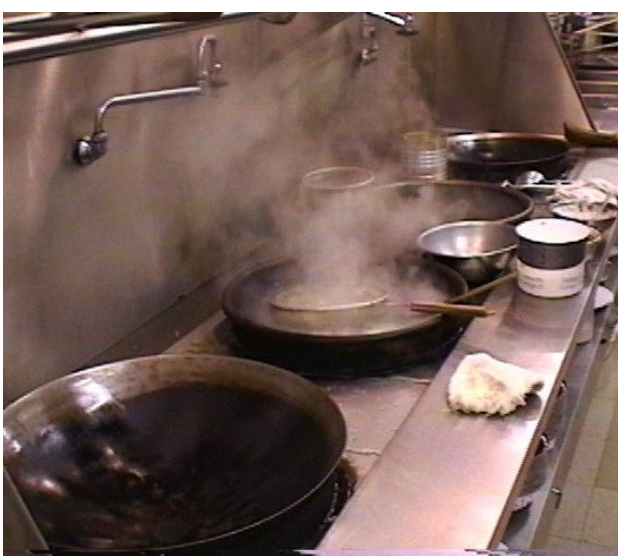
Chapter Five – Cooking Fuels



Cooking Fuels

Cooking Methods

Just a few decades ago our grandparents, and even some of our parents, had only a couple of heating methods for cooking food. A wide assortment of technological advances, along with imported cooking styles and ethnic diversity, have created an assortment of appliances and cooking methods.

Many of these new cooking methods in food preparation have increased the risk of fire in exhaust systems. There are a number of appliances, particularly broilers and deep fryers that, by virtue of their heating technique or mechanical operation, may cause an instant and uncontrollable flash of flame that could touch off an exhaust system fire.

A typical electric cooking application

Cooking Fuel Sources

The three primary sources of cooking energy are:

- **Gas** (natural gas or propane)
- **Electric** (assorted heating coils and elements)
- **Solid** (wood, charcoal, mesquite, pitch, etc.)

A typical gas cooking application

Gas

Fuel gases include natural gas, liquefied petroleum gas, liquefied petroleum gas-air mixtures, manufactured gases, and mixtures of these gases, plus gas-air mixtures within the flammable range, with the fuel gas or the flammable component of a mixture being a commercially distributed product.[1]

The fuel gases most commonly encountered in commercial kitchen fires are natural gas and commercial propane.

Natural Gas: Natural gas is a naturally occurring largely hydrocarbon gas product, often in association with crude petroleum. It accumulates in underground pockets and is recovered by drilling wells. There are no standards that specify its composition; natural gas is mostly methane, with lesser amounts of nitrogen, ethane, propane, and other traces. Natural gas is lighter than air. Its density is 0.59 to 0.719. Its ignition temperature is 482ºC to 632ºC (900ºF to 1170ºF).

Hardwood used in solid fuel cooking

[1] See *NFPA 921, 9.9 Investigating Fuel Gas Systems Incidents*

Commercial Propane: Also known as liquefied petroleum (LP) gas, propane is derived from the refining of petroleum. Propane gas is heavier than air, with a vapor density of 1.5. Its ignition temperature is similar to natural gas, 493ºC to 604ºC (920ºF to 1120ºF).

Natural Gas Systems: One difference between natural gas systems and propane systems is that natural gas is piped directly to the consumer's building, whereas propane is typically stored in tanks on site. The major difference between the two gases is their energy content. A cubic foot of natural gas will produce about 1000 Btus, whereas a cubic foot of LP gas will produce 2500 Btus.

Example of a Natural Gas cooking element

Natural gas and propane burn at temperatures in excess of 1871^{o}C (3400°F). Auto ignition temperatures of lard or vegetable cooking oils are in the order of 273 to 420^{o}C (523 to 788ºF), so the boiling and splattering of oils onto live flames can result in instant ignition.

Gas appliances can quickly start a fire through direct contact of the flame with flammable or combustible food products. This usually occurs with open flames, such as gas range tops or broilers, although instances of combustible materials being drawn into a protected flame (or pilot light) can also occur.[2]

The installation and maintenance of fuel gas systems is covered in *NFPA 54, National Fuel Gas Code.*

Gas Temperature Controls

Appliance temperature controls may be fixed or interactive. An example of a fixed control is the burner control knob on range tops. Interactive controls generally consist of a reactive device, which undergoes some change in response to heat. This change then causes a switch to open or close. Examples of interactive controls are solenoids, relays and thermocouples such as those found in deep fat fryers.

The appliance must be listed or acceptable to the AHJ. They must also be installed in accordance with their listing. Appliances under the control of a thermostat are generally required to incorporate a backup thermostat in case the main thermostat fails.[3]

Certain safety devices are required on all gas appliances. Because of the danger of gas escaping un-ignited from a burner, gas appliances generally incorporate a pilot verification system. This system does not release gas to the main burner until the presence of an ignition source, or pilot is verified. This is generally accomplished with a thermocouple. A thermocouple is a device consisting of two different metal alloys that generate an electrical current when heated. (They convert heat energy to electrical energy). This electrical energy is used to power an electromagnet, which holds open a spring-loaded valve. When the pilot is not ignited, the electromagnet can no longer hold the valve open and the gas is stopped.

Malfunctioning Appliances and Controls. The malfunction and leaking of gas appliances or gas utilization controls, such as valves, regulators and meters, can also produce fugitive, or un-ignited, gas. Fittings and piping junctions within appliances can be sources of leakage. Shutoff valves may leak fugitive gas through the packing materials that are designed to seal the valve bodies from the activation levers. Valves also may allow gas to pass through them when they should be closed. This can be due to dirt or debris in their operating mechanisms or to physical damage or binding of the mechanisms.

[2] See *NFPA 921, 9.2 and 9.3*

[3] See *NFPA 96, Chapter 12.*

Regulators. Failures in gas regulators most often fall into one of three fault categories:

- Internal diaphragm
- The rubber-like seal that controls the input of gas into the regulator
- Vents – permits diaphragm movement

Each of these fault categories can result in the regulator's failing to reduce the outlet pressure to acceptable levels or producing fugitive gases.

Solenoids and Relays. Appliances use solenoids and relays to control a high-power circuit with one of lower power and often of low voltage. Activation of the low-power circuit energizes a coil or an electromagnet that causes a lever to move. The motion opens or closes the high-power circuit. Contacts should be retained after a fire. X-ray often will provide additional information on the usage of the contact.[4]

A solenoid is defined as an electric conductor wound as a helix with small pitch, or as two or more coaxial helices, so that current through the conductor establishes a magnetic field within the conductor.

An electric relay is defined as an electrical device such that current flowing through it in one circuit can switch on and off a current in a second circuit.

Temperature Switches. Switches that operate by temperature are intended to keep the appliance operating within certain temperature limits are called thermostats. Automatic switches that are intended to prevent the appliance from exceeding certain parameters are called cutoffs, limits switches, or safeties.[5]

An old electric Frymaster control panel. The fire started below the control area. Note: the supply power connection in the control bay. Typically the high power lines are limited to the outside of control area - this area usually has low power circuits. A loose lug can arc and could have been the source of ignition.

Control bays can be full of grease - fuel to burn - but this non-burnt unit looks clean! For more information on this case see Case Studies Chapter

Electric Systems

The investigation of an electrical appliance suspected of causing a fire requires some knowledge of circuit construction, but one does not need to be an electrical engineer to understand the function of electrical cooking appliances. Requirements for the design and installation of electrical appliances may be found in the NFPA 70, and in various Underwriters Laboratories standards.

Over time, wiring can become frayed and extremely brittle. Most electric appliances have thermostatic controls that can malfunction. For more information see the *Conducting the Investigation Chapter*.

One way to keep your emergency lighting from getting greasy

[4] See *NFPA 921, 24.5.4 Solenoids and Relays*

[5] See *NFPA 921, 24.5.3.2.2 Temperature Switches*