The Hybrid Advantage: Effective Protection for Restaurant Cooking Equipment

The Evolution of Agent-Plus-Water Systems

Johnson Controls

Introduction

In the late 1950s and early 1960s, concerns in the fire protection industry escalated with the increasing amount of restaurant damage due to grease fires in hoods, ducts and cooking appliances. As restaurant cooking equipment and services evolved, so, too, did the need for far greater performance in fire protection systems. First generation systems in the early 1960s featured single dry chemical suppressing agents, which lacked the increased cooling power of second generation single wet chemical suppressing agents developed two decades later.

Those systems represented state-of-the-art fire protection for restaurants until January 1998 when Johnson Controls, formerly Tyco Fire Protection Products, received an Underwriters Laboratories Inc. (UL) listing for the ANSUL® PIRANHA Restaurant Fire Suppression System with its superior water-plus-agent technology. Almost 20 years later, this third generation, pre-engineered, automatic fire suppression system still provides the leading premium protection solution for commercial and institutional restaurant cooking appliances, exhaust hoods and ducts.

The PIRANHA fire suppression system utilizes the best attributes of both PRX Liquid Fire Suppressant and water. This hybrid technology makes the PIRANHA system up to 15 times faster than conventional single-agent systems in cooling down cooking oils and uses 60 percent less chemical agent. The system requires fewer agent storage tanks than conventional single-agent systems, and various tank sizes can be configured to expand fire suppression system coverage. When actuated, the hybrid system discharges a fixed amount of proprietary wet chemical agent followed automatically by a continuous discharge of water through the same pipe network and nozzles.

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THE FIRE PROTECTION CHALLENGE

There is widespread agreement in the fire protection industry that the most difficult cooking appliance to protect is the commercial deep-fat fryer. There are four reasons to support this conclusion:

1. No other cooking appliance approaches the fuel loading of a commercial fryer, which can hold more cooking grease than any other appliance. When the grease is accidentally overheated to an ignition point, the fryer stores an enormous amount of heat which must be released after flame extinguishment in order to secure the hot grease against reflash.

2. Compared to other appliances with large fuel surfaces, such as griddles, fryers have relatively small grease surface areas. This limits the amount of agent that can be discharged onto the burning fryer. It also results in smaller fire areas, which means longer preburn times and higher peak grease temperatures before the fire is detected and the system is actuated.

3. Modern, energy-efficient fryers are designed to retain more heat to minimize fuel costs. This retards the release of heat from the hot grease in the event of a fire.

4. The trend from animal to vegetable cooking shortenings has raised autoignition temperatures resulting in higher peak temperatures before the fire suppression system is actuated.

In a typical fire scenario with the fryer protected by a single-agent wet chemical system, a malfunctioning vat will heat the grease until it reaches the autoignition temperature of 680 °F to 700 °F (360 °C to 371 °C) for new shortening. The overheating fryer will continue to heat the grease until the fire is detected and the fire suppression system is actuated, at which time the wet chemical discharge begins and the fryer heat source is shut off by the fire suppression system.

During the preburn period between autoignition and system actuation, the burning grease may reach temperatures as high as 760 °F (404 °C) before the agent is discharged. Upon discharge, the wet chemical will rapidly extinguish the flames (typically 4 to 6 seconds) and begin to cool down the hot grease while also reacting with the grease to form a temporary, air-excluding foam blanket on the surface of the grease.

By the end of agent discharge, the hot grease will have cooled 40-60 °F (22-33 °C) below the peak (start of discharge) temperature and the vat above the grease will be full of foam. Although the grease may be close to the original autoignition temperature at the end of discharge, tests have shown the critical reflash temperature may be as much as 60 °F (33 °C) below the autoignition temperature.

Herein lies the fire protection challenge: If the temporary foam blanket breaks down from the heat before the grease cools below its autoignition temperature, the grease will be re-exposed to air and will reflash. Although the foam blanket is excluding air from the grease, it is also an effective insulator that retards the release of stored heat from the top of the vat.

UL Standard 300: Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment fryer fire test protocol recognizes this retarding effect by requiring that the grease cool for 20 minutes or 60 °F (33 °C) below the autoignition temperature (whichever takes longer) without the fire reflashing.

Since the grease surface area and the freeboard between the top of the vat and the surface of the grease limit the volume of the foam blanket, generating more foam by discharging additional wet chemical is usually ineffective. Therefore, the quality rather than the quantity of the temporary foam blanket becomes the more important factor.

Wet chemical agent alone must perform two crucial roles in suppressing fryer fires. First, it must rapidly extinguish the grease fire (a relatively easy task); and second, it must secure the hot grease until it cools below its minimum reflash temperature (a more difficult task).

THE HYBRID CONCEPT

In 1994, Johnson Controls, formerly Tyco Fire Protection Products conducted a series of fryer fire suppression experiments using the UL 300 test protocol to compare the fire suppression performance of its UL listed, single-agent wet chemical system against water discharged through a water sprinkler nozzle that was also UL listed for fryer fires.

Following the UL 300 test protocol the results demonstrated water alone did not extinguish the grease fire until the hot grease was cooled below its fire point, typically 4 to 6 minutes after the start of discharge. When compared to the 4 to 6 second fire extinguishment time for the ANSUL single wet chemical agent, the 4 to 6 minute delay was considered unacceptable since a fryer fire can spread to the hood and duct in that time frame.

It was also observed, that even though the flames continued to burn for several minutes under water discharge, the grease temperatures dropped at a much higher rate compared to when the grease was blanketed by insulating foam following a single-agent wet chemical discharge.

Testing revealed the hybrid approach needed only 38% of the wet chemical required by single-agent wet chemical systems.

These observations raised the question: What would happen if wet chemical agent was discharged just long enough to suppress the fire, then a water discharge for rapid cooling was applied through the same spray nozzles?

Concept tests were conducted and the results exceeded expectations. Fryer fires were rapidly suppressed by the wet chemical discharge and the subsequent water discharge cooled the hot grease 60 °F (33 °C) below its autoignition temperature in less than three minutes, compared to the 20-minute cool-down period required by UL 300.

The dramatic difference in grease cool-down is shown on the chart in Figure 1, which compares the actual fryer fire suppression performance of the hybrid system versus a conventional single-agent wet chemical system when tested per UL 300 protocol using the same gas fryer. From these tests, the time to cool the grease from its peak (start of discharge) temperature down to a safe (no-reflash) threshold of 630 °F (332 °C) was 16.5 minutes for the conventional system compared to 2.3 minutes for the hybrid system.

Further testing revealed the hybrid approach required only 38% of the wet chemical as was required by the single-agent wet chemical system because the water now assumed the role of securing the hazard against reflash by rapidly cooling the hot fuel.

Based on the significant results of these experiments, a project was established to develop, test and UL list the optimum hybrid system. A new wet chemical agent was also developed supplementing the enhanced fire suppression and grease cooling capabilities of the system.

FRYER FIRE SUPPRESSION TESTS: HYBRID VS. CONVENTIONAL WET CHEMICAL SYSTEMS

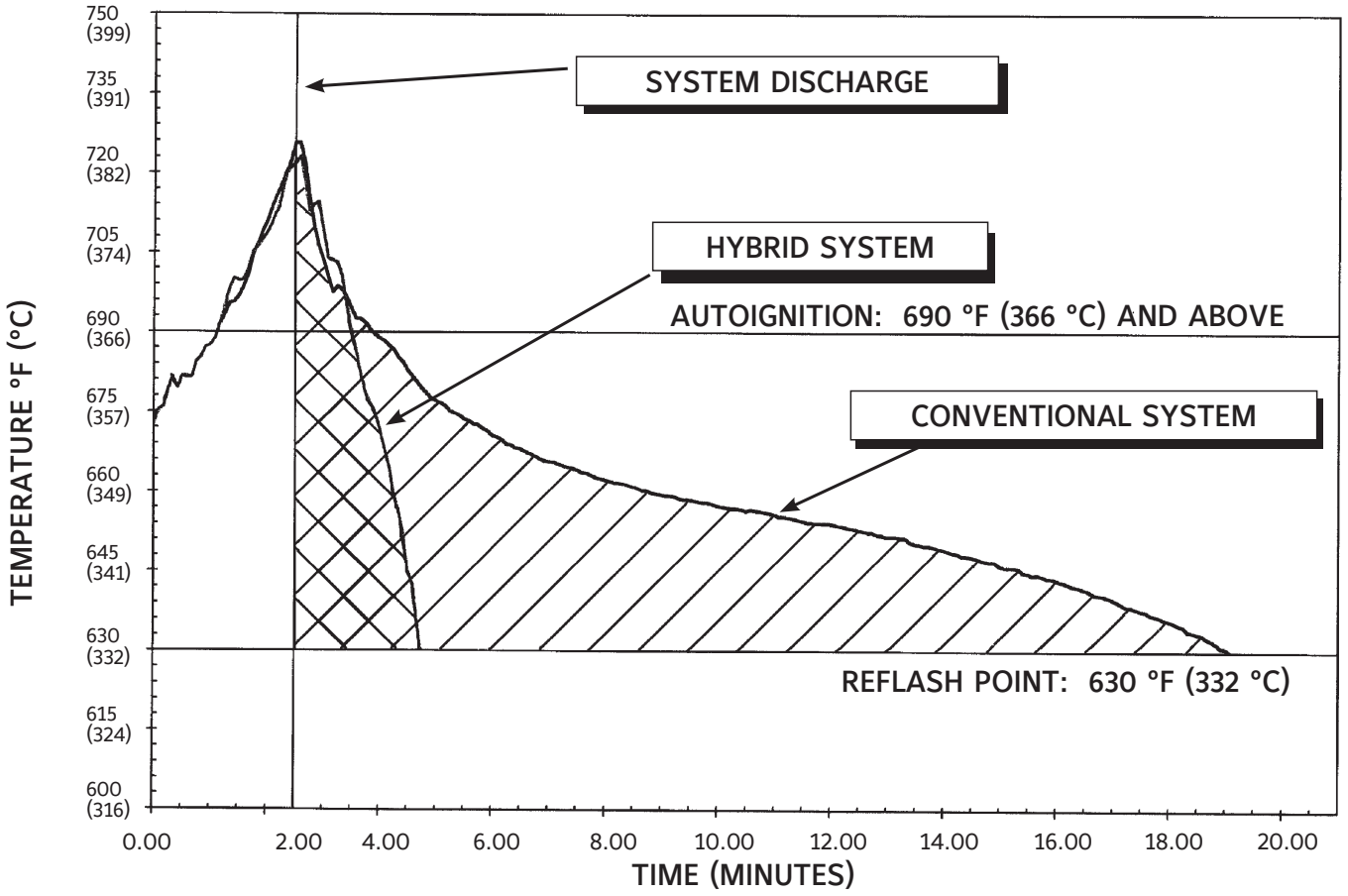

FIGURE 1
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WHY THE PIRANHA SYSTEM?

The PIRANHA hybrid system is inherently more proactive than single-agent wet chemical systems because the water discharge actively reduces the possibility of reflash in the event of hostile fires in restaurant applications (appliance surface, duct, and plenum) particularly cooking appliances such as fryers.

This agent-plus-water technology provides the following advantages over single-agent wet chemical systems:

System Performance: Cools hot grease up to 15 times faster than single-agent wet chemical systems because of the continuous discharge of water following the wet chemical discharge.

Agent Quantity: On average, 60% less wet chemical is required per hazard, which means less total chemical and fewer agent storage tanks are required per kitchen. Accordingly, the PIRANHA system becomes even more cost effective as the number of protected hazards increases.

Design Flexibility: The hybrid system promotes overlapping protection of cooking appliances from nozzles pre-installed in the exhaust hood at uniform spacing, regardless of the mix of appliances that are protected below the hood. Appliances can be moved and rearranged under the hood without compromising their protection. [Exception: some appliances such as upright broilers require specific nozzle placement and cannot be protected with overlapping nozzles.] In addition, only four styles of nozzles cover all appliances, exhaust hoods and ducts.

Patents: The PIRANHA water-assisted wet chemical restaurant fire suppression system has been issued two patents:

First, the PRX wet chemical agent developed specifically for the PIRANHA system.
Second, automatic cooling water discharge following wet chemical discharge.

New Nozzle Design: The performance-tested and proven nozzle design provides increased-height (out-of-view) nozzle installations complementing décor.

CODES AND STANDARDS

The PIRANHA hybrid wet agent system is designed and tested to meet the following codes, standards and recommended practices:

1. Underwriters Laboratories, Inc. (UL) Standard 300: *Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment.*

2. Underwriters Laboratory of Canada (ULC) Standard ORD-C1254.6: *Fire Testing of Restaurant Cooking Area Fire Extinguishing System Units.*

3. National Fire Protection Association (NFPA) Standard 17A: *Wet Chemical Extinguishing Systems.*

4. National Fire Protection Association (NFPA) Standard 96: *Ventilation Control and Fire Protection of Commercial Cooking Operations.*

5. American Society of Sanitary Engineers (ASSE) Standard 1001: *Cross Connection Protection Devices: Guidelines for Selection of the Proper Type of Backflow Preventor – Piped Applied Atmospheric Vacuum Breakers.*

6. International Association of Plumbing and Mechanical Officials (IAPMO): *Installation, Material and Property Standard PS 108-98 – Grease Fire Suppression Systems.*

INDEPENDENT TEST LABORATORY EVALUATIONS

The following independent test laboratories have evaluated the PIRANHA hybrid wet agent system or its components.

Springborn Laboratories, Inc.
640 North Elizabeth Street
Spencerville, Ohio 45887-0143

Stevens Institute of Technology
1 Castle Point Terrace
Hoboken, New Jersey 07030

University of Southern California Foundation
for Cross-Connection Control and Hydraulic Research
3716 South Hope Street
Los Angeles, California 90089-7700

UL Headquarters
333 Pfingsten Road
Northbrook, Illinois 60062-2096

Underwriters Laboratories of Canada
7 Underwriters Road
Toronto, Ontario, Canada M1R 3A9

NFPA STANDARDS

The PIRANHA hybrid wet agent system conforms to the standards set forth in NFPA 17A: Standard for Wet Chemical Extinguishing Systems, and in NFPA 96: Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations. The hybrid system is a pre-engineered system as defined in NFPA 17A with pre-determined flow rates, nozzle pressures, and quantities of wet chemical agent. The hazards protected by a pre-engineered system are to be specifically limited as to type and size by a testing laboratory based on actual fire tests, which is evidenced for the PIRANHA system by its UL listing as described below. NFPA 17A covers the system requirements, plans and acceptance tests, inspection, maintenance, and recharging; all of which correspond to the listings and design manual for the PIRANHA hybrid system.

The PIRANHA system also complies fully with NFPA 96, in particular Chapter 10 – Fire Extinguishing Equipment. This standard specifically references the use of systems which comply with NFPA 17A, and includes a separate section on protection of solid fuel cooking operations. The PIRANHA system has been thoroughly tested and listed for protection of solid fuel cooking appliances.

UNDERWRITERS LABORATORIES (UL) STANDARDS

UL Standard 300, Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment, is the governing document establishing fire test requirements for pre-engineered restaurant systems. It includes an extensive series of fire tests covering all types of cooking appliances, as well as the plenum and duct areas. UL 300 specifies that fires be extinguished and that reignition not occur. Conventional wet chemical systems need a considerable amount of suppressing agent to cool the appliance to prevent reignition. The PIRANHA system attacks fire using the knockdown and securing capabilities of PRX Liquid Fire Suppressant immediately followed by water, which quickly cools the cooking media and helps prevent reignition.

The original full implementation of UL 300 led to changes in the design of all conventional wet chemical systems to meet the more rigorous test requirements of the new standard. These changes made the average system larger and more complex, both to design and to install. Recent NFPA updates mandate all systems must be UL 300 compliant. The PIRANHA system is designed to simplify design and installation, and to reduce the required agent tanks. The system has been fully tested to the requirements of UL 300, and has been listed by UL in a category that acknowledges the unique technology of the hybrid concept: Water-Assisted Wet Chemical Extinguishing Systems.

BACKFLOW PREVENTION

In general, authorities having jurisdiction over cross-connection controls for water supplies follow national guidelines such as ASSE Cross Connection Control document, and model codes such as International Plumbing Code (IPC) and Uniform Plumbing Code (UPC).

Until recently, these guidelines and model codes currently reference only "direct connection" fire systems that require both backpressure and back siphonage protection. The PIRANHA system is an "indirect cross-connection" subject only to backflow potential due to back siphonage.

One model code group identified the need to recognize fire suppression systems that are of "indirect cross-connection" origin. Section 603.4.18.1 of the UPC (Uniform Plumbing Code) states: "...Potable water supplies to fire protection systems that are not normally under pressure shall be protected from backflow and shall meet the requirements of the appropriate standards." The PIRAHNA system comes complete with backflow protection that complies with this requirement and no additional backflow prevention is required. In jurisdictions not yet recognizing these UPC code modifications, the PIRANHA system still conforms with national guidelines for backflow prevention under the "degree of hazard" and "prevention for backflow" guidelines as would be applicable for any other water connected equipment.

Third party testing of the PIRANHA system has demonstrated compliance with the IAPMO PS 108-98 for Restaurant Fire Suppression Systems. Proper backflow protection is the purpose of this Standard. Tyco Fire Protection Products has received approval from IAPMO to utilize the UPC logo on all PIRANHA systems. University of Southern California Foundation for Cross-Connection Control and Hydraulic Research (USCFCCCHR) Report No. 99-001, includes additional backflow prevention testing during conditions of back siphonage and simultaneously back siphonage with backpressure indicating the PIRANHA system protected the water supply from backflow.

The PIRANHA system has an integral ASSE approved atmospheric vacuum breaker to prevent back siphonage (backflow induced by a drop in the water supply pressure). The PIRANHA system itself is unpressurized and is open to the atmosphere, thus eliminating the potential for backflow caused by backpressure.

The AWWA M14 document and USC Manual of Cross-Connection Control both classify potential backflow hazards as either a high hazard contaminant which is hazardous to human health, or a low hazard pollutant which is not hazardous to human health but would constitute a nuisance or be objectionable for odor, taste or appearance.

The ASSE approved atmospheric vacuum breaker used in the PIRANHA system is rated for protection against backflow of high hazard materials. However, PRX liquid fire suppressant used in the systems is, in fact, a low hazard material. Toxicology testing conducted by Springborn Laboratories, Inc. of Spencerville, Ohio, bear this out. They found the PRX liquid fire suppressant to have no negative effects on the test animals at dosages meeting the OSHA definition of toxic or hazardous.

The majority of state and local authorities recognize and accept either ASSE or UPC approved backflow prevention devices. The UPC logo on the PIRANHA system and the ASSE approved vacuum breaker demonstrates compliance to both ASSE and UPC requirements. The IAPMO PS and third party test reports for compliance to the PS and USCFCCCHR Report No. 99-001 are available from Johnson Controls if requested by an authority having jurisdiction.

SUMMARY

Today's booming food service industry serves millions of customers every year. Savvy restaurant owners acknowledge a lapse in kitchen safety can potentially put employees in danger as well as have harmful repercussions to their brands, especially given the power of customer word-of-mouth. The good news is restaurant owners and industry consultants are becoming more informed on the best fire suppression technologies available.

Over the last 50 years, Johnson Controls has continually conducted tests to determine the highly effective fire suppression technologies for the toughest cooking equipment fires. As a result, the ANSUL PIRANHA Restaurant Fire Suppression System was created to comply with rigorous codes and standards such as UL, ULC, NFPA 17A and NFPA 96. This white paper describes how this hybrid system has many advantages over single-agent wet chemical systems. As a result, many are choosing ANSUL PIRANHA Fire Suppression Systems to help protect people and property.

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