Commercial Kitchen Fires

Greater awareness and wider attention needed

By James G. Gallup

RESTAURANT FIRE SUPPRESSION SYSTEMS will not suppress fryer fires properly if ABC-rated fire extinguishers are used before or during the activation of kitchen suppression systems. ABC-rated extinguishers can have a detrimental effect on the suppression of oil and grease fires in commercial kitchens. Although this fact has been known for decades, ABC-rated fire extinguishers continue to be used in commercial kitchens. These extinguishers should be replaced with Class K portable fire extinguishers.

Safety professionals who review or inspect commercial kitchens can help overcome this ongoing fire protection problem. To reveal the scope of the problem and recommended solutions, this article explores the configuration and operation of fixed fire suppression systems in the hoods and ducts of commercial cooking equipment; reviews the extinguishing mechanism for fixed systems as well as that of portable extinguishers; and explains how changes in equipment and cooking oils have changed fire suppression needs in today's commercial kitchens.

Kitchen Suppression Systems

A typical kitchen suppression system has three major components: a detection system, an activation and agent storage portion, and piping to distribute the agent to locations most likely to have a fire. These systems are often "pre-engineered," which means they can be installed to cover various configurations as long as maximum parameters are not exceeded. Pre-engineered systems do not require extensive calculations for flow rates and friction loss in piping.

Kitchen suppression systems are often uncomplicated, mechanically activated devices. Many require no electrical connections for operation. Fusible links are typically used as the detection system. These links are simply two metallic discs held together by a solder that melts at a specific temperature. They are located above the filters in a hood and duct system, and are connected to a control head by a steel cable. When a link operates due to a fire, the tension on the steel cable is eliminated and the control head activates.

Control head activation usually punctures a high-pressure nitrogen or carbon dioxide bottle. The nitrogen places pressure in an agent storage tank and the wet chemical agent is forced through piping to distribution nozzles located at the burning surface, above the filters, and in the duct (Photo 1). The control head also shuts off the sources of fuel, usually natural gas or electric power.

Fixed kitchen suppression systems typically cover all equipment where grease and oils are used or collected, such as deep fat fryers, griddles and ranges. These specific pieces of equipment are normally located under an exhaust hood that carries grease-laden vapors through a filter, into an exhaust duct and past a fan on the restaurant's roof. These fixed systems are automatically activated in a fire and have nozzles for surface fires as well as nozzles above the filters and in the ducts (Figure 1; Photo 2). The extinguishing medium is normally an aqueous wet chemical agent. Extinguishment is accomplished by forming a foam on top of the grease or oils. The ABC extinguishing agent severely reduces the wet chemical agent's ability to create a foaming action.

Extinguishing Mechanism

Dry chemicals and the more recent wet chemicals extinguish oil and grease fires by forming a foam on the top. This foaming is a hydrolysis process in the fats called saponification [FM(a);(b)]. The foam excludes oxygen during the time it takes the oils and greases to cool below the temperature at which they auto-ignite.

The groups of dry chemicals that produce saponification reactions are potassium bicarbonate and sodium bicarbonate [FM(a); (b)]. These chemicals react with common cooking oils and greases to form a soapy foam that floats to the top (Photo 3). The wet

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chemicals used are potassium carbonate or potassium acetate with water. The water content is between 40 percent and 60 percent. The wet chemicals saponify in a manner similar to the dry chemicals; however, the water in the mixture provides a cooling action that does not occur with dry chemicals.

Portable Fire Extinguishers

Portable fire extinguishers are rated for Class A hazards, which are ordinary combustibles such as wood and paper; Class B hazards such as flammable liquids; and Class C hazards for use on electrical equipment. Cooking oils are a special class of flammable liquid that traditionally had been best extinguished with a device rated for BC fires using sodium bicarbonate and potassium bicarbonate chemicals.

A special class of portable fire extinguisher can be rated for Class A, Class B and Class C fires. These use monoammonium phosphate. The Class A portion of the chemical works on ordinary combustibles because the powder melts during a fire exposure and sticks to ordinary combustibles. Oxygen is excluded by the melting and sticking process.

However, monoammonium phosphate has a detrimental effect on saponified cooking oils. If the ABC fire extinguisher is used prior to or during the operation of the kitchen suppression system, the saponification reaction is severely reduced. Photo 4 shows an ABC extinguisher that had a detrimental effect on a fire (investigated by the author). A minimal foam blanket occurred, which did not adequately exclude oxygen from the surface of the fire. As a result, the oils reflashed, as by that time during the fire the oils had reached auto-ignition temperature.

Background & History

NFPA recognized a common fire problem in kitchens in the early 1940s. In response, the group developed information on ventilation of restaurant-type cooking equipment in 1946 and created NFPA 91, Blower and Exhaust Systems. In 1955, the requirements were shifted to a new NFPA committee that was responsible for NFPA 96, Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment. By 1964, NFPA 96 required fixed suppression systems (NFPA 96). The fixed systems could be inert gas, dry chemical or water spray systems. By 1969, foam-water suppression systems were also permitted.

Dry chemical systems became the preferred choice in restaurants. These systems were relatively inexpensive and easy to install, required little storage space and were easy to maintain. They were self-contained and did not require an interface with other systems. In addition, the systems significantly reduced the damage caused by grease fires. Because of their effectiveness, most commercial kitchens at that time were equipped with automatic dry chemical systems. In fact, a restaurant owner could not obtain fire insurance without having such a system in place.

Unfortunately, dry chemicals have a downside from a kitchen operation standpoint. The powder in dry chemical suppression systems and dry chemical portable fire extinguishers is extremely messy; as a result, cleanup after a fire is extensive. In addition, food items become unusable. The melted monoammonium phosphate from an ABC extinguisher is even harder to clean up.

Information as far back as 1973 indicates that ABC chemicals reduce saponification. The 1973 edition of NFPA 96, Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment, states that acid-based (ABC) chemicals impede saponification (Stauffer). The 1976 FM Loss Prevention Data Sheet on Dry Chemical Systems states that multipurpose agents can prevent saponification [FM(a)].

In the early 1990s, deep fat fryers—a leading source of kitchen fires—became better insulated for energy efficiency reasons. These units minimized heat loss up to 25 percent and, therefore, cost less to operate (Gulati). This also meant that the fryers did not cool as quickly after fires, which meant that the saponified material on the surface of the oil had to last longer.

At the same time, oils used in deep frying changed from animal-based products to vegetable oil products. These new oils were introduced due to health concerns associated with animal-fat-based cooking oils, which have a higher percentage of saturated fats (Gulati). However, fires caused by vegetable-based products are more challenging to extinguish. What happens with vegetable oils is that the molecular links in the oils become shorter when heated to the auto-ignition temperature. At that point, the auto-ignition temperature decreases (Voelkert). As cooking oils age, the auto-ignition temperature also tends to decrease. In addition,

Kitchen Fire Problem

According to NFPA, 5,500 commercial cooking equipment fires occurred in the U.S. in 1999 (the most recent statistics available), causing total property damage of $25.3 million—an average of $4,600 per fire. From 1994 to 1998, an average of 4,700 commercial cooking equipment fires occurred, with an average property damage of $7,400. Deep fat fryers are the leading cause of commercial kitchen fires. NFPA reports that the number of commercial cooking equipment fires did drop 54 percent from 1980 to 1999.

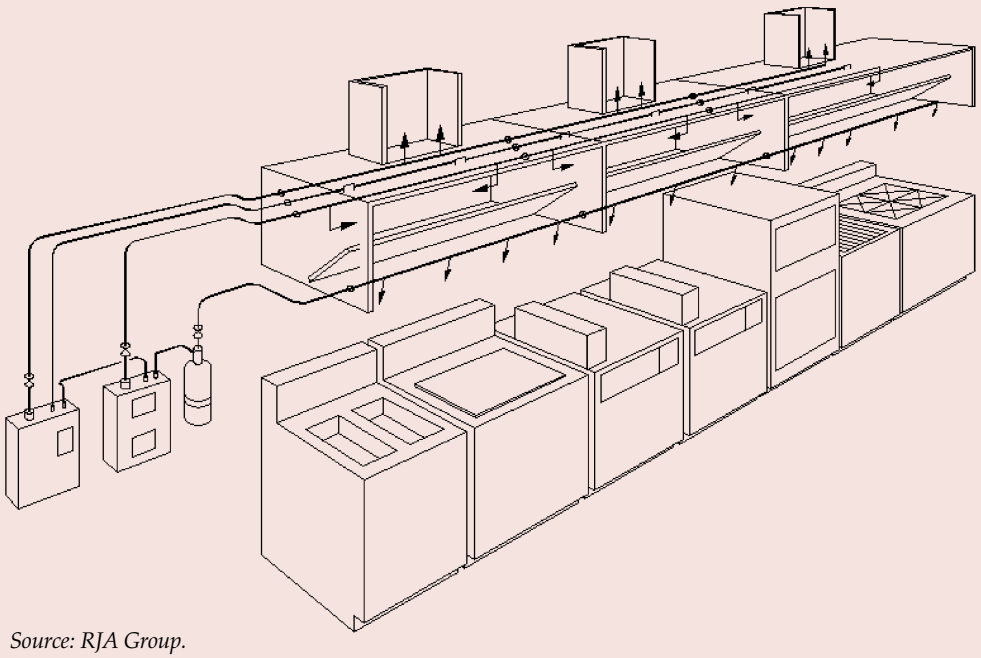
The author and colleagues have seen five to 10 fires per year in which the suppression system did not appear to have properly extinguished the fire. Resulting losses range from the tens of thousands to hundreds of thousands of dollars. Causes vary, but typically the improper use of ABC portable fire extinguishers is among them. Whether improper use of ABC portable fire extinguishers contributed to the extent of a fire, these devices are often the first portables available for use in most fires.

Photo 1: Ansul Automan mechanical release assembly.

PHOTO COURTESY ANSUL INC.

Figure 1

Multiple Tank System Over Appliances



Source: RJA Group.

Photo 2: Typical nozzles.

If, while inspecting a commercial kitchen, an SH&E professional finds ABC extinguishers, s/he should let the owner know that this device should be replaced with a Class K portable fire extinguisher. This recommendation also applies to kitchens in hospitals, schools and universities.

well-insulated fryers slow the cooling process.

As a result of these features, additional strain is placed on the saponified material, causing increased failures of hood and duct extinguishing systems. The saponified material breaks down before the oil temperature is reduced below the auto-ignition temperature. Consequently, the foam blanket breaks down and reflash occurs. Fire control is then either completed by automatic sprinklers in the kitchen or, more often, by the fire department.

The fire suppression system industry responded to these changes with "wet chemical" systems, which respond better to vegetable oils and better insulated fryers. Wet chemical systems became and remain the norm for new systems. Wet chemical portable fire extinguishers also became the recommended fire extinguisher for kitchen fires. Underwriters Laboratories Inc. (UL) classifies the wet chemical fire extinguisher as Class K (NFPA 10) (Photo 5). These devices provide more cooling than BC fire extinguishers and make cleanup easier.

Current Suppression Recommendations

The fire protection industry currently recognizes cooking media (oils) as a "special hazard" liquid. Fixed automatic wet chemical systems are the best extinguishing method for oil and grease fires. Class K portable extinguishers are recommended as a secondary (or backup) extinguishing method.

The automatic systems shut down the electric or gas heating sources, which initiates the cooling process. If the portable fire extinguisher is used prior to operation of the automatic system, the fire may be extinguished at the cooking surface but may have extended unnoticed into the duct above. Automatic system operation may be slowed or negated if a Class K device is used prior to activation of the automatic system.

Although most kitchens contain limited quantities of paper and other ordinary combustibles, significant quantities of such combustibles are typically stored just outside the kitchen. For fires involving these materials, a portable fire extinguisher rated at 4A 40BC should be used. This extinguisher should be located so that it will not be the first device used on an oil or grease fire.

Fixed automatic hood and duct suppression systems are tested by UL according to UL 300, Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas. Commercial cooking equipment is subjected to a fire lasting at least two minutes after auto-ignition before the automatic systems discharges. Complete extinguishment is required. Reflash in fryers must be prevented for a period of 20 minutes or until the oil temperature is reduced to at least 60°F below the auto-ignition temperature. If the automatic system passes this test, it will be listed provided it meets other UL criteria. Wet chemical systems are the only systems that will currently meet this criterion.

PHOTOS 2 AND 3 COURTESY ANSUL INC., PHOTOS 4, 5 AND 6 COURTESY RJA GROUP

Photo 3 (left): Saponified kitchen appliance. Dry chemicals and the more recent wet chemicals extinguish oil and grease fires by forming a foam on the top. This foaming is a hydrolysis process in the fats called saponification.

Photo 4 (below, left): ABC extinguisher used in a kitchen fire. Such extinguishers can have a detrimental effect on the suppression of oil and grease fires in commercial kitchens.

Photo 5 (below, middle): Class K extinguisher. Fixed automatic wet chemical systems are the best extinguishing method for oil and grease fires. Class K portable extinguishers are recommended as a secondary (or backup) extinguishing method.

Photo 6 (below): ABC extinguisher found in a commercial kitchen. Employee training should stress the negative impact of using an ABC portable on oil and grease fires.

Other Measures

Equipment Concerns

Heated cooking equipment will continue to fail and cause fires on occasion. Restaurant owners can minimize the potential for these fires by properly repairing any faulty equipment. The extent of fire spread can be reduced by regular and frequent cleaning of grease and oil accumulations in the cooking equipment and in the hood, filter and duct systems. Automatic sprinklers will also limit total fire spread.

Worker Training

Once proper portable fire extinguishers are installed, restaurant workers should be trained in the operation of the fixed suppression system as well as of the portable extinguishers. The reliability and expectations of the fixed system should be stressed. Workers must also understand the differences between ABC portables and Class K portables. The exact location of each type of device should be reviewed as well. Training should stress the negative impact of using an ABC portable on oil and grease fires, and proper use of a Class K portable after the kitchen system has activated should be periodically reviewed as well.

Call to Action

If, while inspecting a commercial kitchen, an SH&E professional finds ABC extinguishers (Photo 6), s/he should let the owner know that this device should be replaced with a Class K portable fire extinguisher. This recommendation also applies to kitchens in hospitals, schools and universities. ■

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