FIREHOUSE® Weekly Drill

Drill #96:
The Physics of Fire

Introduction

Understanding of the chemical and physical properties of fire can help firefighters when it comes to controlling it. Having the ability to predict what the fire will do with the fuel available and where it will head will make it easier for choosing the appropriate extinguishing agent.

Every firefighter should know that fire is the rapid self-sustaining oxidation process that is accompanied by heat and light in varying intensities. Another oxidation process, rusting, is a much slower process. Combustion on the other hand is a chemical reaction that releases energy as heat and, in some instances, will produce light along with it.

In order to have a fire, there has to be three elements present: fuel, heat and oxygen. This make-up has been called the fire triangle, however, science has identified a fourth element, a chemical chain reaction. By adding this fourth element, the well-known fire triangle has transformed into the fire tetrahedron.

As mentioned above, heat is produced during this process. Heat is a form of energy and can be in anyone of these forms – chemical, mechanical, electrical or nuclear. In the fire service, we think of heat as being measured in British Thermal Units (BTU). A BTU is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.

This heat can be transferred in several different ways. The most common is that of conduction. Conduction is the transferring of heat through an object from one point to another. This transfer takes place at the molecular level. When an object heats up, the atoms within the object become very active and, we could say, they begin to bounce around hitting one another. As the heat increases, so does the activity of the atoms trying to pass the heat to a cooler area. The denser the object the better of a conductor it becomes for this heat transfer.

Another form of heat transfer is that of convection. Convection is the transfer of heat through a circulating medium. In other words, air that is hotter than its surroundings will rise, pushing the cooler air down. This circulation affect is also call the Mushroom affect. Here, the heated air rises till it reaches the ceiling and then

begins to move horizontally, eventually reaching the walls. As it spreads across the ceiling, it cools and starts to circulate back down into the room, where it will heat up again and rise.

Radiation is the next form of heat transfer and is caused by the light produced by the fire. Lightwaves can range from ultraviolet to infrared. Infrared lightwaves can cause objects remote from the fire to heat up and eventual ignite. Radiation is a major contributing factor when it comes to flashovers. As the convection currents rise to the ceiling, they begin to build up energy or heat. This heat will eventually start radiating back down into the room, assisting the convection and heating of the objects within the room. At some point the room and furnishings will reach their ignition temperature and ignite all at once. This is known as a flashover.

The last form of heat transfer is known as direct flame impingement or auto exposure. Auto exposure is a combination all three of the previously mentioned forms of heat transfer.

–Prepared by Russell Merrick