 / 46

Lateral lengths are based on flows allowing for a 1½ fps flushing/scouring velocity

Bioline Data - Maximum Length of a Single Lateral - 1.0 fps Flush Velocity

Additional Flow of 0.8 GPM Required Per Lateral to Achieve 1 fps

Dripper Spacing		12"			18"			24"		
Dripper Flow Rate (GPH)		0.4 GPH	0.6 GPH	0.9 GPH	0.4 GPH	0.6 GPH	0.9 GPH	0.4 GPH	0.6 GPH	0.9 GPH
Inlet Pressure (psi)	15	248	205	163	344	285	228	427	355	285
	25	315	258	203	440	361	286	549	453	359
	35	367	299	234	513	419	331	643	527	417
	40	389	316	248	545	445	350	683	559	441
	45	409	332	260	574	468	367	721	589	463
Flow per 100' (GPM / GPH)		0.67 / 40	1.02 / 61	1.53 / 92	0.44 / 26.67	0.68 / 41	1.02 / 61	0.34 / 20	0.51 / 31	0.77 / 46

Lateral lengths are based on flows allowing for a 1 fps flushing/scouring velocity

Bioline Data - Maximum Length of a Single Lateral - 0.5 fps Flush Velocity

Additional Flow of 0.4 GPM Required Per Lateral to Achieve 0.5 fps

Dripper Spacing		12"			18"			24"		
Dripper Flow Rate (GPH)		0.4 GPH	0.6 GPH	0.9 GPH	0.4 GPH	0.6 GPH	0.9 GPH	0.4 GPH	0.6 GPH	0.9 GPH
Inlet Pressure (psi)	15	301	242	188	422	341	265	531	429	335
	25	369	296	228	520	418	323	655	527	409
	35	421	337	260	595	476	368	749	603	467
	40	443	354	273	626	501	387	790	635	491
	45	464	371	285	656	524	404	829	665	513
Flow per 100' (GPM / GPH)		0.67 / 40	1.02 / 61	1.53 / 92	0.44 / 26.67	0.68 / 41	1.02 / 61	0.34 / 20	0.51 / 31	0.77 / 46

Lateral lengths are based on flows allowing for a ½ fps flushing/scouring velocity

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