Fire Management Tech Tips

United States Department of Agriculture
Forest Service
National Technology & Development Program

April 2010

5100 1051 1302—SDTDC

Performance of Hoseline Tees With Valves as a Function of Tee-Waterway Diameters

by
Sam Wu, P.E., Mechanical Engineer

INTRODUCTION

The hoseline tee is a fitting that has male and female threaded ends and a male tee branch. It is used for diverting water from a main trunkline to a lateral branch (figure 1). Previous editions of Forest Service (FS) Specification 5100-107 (before 2005) did not include a minimum waterway diameter for the tee branch. As a result, the branch orifice diameter was very different from manufacturer to manufacturer. In 2005, the Forest Service addressed the problem in its most recent update to FS Specification 5100-107d. In the update, a minimum flow rate through the tee branch is specified for hoseline tees with valves, as well as a minimum waterway diameter for both hoseline tees with and without valves.

Figure 1—Hoseline tee with valve.

In 2009, to address concerns in the field about whether older hoseline tees with valves should still be used, San Dimas Technology and Development Center (SDTDC), a National Technology and Development Center of the Forest Service, U. S. Department of Agriculture, ran a series of tests. The tests' objectives were to (1) measure the performance difference between hoseline tees with different waterway diameters, (2) determine whether the performance difference between the tees was significant, and (3) provide recommendations for potential actions with existing stocks of hoseline tees.

TESTING AND OBSERVATIONS

SDTDC tested eight hoseline tees with valves (1½-inch National Hose [NH] by 1½-inch NH by 1-inch National Pipe Straight Hose [NPSH]) with tee waterway diameters ranging from 0.375 inches to 1 inch; a standard wye valve (1½-inch NH by 1½-inch NH by 1½-inch NH); and a mini-wye valve (1½-inch NH by 1½-inch NH x 1-inch NPSH) (figure 2). The change in pressure was recorded for each fitting as a function of flow, lateral-hose diameter, and lateral-hose length.

Figure 2—Sample setup of hoseline tee test.

For additional information, contact: Fire Management Program Leader, San Dimas Technology & Development Center, 444 East Bonita Avenue, San Dimas, CA 91773-3198; Phone 909-599-1267; TDD; 909-599-2357; FAX: 909-592-2309
Lotus Notes: Mailroom WO SDTDC@FSNOTES • Intranet (web site): http://fsweb.sdtdc.wo.fs.fed.us • Internet e-mail: mailroom_wo_sdtdc@fs.fed.us

Equation 1 relates the correlation between flow and change in pressure. Q_{gpm} is the flow of water through the fitting, Δp_{psi} is the change in pressure due to the fitting, and C_v is the valve-flow coefficient.

$$C_v = \frac{Q_{gpm}}{\sqrt{\Delta p_{psi}}} \qquad \text{Equation 1}^1$$

One way to conceptualize the valve-flow coefficient is to think of it as the flow in gallons per minute (gpm) for a 1-pound-per-square-inch (psi) pressure drop. To determine the valve-flow coefficient (C_v) for a particular fitting, C_v was calculated and averaged across different flows and hose lengths for the fitting (table 1). Using the average C_v for each fitting, the hoseline tees can be compared to each other as a function of flow and pressure drop (figure 3). The valve-flow coefficient is, essentially, a way to compare the performance of various fittings. While C_v is not solely dependent on the orifice size of the tee, there is reasonable correlation; the smaller the waterway diameter of the tee, the smaller the flow coefficient and hence, the larger the pressure drop. As the hoseline tee is used to establish a lateral off of the main trunk hoseline, the lateral hose typically will have a 1-inch-nominal diameter. For 1-inch-diameter nozzles, flow rates will be between 10 to 30 gpm.

At low flows, figure 3 and table 1 indicate that the difference in pressure drops between different hoseline tees with valves is minimal. At 10 gpm, the range between the largest and smallest pressure drop is between 0.2 and 9.0 psi. However, as flow increases through the tee, the difference between fittings becomes much more pronounced. At 30 gpm, the range between the largest and smallest pressure drop is between 2.1 and 81 psi. At 50 gpm, the range between the largest and smallest pressure drop is between 5.8 and 220 psi. By comparison, pressure drops through the wye valves are minimal. Even at 50 gpm, the pressure drop for a standard wye valve with a 1½-inch to 1-inch reducer is 2 psi.

When considering what pressure drops are unacceptably high in a hoseline-tee lateral, it should be noted that in most field applications, all hoseline tees can be made to function in a hose lay by relying on methods to reduce friction loss. However, the data show that using some hoseline tees will cause the hose lay to be extremely inefficient. By restricting the data solely to hoseline tees with pressure drops under 25 psi for the most common flows (10 to 30 gpm), a trend of better efficiencies (lower pressure drops) with larger waterway diameters is clearly noted.

[1] *The actual equation for the valve-flow coefficient involves the specific gravity of the fluid. The specific gravity of water is 1, therefore, the following equation simplifies to Equation 1.* $C_v = \frac{Q_{gpm}}{\sqrt{\frac{\Delta p_{psi}}{SG}}}$

Table 1—Average C_v and pressure drops at different flows for various fittings–flows in red are indicative of normal flow conditions. Highlighted cells are indicative of pressure drops above acceptable thresholds

		Pressure Drop (psi) at Various Flow Rates					
Tee Waterway Diameter (in)	**Avg C_v[2]**	**10 gpm**	**20 gpm**	**30 gpm**	**40 gpm**	**50 gpm**	**60 gpm**
0.375	3.49	8.2	33	74	130	210	300
0.43	3.34	9.0	36	81	140	220	320
0.437	5.60	3.2	13	29	51	80	120
0.495	4.94	4.1	16	37	66	100	150
0.5	6.24	2.6	10	23	41	64	92
0.532	6.72	2.2	8.9	20	36	55	80
0.744	10.66	0.90	3.5	7.9	14	22	32
1	20.74	0.20	0.90	2.1	3.7	5.8	8.4
Standard wye, with reducer	35.32	0.10	0.30	0.70	1.3	2.0	2.9
Standard wye, without reducer	100.71	0.00	0.00	0.10	0.20	0.20	0.40

[2] Average C_v *values in this column are to be used only for calculations*

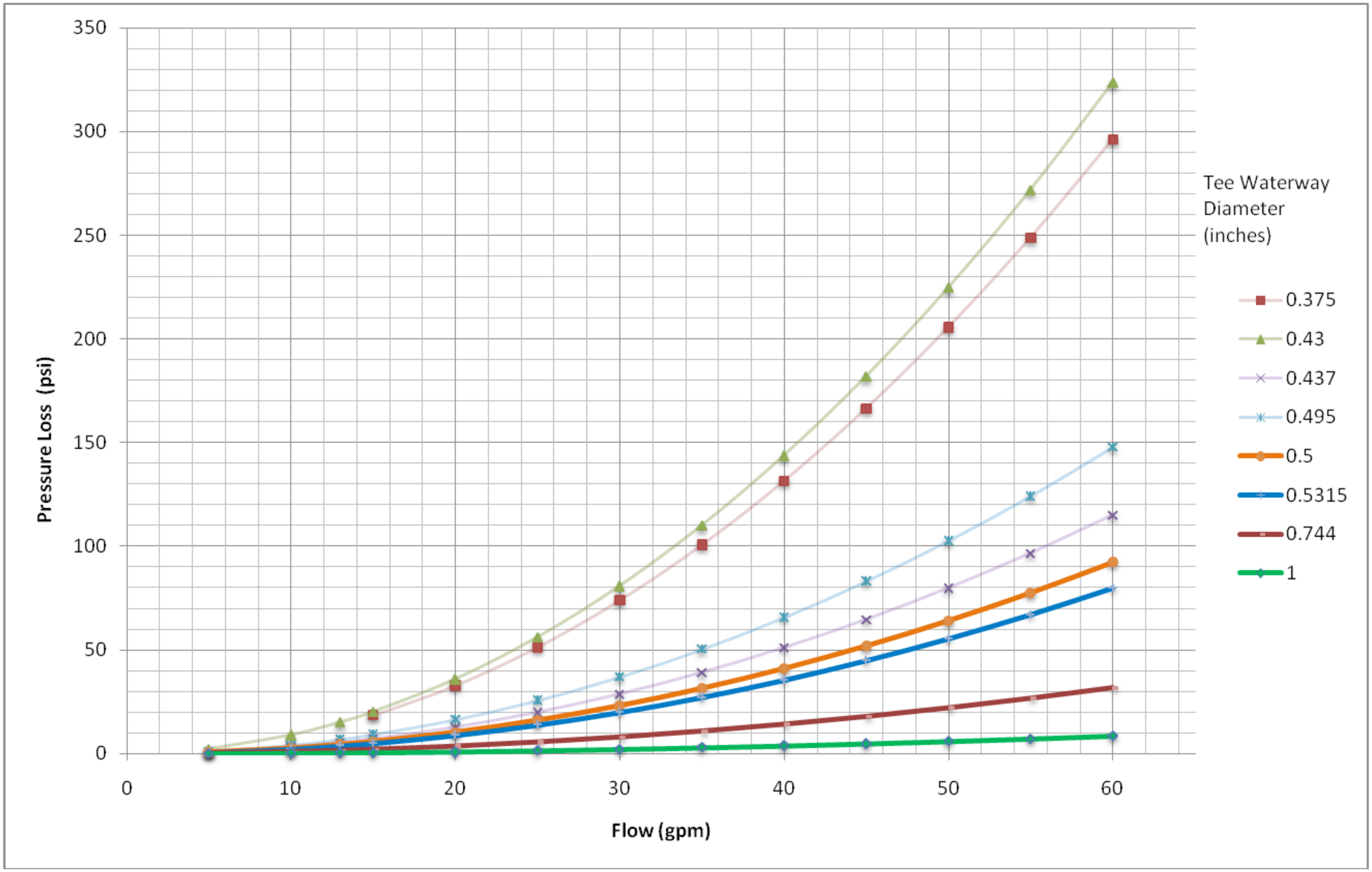

Figure 3—Pressure loss versus flow rate for various hoseline tees, based on average C.

CONCLUSIONS AND RECOMMENDATIONS

There is a marked difference between the performances of various hoseline tees. The two hoseline tees with the smallest tee-waterway diameter had pressure drops across the fitting that would not be acceptable for normal use in field operations except under very low flows. While it would be ideal to be able to test each fitting manufactured before 2005, it is not very practical. While the performance of the hoseline tee depends on a variety of factors including valve geometry and body type, the waterway diameter of the tee is the easiest to measure and gives a reasonable correlation with performance of the hoseline tee.

Although the hoseline tees with valves manufactured under a General Services Administration contract after the FS 5100-107d specification update have a minimum tee-waterway diameter of 0.75 inches, many of the hoseline tees in the field and cache systems have branch-orifice diameters smaller than 0.500 inches.

SDTDC recommends that all hoseline tees with valves with waterway of less than 0.500 inches in diameter be removed from the field and culled from the national caches; this will help ensure that all hoseline tees sent to the field can be used effectively in most situations.

The National Technology and Development Center's national publications are available on the Internet at: http://www.fs.fed.us/eng/pubs/.

Forest Service and U.S. Department of the Interior, Bureau of Land Management employees also can view videos, CDs, and National Technology and Development Center's individual project pages on their internal computer network at: http://fsweb.sdtdc.wo.fs.fed.us/.

For additional information on the performance of hoseline tees, contact Sam Wu at SDTDC. Phone: 909–599–1267 ext 292. Email: swu@fs.fed.us.