International
SprinklerScene

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Benefits of Hydraulic Calculation

Hydraulic calculations were incorporated into NFPA 13, *Standard for the Installation of Sprinkler Systems*, in the 1972 Edition by the addition of the density-area curves. However, some guidance on hydraulic calculations can be found as early as the 1966 Edition. Prior to that, the pipe schedule method was used for sizing the sprinkler system piping to ensure adequate water flow through the piping network. This method had limitations in the length of branch lines as well as requires fairly large diameter pipes to feed the sprinklers. Hydraulic calculations have led to the downsizing of pipe diameters and better flow and pressure demands to ensure an adequate water supply.

The driving force within hydraulic calculations is the friction loss through the pipe. Water in pipes is not exclusive to fire sprinkler systems. The most common equation for friction loss applied to fire sprinkler systems is the Hazen-Williams formula:

$$P_{loss} = \frac{4.52 \quad Q^{1.85}}{C^{1.85} d_i^{4.87}}$$

This formula was developed from empirical data by A. Hazen and G.S. Williams in 1906 as a simpler calculation for friction loss than others available at that time. It has been applied to fire sprinkler systems because it is a reasonably simple approach and the conditions of the water within the sprinkler piping are in the range of acceptability for using the equation.

By going through the hydraulic calculations, many benefits can be realized. To begin, pipe sizes can be minimized. This means the smallest diameter pipes can be used to get the required amount of water to the sprinklers. By minimizing the pipe diameters, the cost of the system can be reduced as smaller pipes cost less than larger ones. The actual sizes needed to feed branch lines will vary based on the water supply for the building. For example, it may be cost effective to use a larger diameter for branch lines and mains opposed to smaller diameter pipes and use of a fire pump.

The next item the calculations can affect is the type of pipe that is selected. In applications where there are options for acceptable piping materials, hydraulic calculations can assist in making that decision. The type of pipe affects the water flow by applying a roughness coefficient, C. This represents the interaction between the pipe surface and the water when in motion.

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C values can be found in NFPA 13 (Table 22.4.4.7 in the 2007 Edition) or the manufacturers listing information for specially listed pipes. As an example, the friction loss in 10 feet (3.0 m) of 2-inch Schedule 40 pipe installed in a dry pipe system and flowing 100 gpm (380 l/min) would be:

$$P_{loss} = \frac{4.52(100\,gpm)^{1.85}}{100^{1.85}\,2.067^{4.87}}(10\ feet) = 1.32\ psi(\ 0.09 bar)$$

Comparatively, if the dry pipe sprinkler system used galvanized pipe the C-factor would change to 120 and the friction loss would now be:

$$P_{loss} = \frac{4.52(100\,gpm)^{1.85}}{120^{1.85}\,2.067^{4.87}}(10\ feet) = 0.94\ psi(\ 0.06 bar)$$

The longer the run of piping, the greater the impact the material will have through its C-factor contribution.

Finally, the hydraulics can be used to help determine the best flow rates to use for sprinklers, especially spray sprinklers. In other words, sprinklers that rely on the density/area method of calculation will vary the amount of water required from each sprinkler based on the amount of floor area that sprinkler is responsible for protecting. For example, a remote sprinkler in the corner of the space is 6 ft (1.8 m) from the wall and 10 ft (3.0 m) from the next branch line in the north-south direction. In the east-west direction, that same sprinkler is 6 ft 9 in (2.1 m) from the wall and 12 ft (3.7 m) from the next sprinkler along the branch line. The area this sprinkler covers is found from A = S x L as noted in Section 8.5.2.1.2 of NFPA 13. In this example, S = 13.5 ft (4.1 m) and L = 12 ft (3.7 m), therefore, A= 12 x 13.5 = 162 ft^2(15.1 m^2). If the remainder of the branch line sprinklers all cover 10 ft x 12 ft = 120 ft^2 (11.2 m^2), then it may be a better decision to locate the sprinkler covering more area closer to the main to reduce the necessary pressures required for the total demand. Specifically, for a light hazard occupancy, at 0.1gpm/ft^2 (4.1 mm/min) the corner sprinkler would flow 16.2 gpm (61.3 l/min) while a sprinkler covering 120 ft^2 (11.2 m^2) only needs 12.0 gpm (45.4 l/min). The necessary corresponding pressures for a K-factor 5.6 (K_M=80) spray sprinkler are 8.4 psi (0.58 bar) and 4.6 psi (0.32 bar) respectively. NFPA 13 would require a minimum of 7 psi (0.48 bar) to be used, but this is still a lower starting value compared with the 8.4 psi (0.58 bar).

The starting values will drive the rest of that branch line. Higher pressure requirements at the end of a branch line will force the other sprinklers to flow more than necessary. If the spacing is redistributed so that the sprinkler covering the greater flow area is physically closer to the main, then the extra flow created by the higher pressure requirements is minimized. It is important to verify that the minimum required from the sprinkler is still achieved wherever it is along the line.

Through the years, NFPA 13 has restricted and minimized the use of the pipe schedule method. The variations in available water supplies are not taken into account with the pipe schedule method. Whereas, hydraulic calculations can then be compared to the water supply onsite. They can also provide benefits in sizing the sprinkler pipe, permitting smaller diameters, which in turn saves cost in the system. In general, there is a greater reliability in the calculations than with the schedule method.

World News:

Sprinklered Jumbo Hostel

A Jumbo Jet, Boeing 747, has been revamped to serve as a hostel in Stockholm, Sweden at the Arlanda International Airport. The hostel has 25 guest rooms with more than 70 beds all protected by residential fire sprinklers. The jet is located in walking distance to all the terminals at the airport and even has its own small café. The jet itself was built in 1976, the concept to turn it into a hostel was created in 2002 by an entrepreneur, Oscar Dios. After working with the Transjet (the previous owner of the Boeing aircraft) and the airport to buy a small piece of land, the idea became reality in January 2009 when it was inaugurated.

Residential Sprinklers Increased in Norway

The European Fire Sprinkler Network reports that Norway has a public proposal open for comment until October that would require sprinklers for new homes more than two stories and other buildings, such as health care facilities. Currently, about 20 percent of new homes are sprinklered. This proposal would increase that number.

IFSA Training Course

The IFSA will be returning to Puebla, Mexico this year to teach another 3-day program. This year's topics will include: Sprinkler Protection for General Storage (1-day), Flammable Liquid Storage (½ day), Standpipe Systems for Fire Protection (½ day), Hydraulics for Fire Protection (1 day). Classes will be held 1-3 September 2009 at the Holiday Inn Express Puebla. For further information, email seminars@sprinklerworld.org.

Upcoming Events

12-14 August 2009	Seguriexpo Buenos Aires 2009	Argentina
7-9 September 2009	Fire India	India
8-10 September 2009	AUBE 09	Germany
23-24 September 2009	International Water Mist Conference	Great Britain
24-25 September 2009	Eurofire	Belgium
21-23 October 2009	CCPS 2nd Latin America Conference	Brazil
3-5 November 2009	3rd Algeria Fire, Safety & Security Expo	Algeria
17-29 January 2010	Intersec	Germany
21-22 April 2010	EFSN	Belgium

Editor's Note:

If you have upcoming industry events, sprinkler saves, or industry news, please send it to valentine@sprinklerworld.org. Also, remember to visit the website www.sprinklerworld.org for industry news and updates on upcoming events.