HIGH EXPANSION SYSTEMS

HIGH EXPANSION FOAM

DESCRIPTION

Buckeye offers a range of High Expansion (Hi-Ex) Foam Generators to provide high quality, highly expanded foam for use in these systems. Buckeye water powered high expansion foam generators require no external power other than foam solution to ensure correct operation.

It is recommended that High Expansion Foam Fire protection systems be installed by a contractor having previous experience in installing similar fixed fire protection foam systems.

The Hi-Ex Foam Fire Protection System must be designed and installed in strict accordance with NFPA 11 A, the Standard for High Expansion Foam Systems and any guidelines established by the Authority Having Jurisdiction (AHJ) or the Insurance Carrier.

The output of a Buckeye Hi-Ex Foam Generator in a fixed installation depends on which generator is selected. These generators are available in a wide flow range (in cubic feet per min.) at various foam solution inlet pressures. When multiple units are used an almost limitless output can be achieved.

The Hi-Ex Foam System is suitable for use for fire extinction of solid fuel or flammable liquid fires in areas where the expanded foam can be contained. Examples:

- **Ship holds**
- Aircraft hangars
- Hazardous material/waste storage areas
- Flammable liquid packaging areas
- Flammable liquid drum storage
- Warehouse areas such as:
- Rolled paper, tire storage, in rack storage of combustible materials and boat storage.

High Expansion Foam Systems have been installed as added protection for Liquid Natural Gas facilities where it is used as a fire suppressant and for controlling any vapors released from an accidental LNG spill.

Blanketing such spills with Hi-Ex Foam is an effective method to help reduce and control fire intensity and to decrease LNG vapor generation.

METHOD OF OPERATION

High Expansion Foam concentrate and water are mixed in the correct proportion by various methods to form a foam solution. This solution flows to the Hi-Ex generator where it is discharged through nozzles onto a fine mesh screen. A rotating fan, driven by the incoming foam solution, is incorporated into the generator. This fan forces large volumes of air through the fine mesh screen at the same time as the foam solution is being sprayed. The air mixes with the foam solution to form a large discharging mass of stable bubbles at a rate of up to 1,000 gallons of expanded foam for each gallon of foam solution. This clean highly expanded foam mass quickly fills large areas flow-ing around obstacles and flooding every void quickly and effectively smothering any fire.

METHOD OF EXTINGUISHMENT

When the Hi-Ex foam is discharged into a Hazard area, three extinguishing mechanisms happen.

- The large mass of the discharging foam fills all voids and seals the area involved in the fire and prevents fresh air from reaching the base of the flames. The foam mass maintains an oxygen deficient area until the fire is extinguished.
- The steam generated is a result of the radiant heat from the fire evaporating the water in the foam blanket. This conversion to steam absorbs a large quantity of heat and the resulting steam/air mixture is well below the oxygen level that is required to support continued combustion.
- The cooling effect of the Hi-Ex foam occurs as the bubbles break and release water onto any hot surfaces. The surface tension of the draining water is lowered and the cooling and wetting effect of the draining water penetrates any Class A combustibles more rapidly than water. This cools the burning material to below its ignition temperature.

INSTALLATION

The installation of the Hi-Ex Generator system components should be located and arranged so that any recharging, inspection, testing or general maintenance will cause a minimum disruption to the fire protection system. The Hi-Ex generators may be installed in either a vertical or a horizontal position.

When mounting the generator in a fixed location, care should be taken so as not to distort the cylinder section of the generator housing as this could interfere with the rotation of the fan/motor assembly. The generator should be supported from the bottom not the top and both the front and the rear. It is imperative that the generator be firmly braced to ensure there is no movement when the system is in operation.

PIPING MATERIALS

Stainless steel 304, 316, brass and schedule 40 black steel pipe are suitable for use with foam concentrate. Carbon steel pipe is not recommended for use with foam concentrate unless the pipe is kept flooded at all times. Stainless steel pipe is suitable for use with the foam concentrates at all times. Galvanized pipe cannot be used with foam concentrate. Galvanized pipe is suitable for use with foam solution only.

It is recommended that where threaded pipe joints are in contact with the foam concentrate or the foam solution, a quality Teflon TM based pipe joining compound and a quality Teflon TM tape in accordance with MIL-T-27730 are both used to ensure leak tight screwed fittings.

DESIGN INFORMATION

TOTAL FLOODING SYSTEMS

A total flood system is a fixed foam fire protection system consisting of the Hi-Ex generator(s), proportioning system, foam concentrate, water supply and necessary interconnecting piping. This type system is designed to discharge the expanded foam into an enclosed space or around the hazard. The total flood system is suitable for use where there is a permanent enclosure around the hazard that is capable of holding the required amount of foam for the designed duration.

For adequate protection there should be sufficient foam concentrate to allow the system a discharge rate sufficient to cover the hazard to an effective depth before any unacceptable damage occurs.

The minimum total depth of foam is to be not less than 1.1 times the height of the highest hazard being protected but in no case can it be less than 2 ft. above that hazard.

Submergence time for Hi-Ex foam varies with the type of building construction and whether the building does or does not have a sprinkler system.

Fig. 25 provides maximum submergence times in minutes for high expansion foam measured from the start of foam discharge. The chart does not include submergence times when used on water miscible/polar solvent type fuels or flammable liquids having a boiling point less than 100F (38C). These products may require higher application rates. Check with the engineering department at Buckeye for the Application guidelines. When used in tire storage areas, the submergence time shown reflects the area also having sprinkler protection. When certain combustible products are stored 15 feet or higher, fire spread may still be rapid and the discharge times in the submergence chart may not be suitable. A faster submergence time may be more appropriate.

The foam discharge rate is to be sufficient to satisfy the foam depth requirements and submergence times allowing compensation for normal foam shrinkage, foam leakage and breakdown effects of any sprinkler discharge.

The factor for compensation for normal foam shrinkage is 1.15.

The factor for compensation for loss of foam due to leakage around doors, windows and through unclosable openings is determined by the design engineer after proper evaluation of the structure. This factor cannot be less than 1 .0. Depending on foam expansion ratio, sprinkler operation and foam depth, this factor may be as high as 1.2 for a building with all openings normally closed.

The factor (Rs) for compensation of breakdown by sprinkler discharge is determined by the following formula or by test.

Rs = S x Q where:

S = Foam breakdown in cfm per gpm of sprinkler discharge. S is to be 10 cfm/gpm (0.748 cu m/min./ L/min.)

Q = Estimated total discharge from maximum number of sprinklers expected to operate in gpm (L/min.)

The following is the formula for calculating the minimum rate of foam discharge or total generator capacity allowing for compensation of normal foam shrinkage, foam leakage and breakdown effects of sprinkler discharge.

R=(V/T + Rs) x Cn x Cl where:
R=rate of discharge - cfm (cubic meters per min.)
V= submergence volume - cubic feet (M 3)
T=submergence time - minutes
Rs=rate of foam breakdown by sprinklers - cfm (M3/min.)
Cn=compensation for normal foam shrinkage
Cl=compensation for leakage

All openings such as doorways and windows below the design filling depth shall close automatically before or during foam discharge when the system is activated.

Discharge duration: There shall be sufficient high expansion foam concentrate and water to allow continuous operation of the system at the design density for 25 minutes OR generate 4 times the submergence volume.

The following is a typical High Expansion Foam System for an unsprinkled building.

Building - Light steel, not sprinkled, 100 ft. x 30 ft. x 1Oft.

Products Stored - Low density combustibles 7 ft. in height.

Cubic area to be protected -100 x 30 x 9 (2 ft. above height of combustibles) =27,000 cu. ft.

Fill Time - Per NFPA 11A, 3 min.

Formula for system without sprinklers

R=(V/T) x Cn x Cl

V=27,000 cubic feet

T = 3 minutes

Cn=1.15

Cl=1.1 (Slight leakage)

R=(9,000) X 1.15 X 1.1=11,385 cfm

11,385 cfm is required for the above building.

EQUIPMENT LIST

1 x High Expansion Foam Generator.
12,000 CFM/59 psi/170 gpm

1 x 3" Between flange style, Ratio Controller, Flow range 70-750 gpm.

1 x 50 Gallon vertical style bladder tank.
(170 gpm x 0.02 - 3.4 gpm of High expansion foam concentrate (2% mix ratio) x 15 min. = 51 gallons of foam concentrate)

55 x Gallons High expansion foam concentrate

(51 gallons system fill, 4 gallons system test.)

Plus miscellaneous swing check and ball valves.

LOCAL APPLICATION SYSTEM

This type of system consists of a fixed foam generating device complete with the necessary piping and foam concentrate proportioning equipment. The system is designed to protect a specific piece of equipment or discharge directly onto a potential hazard area. Local application systems can be used to protect hazards located indoor, outdoor or in partly sheltered areas. When used outdoors or in partly sheltered areas, provisions should be made to compensate for the effects of wind or other climatic conditions.

FIGURE25

MAXIMUM SUBMERGENCE TIME (MINUTES) FOR HIGH EXPANSION FOAM MEASURED FROM START OF ACTUAL FOAM DISCHARGE

Hazard	Light or Unprotected Steel Construction		Heavy or Protected or Fire-Resistive Construction	
	Sprinklered	Not Sprinklered	Sprinklered	Not Sprinklered
Flammable liquids [flash points below 100°F (38°C)] having a vapor pressure not exceeding 40 psia (276 kPa)**	3	2	5	3
Combustible liquids [flash points of 100°F (38°C) and above]**	4	3	5	3
Low density combustibles (i.e., foam rubber, foam plastics, rolled tissue, or crepe paper)	4	3	6	4
High density combustibles (i.e., rolled paper kraft or coated banded)	7	5	8	6
High density combustibles (i.e., rolled paper kraft or coated unbanded)	5	4	6	5
Rubber tires	7	5	8	6
Combustibles in cartons, bags, fiber drums	7	5	8	6