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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
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THE USE OF FOAM-MAKING EQUIPMENT AGAINST BACK-PRESSURES

by

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Summary

This note discusses the possible use of standard foam-making equipment against the back pressure of pipe-lines or heads of flammable liquids.

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Introduction

In areas where there is appreciable risk of fires in oil storage tanks or in other situations where it may be necessary to pump foam against the back-pressure of a head of liquid or foam, the fire brigade will generally carry equipment suitable for this purpose, e.g. the in-line foam generator.

In other areas where such risks rarely arise the brigade may only be provided with foam-making branchpipes, which are not designed to pump foam against a pressure head, but to provide the maximum efflux velocity.

This note discusses the possible use of such foam-making equipment against back-pressures.

Foam-making branchpipes

The foam-making branchpipe is primarily designed for projecting foam made at the end of the hose line, and it does this by providing the maximum possible efflux velocity. It is not recommended for use against even small back-pressures.

Tests[1] carried out at the Fawley oil refinery by the Hampshire Fire Brigade have demonstrated the limitations of this type of equipment. A 100 gal/min. branchpipe, operated at 150 lb/in^2, was connected to a length of 6 in pipe having a 50 ft horisontal run followed by a 55 ft riser. Very little foam was delivered from the end of the pipe and there was considerable back flow through the air ports. These conditions are estimated to give a back pressure of only 6 to 8 lb/in^2.

It is evident that such equipment could only operate against very small heads. It would be important to ensure that the pipeline was of adequate size and that any hose used was free of kinks.

In-line foam generators

This type of generator is designed to be used at or near the pump and to deliver the foam through hose or pipelines. It is usually operated at a water pressure of 150 lb/in^2 and will function with a back pressure of up to 15 to 25 lb/in^2 according to the size of generator. Under normal operating conditions, a foam expansion of 6 to 7 is obtained, but increasing the back pressure will appreciably reduce this. In the case of a 55 to 60 gal/min. generator a 13 to 15 lb/in^2 back pressure will give an expansion of 4 to 3. However, foam expansion is of no great importance in itself as the efficiency of a foam is, in most applications, dependent upon the water rate of application, so that the volume of foam production cannot be used as a measure of the performance of an appliance. A very low expansion may result in a somewhat unstable foam, but the foam produced under the conditions given above would be suitable for normal applications.

A 120 gal/min. in-line foam generator performed satisfactorily at the Fawley oil refinery when used under the same conditions that had caused the ordinary branchpipe to fail.

Table 1 gives some indication of the performance of generators of this type and the pressure loss likely to be experienced when delivering through pipelines of the recommended size. Up to 400 ft of delivery line can be used or perhaps more with the larger type. This Table also gives the loss through long sweep elbows and standard elbows as the equivalent length of straight run of pipe.

If the expansion of the foam is taken as 4 under average back pressure conditions, there would be about 1 lb/in^2 to be overcome for 10 ft head of foam.

The pumping of foam

It has been demonstrated by the Joint Fire Research Organization[2] and other bodies[3] that further foam pressure can be obtained by connecting the in-line generator to the suction eye of a centrifugal pump. If the pump speed and controls are adjusted to give a back pressure of 12 to 14 lb/in^2 at the generator and a positive pressure of from 50 to 70 lb/in^2 in the pump, a foam expansion of $3\frac{1}{2}$ to 4 will be obtained. A stable but fluid foam is produced and there is adequate pressure available to cover the losses likely to be encountered in any situation. Under these conditions the fluid density inside the pump will be about $\frac{1}{2}$ and the normal pump cooling system will function with this foam as a coolant.

Foam produced by this method can also be used for base injection into petrol storage tanks with suitable inlet conditions[4].

Conclusions

The possibilities of using foam-making branchpipes even under very small heads is very limited and should only be considered as a last resort when no other more suitable equipment is available.

In-line generators are the more suitable appliance for use where heads are involved and the pressures available can be further improved when necessary by using the generator in conjunction with a centrifugal pump. The relative size of in-line generator and centrifugal pump should be chosen to give a back-pressure of about 12-15 lb/in^2 on the generator.

The fact that use of foam generators against a head can lower the volume of foam produced is generally of no great importance. The use of the centrifugal pump can improve the foam stability with little or no increase on foam stiffness, for modern low-viscosity foam compounds.

References

(1) Fire Protection Review, April 1959.

(2) FRENCH, R. J. and HINKLEY, P. L. The production of foam for injection at the base of petrol tanks. Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organization, F.R. Note No. 271 Sept., 1956.

(3) The Times, February 16th, 1961. "Fire", April 1961.

(4) NASH, P., HIRD, D. and FRENCH, R. J. The base injection of foam into petrol storage tanks - large scale tests at I.C.I. Ltd., Billingham. Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organization F.R. Note No.379, May, 1959.

Other references

(5) "The mechanical properties of foam and the flow of foam through pipes". PENNERY, W. G. and BLACKMAN, M. Ministry of Home Security, R.E.N. 282 dated October 1943.

(6) "Estimation of pressure drop for foams flowing in closed systems". SOBOLENSKI, E. W. and GROVE, C. S. Syracuse University Research Institute. Report No. 11 on Projects O.N.R. 248-04 etc.

TABLE 1

Size of in-line generator gal/min	Normal size of delivery pipe in.	Maximum back pressure lb/in^2	Pressure drop through 100 ft of delivery pipe lb/in^2	Equivalent length of pipe for long sweep bend ft	Equivalent length of pipe for standard elbow ft	Back-pressure for 10 ft head of foam (approx) lb/in^2
55 - 60	$2\frac{1}{2}$ - 3	15	$2\frac{1}{2}$ - 1	3	6	1
120 - 125	3 - 4	20	3 - 1	3 - 4	6 - 8	1
240 - 250	4 - 6	25	3 - $\frac{1}{2}$	4 - 6	8 - 12	1
350	6 - 8	25	2 - $\frac{1}{2}$	6 - 8	12 - 18	1