Smooth-bore Nozzles 101

By Troy Cool

Many articles have been written on the topic of different types of nozzles, including the smooth-bore nozzle. Of the articles written detailing and explaining nozzles, many have covered the various types of fog nozzles and their operation. However, most of these articles have referred to smooth-bore nozzles as a single classification. There are many different variations of smooth-bore nozzles from which the stream quality and reach can vary considerably.

In the most basic of terms, a smooth-bore nozzle is a piece of pipe with a fixed orifice or opening attached to a control valve. The purpose of the control valve or shutoff is simply to control the flow of water. The purpose of “the pipe” is to shape the water into a solid fire stream. While there are a few variations of shutoff that can affect stream quality, the size and shape of the smooth-bore tip will have the greatest influence on the quality and reach of the stream.

A nozzle, smooth-bore or fog, can be specified as a one-piece unit or one in which the tip or tips attach to the shutoff as a threaded appliance. As a one-piece unit, the nozzle has little or no variation. However, as a threaded appliance, a nozzle can be extremely versatile and offer more options and flexibility. The greatest degree of flexibility is derived from a shutoff with a built-in smooth-bore orifice to which a variety of fog or additional smooth-bore tips can be attached.

As mentioned above, there is a wide variety of smooth-bore tips available from the major nozzle manufacturers. These different tips can produce varying qualities of solid streams. The primary factor affecting this stream quality is the length and degree of taper contained within the tip. This taper is responsible for shaping the fire stream, giving it the tightness and reach indicative of a good solid stream. A long, gradual taper within the tip will produce the best-quality stream with the longest reach.

Built-in or integrated smooth-bore tips simply design the smooth-bore orifice into the shutoff and offer a great deal of flexibility. Early versions of these integrated smooth-bores, sometimes referred to as slug tips, generally produced a lower-quality solid stream. However, newer models have been improved and produce a good-quality stream. As a stand-alone nozzle, the integrated version will be a very compact, lightweight nozzle.

There are two options that are commonly added to an integrated tip. The first is for those who want the ability to have both a fog nozzle and smooth-bore nozzle in one. This is achieved by attaching a fog tip to the male threads on the outer edge of the integrated tip that can be removed if increased flows are required or the fog tip becomes clogged with debris. A popular option is to attach a low-pressure fog tip to an integrated smooth-bore. If a 150-gpm-@-50-psi fog tip were removed to reveal a one-inch smooth-bore, the increase in flow, depending upon the hose, would be around 40 gpm if pump discharge pressure remains constant.

The second option is to attach a smaller smooth-bore tip to a larger integrated tip. For example, a 15/16-inch tapered tip could be attached to a 1-1/8-inch integrated tip. This variation would provide an adequate fire stream flowing 180 gpm @ 50 psi. If more gallons-per-minute are required to achieve knock down, the outer tip could be removed and, without changing the discharge pressure, the integrated tip would provide an additional 40-50 gpm of flow if used with a “good” hose that will support the higher flows.

Two common variations of the smooth-bore are stacked tips and tapered tips. Stacked tips are usually 2-3 smooth-bore tips that decrease in size as they go up in the stack from the shutoff. Removing tips leaving a tip with a larger orifice increases the gpm flow. The transition area from tip to tip can create slight turbulence affecting stream quality of a stacked-tip arrangement. Stacked tips will also commonly have a limited taper that will also affect the quality of the stream. Tapered tips generally produce the best-quality solid stream. A longer and more gradual taper inside the tip will generate a tighter and longer-reaching solid stream. Some nozzle manufactures have begun producing new “old school” long, tapered tips available for 1.75-inch as well as 2.5-inch attack lines.

While the length and taper of the tip will have the greatest affect on stream quality, other factors can have an impact as well — such as the shutoff design, as well as other appliances that may be used. The design and construction of a shutoff can affect how the water will flow through to the tip and ultimately will affect stream quality. A smooth transition from the hose to the tip is important, especially with an integrated design, because of the short distance to shape the stream.

Appliances such as stream shapers can also improve stream quality and increase reach by reducing the turbulence of the water as it leaves the hose. If you are using a stream shaper with an integrated or one-piece design, it should be placed between the hose and the shutoff. If a tapered or stack tip design is used, then the shaper can be placed between the shutoff and the tip. One potential drawback when using a stream shaper is the potential for debris to obstruct the water flow, especially in high-rise applications. The space between the vanes is usually large enough to pass most debris, but a large object that would normally pass through a smooth-bore nozzle could potentially get stuck and severely restrict flow.

The final element of a water-delivery system, which cannot be overlooked, is the hose. Modern fire hose has improved tremendously; therefore, many of “the rules,” such as tip size in relation to hose diameter and maximum flow capabilities, have changed. It is now possible to get big water through a small hose. All fire hoses are certainly not created equally and therefore a thorough, objective comparison is vital when making a decision regarding your water delivery system. Nozzle and hose must be considered as a package and must be evaluated as such in order to achieve the best results. Friction loss, especially at higher flows, can vary greatly. During our nozzle tests, we were able to flow 270 gallons per minute through one particular brand of 1.75-inch hose with an 1-1/8-inch smooth-bore tip while other hose brands would not support nearly that high a flow rate. These high flow rates through 1.75-inch hose should only be considered under extreme situations for a short period of time if a fire increases in intensity or is larger than originally estimated prior to stretching the initial line while larger attack lines are placed into service.

Generally, if a flow rate of more than 200 gpm is necessary to advance on or achieve knock down within a relatively short period of time, a 2.5-inch line will usually be more appropriate. Extremely high flow rates through 1.75-inch hose, as mentioned above, can be very difficult to manage and maneuver even with the best of hoses. At these flow rates, smaller diameter hose can potentially be dangerous; therefore, they should only be considered as an option under extreme fire conditions for a limited period of time.

Although much documentation, research, and practical fire-ground experience would recommend against it, many departments continue to use 1.75-inch hose for standpipe operations. While the author does not advocate this potentially dangerous tactic, if it is going to be done, it is vital that a hose with the lowest possible friction loss and a nozzle designed to operate at low nozzle pressures are selected. This is important because of the potential limits in pressure due to friction loss, pressure-reducing valves and other factors within the standpipe system. When evaluating hoses, there are other factors to consider in addition to friction loss. Some hoses are much more prone to kinks at the lower pressures typical of smooth-bore nozzles while others are very difficult to kink. Some hoses tend to snap over violently when the stream is whipped aggressively even at moderate flow rates. Bottom line: test your hose!

Summary

It is important that the millennium engine company understand the options available to them as they do battle on the fire ground. The smooth-bore nozzle has been and will remain a vital tool in the engine company’s arsenal. There are many variations of smooth-bore nozzles and options to consider. The importance of matching the proper nozzle to good hose must also be taken into consideration. While the author of this article does not advocate replacing 2.5-inch hose, under extreme conditions, some modern 1.75-inch hose can support flows typical of 2.5-inch hose for a brief period of time. When mated to the proper hose, the smooth-bore nozzle provides a very reliable, lightweight tool that produces a high flowing, hard-hitting fire stream that will improve the efficiency and effectiveness of structural fire attack.