Foam Proportioning

Line Proportioner System Design

Fire Engineering
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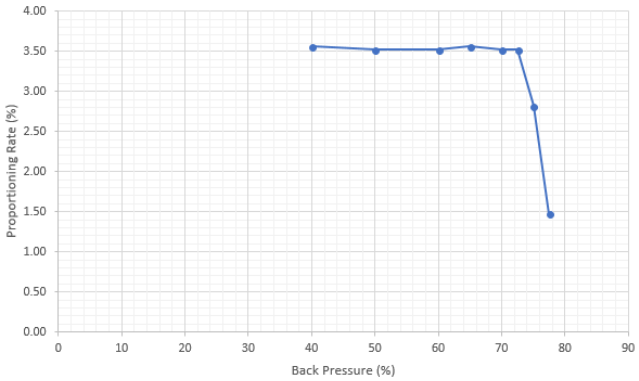
Design

Systems that use a line proportioner are fixed flow systems. The flow rate in the system is controlled by the proportioner and the pressure at the inlet to the proportioner.

When ordering line proportioners it is necessary to specify the flow rate and operating pressure at the proportioner inlet as well as the type of foam concentrate and the proportioning rate. Line proportioners are manufactured with a proportioning rate in the upper 50% of the allowed range to allow for losses in the actual system and worst case operating conditions (empty foam tank).

Line proportioners are used in fixed foam systems where the operating pressure and flow are well known. If the conditions at the line proportioner vary appreciably from the design conditions the proportioner may stop working completely. All line proportioners are designed for a minimum pressure differential between inlet and outlet of 30% of the inlet pressure (70% back pressure) for 3% and lower proportioning rates and 35% differential for 6% proportioners. If this minimum pressure differential is not maintained the proportioner will not work correctly. The proportioning rate drops rapidly once the maximum back pressure is exceeded.



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The minimum operating pressure for line proportioner is normally 500 kPa. They can work as low as 400 kPa, but the maximum allowed back pressure is then reduced by 5%.

Line proportioners have a single operating point and control the actual foam system flow. The inlet pressure cannot vary by more than 100kPa from the design pressure without causing the proportioning rate to fail.

A line proportioner is manufactured for operation with a particular type of foam concentrate. The viscosity of the foam concentrate influences the induction rate and changing foam concentrates may result in an inaccurate induction rate.

Foam Sprinkler Systems: Line proportioners are not a good choice for these types of systems as the risk of nozzle blockages is too high. Blocked nozzles increase the back pressure on the proportioner and will lead to reduced or no foam proportioning. If you must do this, design of 50% back pressure so that there is some ability to cope with blockages.

Installation of Line Proportioners

1. Location: The best practice when installing line proportioners is to locate them immediately on top of the foam tank (see photo above). When the proportioner is installed at a level lower than the level of foam concentrate there is a risk of siphoning the entire contents of the foam concentrate storage tank into the system pipe work – then use of an Orion water operated concentrate control valve to prevent siphoning.

2. Orientation: There is no restriction to the orientation of the proportioner. It may be located vertically, horizontally or at any angle.

3. Installation: When installing line proportioners a minimum of five (5) pipe diameters of straight, unobstructed pipe are needed on both the inlet and outlet sides of the proportioner to provide well developed flow conditions. This includes locating valves and other fittings at least five pipe diameters away from the proportioner. The pipe size must be the same size as the proportioner. The 5 diameters are measured from the ends of the proportioner. If in doubt, use a longer pipe. The maximum foam tank height should be 1.5 meters and the proportioner should be installed no more than 1 meter above the tanks.

4. Dedication: Line proportioners are normally installed so that they are dedicated to a single foam system. When there are many different foam systems at a particular location each one usually has a dedicated proportioner. Sometimes it is necessary (or convenient) to use one proportioner for a number of systems. For this to work correctly ALL systems must be designed so that they have the same flow rates. The designer must ensure that back pressures are correct for each system. Only one system can then be operated at any one time.

5. Foam Concentrate Piping: Concentrate piping should be 316 stainless steel, and the internal diameter should be sized so that friction losses and elevation changes in this pipe are limited to less than 20 kPa. Special care needs to be taken with high viscosity concentrates such as Alcohol type AFFF's. A good quality non-return valve should be installed in the concentrate line to reduce the possibility of water flowing back into the foam concentrate storage tank. If possible, an isolating valve should also be used as well as a check valve. Foam concentrate piping must be the same size or one size larger

than the concentrate connection on the proportioner. One size larger is highly recommended for high viscosity foam concentrates.

6. Pressure gauges should be located 5 diameters before and after the proportioner. This allows the system to be checked with no foam induction. Do not locate pressure gauges less than 5 diameters from the proportioner outlet as pressure readings will be unreliable.

System Hydraulic Design

When designing foam systems which use line proportioners, the first objective is to determine the minimum design flow rate for the system, and then carry out the hydraulic calculations to determine the actual flow rate. Hydraulic calculations for systems using a line proportioner should be carried out as two separate calculations as the proportioner produces a pressure discontinuity which cannot be modelled as an equivalent length of pipe. The pipe network from the water supply to the inlet of the proportioner represents one part and the pipe network from the proportioner outlet to the discharge device(s) is the second part.

The piping and nozzle arrangement downstream of the proportioner has no influence on the system flow, so it can be treated as a completely independent system with a fixed flow rate. The system flow is determined by the proportioner. This can simplify the overall hydraulic model.

Depending on the constraints imposed on the designer there are two common ways to approach the problem.

The first problem type starts with a minimum design flow rate and water supply and we need to design the pipe network and select nozzles:

For a given water supply and design flow rate, carry out the hydraulic calculations up to the inlet to the proportioner. This determines the operating point for the proportioner and determines the size of proportioner to be used. NOTE: The flow rate in this section will be lower than the design flow rate by the amount of foam inducted.

We then model that part of the foam system from the proportioner outlet onwards. The pressure used to drive this part of the system must be less than the maximum allowed back pressure at the outlet of the proportioner and the flow rate is fixed at the proportioner flow rate (plus foam concentrate flow). The proposed pipe network and discharge device(s) are adjusted until they are able to pass this flow with this pressure limitation and any imposed by the foam discharge devices (nozzles or foam makers etc.).

It may be necessary to modify the design flow rate (upward) at this point and the calculations are then repeated with this new flow.

The second problem type starts with a given pipe network, discharge devices and minimum design flow rate for which we must select a proportioner and a water supply:

In this case we carry out hydraulic calculations in the opposite order to the first example. The hydraulic calculations for the pipe network downstream from the proportioner are carried out to determine the pressure required at the outlet of the proportioner which will

produce the required flow rate. This pressure must be less than the allowed back pressure at the proportioner outlet.

We then calculate the water supply pressure need to produce this inlet pressure. It is often necessary to build a proportioner specifically for this type of system.

The appropriate line proportioner can be selected from the following charts. When specifying the proportioner, the required solution flow rate (including foam concentrate flow), the inlet pressure, the foam induction rate and the type of foam concentrate must be given. Orion Fire can manufacture custom proportioners for many applications.

Orion provide technical services for foam systems design and testing. It is always better to design correctly than to fixed any problems later.

Commissioning

Line proportioner systems should be thoroughly tested after installation. The commissioning tests should run the system for some minutes before a foam sample is taken for testing. The minimum time for a system test should be twice the time taken to fill the pipe downstream from the proportioner plus at least 1 minute. We recommend taking 3 samples about 10-15 seconds apart to ensure that the system has reached it operating point.

Check that the system operating pressure is correct.

When a system is first started with dry pipes the system back pressure is much lower and the proportioner has no difficulty working, however, as soon as the piping is filled the back pressure rises to its full operating level. At this point the piping contains foam solution that is not representative of the long term performance and must be flushed out before the sample is taken. Installations have been found which stop proportioning after running for several minutes because of this problem.

With due care during design and installation line proportioners will provide reliable proportioning with minimal maintenance for many years. Their simplicity makes line proportioners the most reliable proportioning method available when used correctly.

Orion can provide design and testing services for foam systems. We have the data and understanding to do foam system hydraulic calculations correctly and decades of experience with testing.