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Straight Streams Versus Fog

J. J. Amyot

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Article abstract

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Il y a à l'usage des appareils lance-brume une assez forte résistance dans les grandes villes, où l'on est, cependant, mieux outillé généralement que dans les petites.

C'est à la démonstration de ces faits que s'attache notre collaborateur dans l'étude technique que nous reproduisons ici. Nous lui laissons la parole. – A.

Straight Streams Versus Fog

par

J. J. AMYOT,

*Chief Engineer, Municipal Fire Protection Department,
Canadian Underwriters' Association*

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Three elements are essential for combustion, i.e. a burning material, oxygen and heat. All three of them have to be present simultaneously before combustion can occur. The main object of fire prevention is to prevent the combination of the three elements. In the majority of cases the tactic employed is to attack the heat factor.

Heat is essentially composed of two elements which are entirely independent from one another. The intensity of heat is measured in degree and is what we are commonly referring to as its temperature. The other factor is the quantity of heat and that quantity is measured in *b.t.u.* — *British Thermal Units* —. A *b.t.u.* is the quantity of heat required to bring about an increase in temperature of one pound of pure water of one Fahrenheit Degree.

The flame of a single match has a temperature sufficient to ignite most of the common materials but the quantity of

heat supplied is small. If a bunch of matches is lighted, the flame temperature remains the same but the quantity of heat supplied is much larger.

Before combustion can occur, a burning material has to be heated up to a point where combustible gases are produced. The point at which these gases sustained self-combustion is known as the ignition temperature of this material. Ordinary combustible materials have ignition temperature ranging between 400° F. and 1000° F. It is disclosed by tests that ignition temperatures vary in different materials and that ignition temperature of individual materials may vary depending upon the size of the particles, duration of heat application and other technical factors. Practically all common burning materials have ignition temperatures below the temperature of a match flame, or a burning cigarette. Combustion of ordinary materials such as wood when burned with an ample supply of oxygen produces gases which are relatively harmless unless they deplete the normal oxygen supply in the air or raise the air temperature to a degree so as to make it unsafe for breathing. When carbon or materials containing carbon burn in a restricted air supply carbon monoxide is formed — this is an explosive and toxic gas.

It is the usual impression that an open flame or a spark is necessary to produce ignition. This is not so and a simple example will prove it. The soldering iron heated to a temperature of 600 to 700° F. still maintains a dark colour — and obviously there is no flame to the soldering iron but still the heat is sufficient in intensity to ignite paper, shavings, etc.

Heat is transferred from one material to another by one or more of the three methods which are described as conduction, radiation or convection. Conduction is the transfer of heat from one object to another by actual contact. A steam pipe passing through a wood partition or other construction transfers its heat by actual contact. Radiation is the transfer of heat by direct rays that may cover considerable distances. The heat of the sun reaches the earth by radiation. The transfer of heat by convection is the method by which liquids and gases are heated. The molecules which are in contact with the heat absorb it and become lighter, therefore they rise and are replaced with colder molecules which are heavier. This process continues as long as the heat is applied. Propagation of fires is mainly by this method. The air in contact with the burning materials absorbs some of the heat. The hot molecules rise to the ceiling and give up their heat to any colder objects with which they become in contact. The temperature of the ceiling and of the other objects rises and may reach temperatures of up to 1500° F.

WATER

Water at its normal stage is a liquid which solidifies at 32° F. and vaporizes at 212° F. Steam vapour is a colourless gas which becomes white only when condensation occurs. If you observe a steam whistle in action, the jet of steam coming out of it is invisible and it is only a short distance above the opening that the whitish colour appears. At this point condensation has begun and the white gas is a mixture of water and gas.

A gallon of water weighs 10 pounds. To increase its temperature one degree 10 b.t.u. are required. To raise the temperature of a gallon of water from 62 to 212° F., 1500 b.t.u. are required. As soon as water has reached the temperature of 212° F. vaporization starts, but a very large quantity of heat is required to change the liquid into a gas or vapor. This quantity of heat is known as the entropy and for a gallon of water it equals 9,704 b.t.u. The sole fact of vaporizing water requires about 6.5 times more heat than to increase its temperature from 62 to 212°. This is a very important factor and I will deal with it at length later.

Water in a gaseous form or steam occupies a volume of about 1600 times greater than at its liquid state. A single cubic inch of water once vaporized forms about six gallons of steam. A gallon of water vaporized occupies a volume of about 260 cubic feet or four gallons of water vaporized are sufficient to fill completely with steam a room 12 feet by 10 feet in area by 8 feet in height. This is another factor which could be used advantageously to displace smoke and hot gases and to replace them with another gas which is not toxic, free from oxygen and having a temperature of 212° F. which is considerably below the ignition temperature of most of the common burning materials.

Now that we have reviewed the cooling capacity of water, it might be of interest to know the quantity of heat given by some of the common combustible materials. One gallon of fuel oil contains 136,000 to 152,000 b.t.u., or enough heat to vaporize 12 to 14 gallons of water. One ton of coal could vaporize about 2,700 gallons of water. One thousand feet (Board measure) of lumber, supplies enough heat to vaporize about 1,600 gallons of water. The lumber is measured one inch in thickness but in an actual fire this depth is not all involved at once. If we assume that it is burning only a ¼-inch deep at the time, one thousand feet board measure will represent an area of 4,000 square feet in flames at the same time.

As it has been seen previously, the principal value of water in extinguishing fires is it cooling effect. Cooling is obtained largely by absorbing heat from the burning material, and from the hot gases contained in the rooms where fire is going on. The maximum cooling effect of water has been obtained when it has been converted into steam or vapour. The mass of water that actually contacts the burning material and the hot gases produced is what really counts. Quantity of water and ability to reduce the temperature rapidly are two main factors in combating any large fires. The most effective fire fighting method will be the one presenting the maximum combination of these two factors.

Solid streams are mainly effective when they may be directed at the seat of the fires, but how can this be done when it is impossible to enter into the burning buildings ? Sometimes, 5, 10 or 15 streams or more are being used, water cascading in torrents from the stairways, streets flooded and yet several hours are needed to bring fire under control. Whilst all this quantity of water was being applied to the fire, it had obviously very little effect on the fire. In most cases, water discharging from a burning building is cold to the touch proving that it has absorbed very little or no heat. Control or extinguishment of these fires was attained when roof and floors were collapsing and then water was running on the burning materials, or when the fire was dying out by itself due to the lack of combustible materials. When the brick walls of a building are standing up after a fire and when within the walls there is hardly enough combustible material left to fill up the area to the first floor level, it may be assumed that the fire went out by itself and that fire fighting operations had very little effect on the outcome. Due to the heat transfer by convection, hot gases are rising to the ceiling level and to upper floors by vertical openings, the temperature of these gases is very high and may reach the temperature of 1500° F. If you try to cool gases with solid streams, these offer a very small surface of contact which may range from a few inches in diameter for hand streams to a few feet in diameter for large streams appliances or deluge sets. Streams, upon striking an obstacle drop on the floors where the amount of heat is at a minimum. From personal observations at fires, I assume that on large fires where several streams are used, the effectiveness of solid streams ranges from 5 to 10% only.

A lot of equipment and manpower is required to fight fires under the solid stream method and the results obtained

are very poor.

The use of water in the fog pattern originated before World War No. 2, but it was then designed and used mainly to replace first-aid appliances, to fight oil fires or for electrical fires.

During the war, extensive research on fog were made and 1½ and 2½ unit fog nozzles were popularized. Since the end of the war, extensive tests have been made in the United States at several locations and now the experimenting stage is over and fog streams have proven their ability many times over. They have been adopted by several fire departments.

Fog streams present the advantage of offering a very large surface of contact with the hot gases or the flames produced by the burning materials. This increase area of contact and the fact that water is divided into very fine particles assures a maximum cooling effect because water is vaporized. We have seen previously that to vaporize water it takes 6.5 times more heat than to heat it up from 62 to 212° F. Furthermore, the stream produced also served for the evacuation of the hot gases and for the elimination of oxygen.

In Canada and the United States, most of the large cities are still using the solid stream method. They were probably the first municipalities to buy fog equipment, but this equipment is considered as auxiliary and very seldom used. The chiefs of the smaller towns have responded later but with much more enthusiasm. Equipment bought has been placed in service and used extensively. In these towns, sometimes the water supply, manpower and equipment are below requirements, yet the results obtained with fog are wonderful and every new experience has proven to the chief that he was on the right track. Fires that used to develop rapidly beyond control are now being extinguished rapidly and the number of requests for help to nearly towns has been reduced considerably. A fire department equipped with an aerial ladder can convert this piece of apparatus into a most effective fire fighting apparatus, if fog nozzles are used in place of solid streams. The use of fog streams has proven that a great majority of well going fires are extinguished in minutes. Fires, that were too large to be handled by equipment responding to the first alarm, have been held in check whilst additional equipment was summoned because the normal spread of fire had been considerably retarded. Fog streams have been very useful in instances where lives were involved and the progress of the fire was halted whilst most of the brigade was engaged in rescue work. The big argument that chiefs using solid streams have against fog streams is that the reach is poor and that the quantity of water discharged is small. It is true that the reach of fog nozzles is less than that of solid streams, but on the other hand the cooling effect is very much greater and it allows the fire fighters to work at a much closer range. The cooling effect of fog streams rapidly diminishes the embanked heat stored at the ceiling levels thus reducing the intensity of the flames and very often permitting access to the burning areas. Fire department operating solid streams in aerial ladders do it at such a close distance that fog streams can be used to replace solid streams with the best advantage. As to the quantity of water discharged, fog streams are now available discharging from 500 to 1000 g.p.m. which quantity of water is equivalent to any solid streams.

Manufacturers of fog nozzles have made considerable progress since the early stages of the use of fog. To-day nozzles are available to replace all kind of solid streams.

Research are still being carried out and undoubtedly other important improvements will be found out.

Fog nozzles are divided into two different classes i.e. low pressure fog with working pressures ranging from 100 to 150 pounds per square inch and high pressure fog with pressures ranging from 600 to 8000 pounds per square inch. Pumps capable of creating such high pressures are of small capacities only. These high pressures are suitable for the indirect method of attack using a gun type nozzle.

Practically all manufacturers of fog nozzles are recommending a working pressure of 125 pounds. At this pressure 1½inch fog nozzles discharging from 40 to 100 gallons per minute are available. At the same working pressure 2½-inch nozzles are discharging from 100 to 1000 g.p.m. Some fog nozzles are of the fix type, others are of the adjustable type and may supply a stream ranging from solid to a 90° cone.

Firemen who are using fog, utilize different type of nozzles and all are satisfied. I guess the main factor is to study thoroughly the characteristics of the nozzles and to use them to their best advantage.

Every chief should have as many fog nozzles that he has solid streams now. 1½-inch fog nozzles of 100 g.p.m. capacity are suitable for 1½-inch leader lines. 2½-inch fog nozzles giving from 150 to 250 g.p.m. should be in service on hose wagons. Nozzles of 350 to 1,000 g.p.m. should be placed in service for large ground streams or on serial ladders.

In concluding, I believe the time has come to make a thorough study and to revise fire-fighting tactics. All nozzles in service should be of the fog type and solid stream nozzles should now be carried out in the tool compartments and held in reserve for very unusual conditions. Chiefs of the large cities possess aerial ladders and if they equip these appliances with large fog nozzles they will have an incomparable weapon to combat important fires.