Alvaro Sanjinés Mech Engr, M.Sc, Ph..D.
I.A. Certified Irrigation Designer - Engineering Consultant
Phone (571) 3111109 e-mail alvsan@ibm.net
Alvaro Sanjines Mech Engr, M.Sc, Ph.D.
I.A. Certified Irrigation Designer – Engineering Consultant
asanjines@valrex.biz

TURBULENT FLOW AND LINE FLUSHING

by

Dr. Alvaro Sanjines.

The purpose of this discussion is to determine when is there enough velocity in the pipe to carry over and properly "flush" driplines.

Flow regimes are characterized by the Reynolds number, a non-dimensional factor that was empirically found correlates with the flow pattern.

During laminar flow, at lower speeds, flow streams are parallel to each other and gravity will settle particles at the bottom of the pipe.   As speed increases and hence Reynolds number, eddies and turbulence appear that keep particles suspended and in motion, helping flush the line properly.

The Turbulent flow regime is defined by the Reynolds number

N_r = Velocity (ft/sec) * Diameter (ft) / kinematic viscosity (ft^2/sec)

The kinematic viscosity varies with temperature

at 60   F is 0.0000121 ft^2/sec
at 80   F is 0.0000093 ft^2/sec
at 100 F is 0.0000074 ft^2/sec

To express this equation in an easier form:

N_r = 3277 * Flow in GPM / Pipe Diameter (inches)

This value is for ambient temperature of 70 F.

Now, the laminar region is for N_r less or equal to 2,000

The turbulent flow region is for N_r larger than 2,500. The question then is how much larger than 2,500 do you want the Reynolds number to be. Higher pressures and larger pumps are required in order to flush the lines if the standard is set at higher Reynolds numbers.

For various Reynolds numbers, a Table was calculated, giving the flow that has to exist at the end of the pipe to assure that turbulent flow exists all along the pipe.

For standard WASTEFLOW® which has an internal diameter of 0.55" a Reynolds number of 2,500 requires 0.42 gpm or 0.58 ft/sec per lateral.

The Reynolds number will be higher at the entrance and middle sections of the pipe where the flow is always larger as there is leakage through the emitters along the pipe, when flushing.

The values for required flow at the end of the line to attain Turbulent flow are calculated.

A model can be set up to calculate what the pressure should be at the beginning of the line to assure turbulent flow at the end of the line, taking into account the leakage at each emitter along the dripline. This is also dependent on the length and diameter of driplines.

DISTAL FLOW IN GPM FOR VARIOUS REYNOLDS NUMBERS

70 Degrees F	**Internal Diameter (Inches)**						
Reynolds	**0.5**	**0.52**	**0.54**	**0.56**	**0.6**	**0.7**	**0.83**
2000	0.31	0.32	0.33	0.34	0.37	0.43	0.51
2500	0.38	0.40	**0.41**	**0.43**	0.46	0.53	0.63
3000	0.46	0.48	0.49	0.51	0.55	0.64	0.76
4000	0.61	0.63	0.66	0.68	0.73	0.85	1.01
5000	0.76	0.79	0.82	0.85	0.92	1.07	1.27
6000	0.92	0.95	0.99	1.03	1.10	1.28	1.52
7000	1.07	1.11	1.15	1.20	1.28	1.50	1.77
8000	1.22	1.27	1.32	1.37	1.46	1.71	2.03
9000	1.37	1.43	1.48	1.54	1.65	1.92	2.28
10000	1.53	1.59	1.65	1.71	1.83	2.14	2.53

DISTAL END VELOCITY IN FT /SEC

70 Degrees F	**Internal Diameter (Inches)**						
Reynolds	**0.5**	**0.52**	**0.54**	**0.56**	**0.6**	**0.7**	**0.83**
2000	0.51	0.49	0.47	0.45	0.42	0.36	0.31
2500	0.64	0.61	**0.59**	**0.57**	0.53	0.45	0.38
3000	0.76	0.73	0.71	0.68	0.64	0.55	0.46
4000	1.02	0.98	0.94	0.91	0.85	0.73	0.61
5000	1.27	1.22	1.18	1.14	1.06	0.91	0.77
6000	1.53	1.47	1.41	1.36	1.27	1.09	0.92
7000	1.78	1.71	1.65	1.59	1.48	1.27	1.07
8000	2.04	1.96	1.88	1.82	1.70	1.45	1.23
9000	2.29	2.20	2.12	2.04	1.91	1.64	1.38
10000	2.54	2.45	2.36	2.27	2.12	1.82	1.53