

U.S. Fire Administration / National Fire Academy

*Coffee Break Training***Topic:** Flame Descriptions

Learning objective: The student shall be able to explain the difference between a premixed flame and a diffusion flame.

Combustion is a dynamic and complex chemical reaction that research scientists must try to explain and understand.

The simple, traditional descriptor of the “fire triangle” or the more modern “fire tetrahedron” may serve as simple verbal shorthand to explain combustion to a lay person, but clearly they are not sophisticated enough to describe the intricate chemical decomposition and simultaneous physical changes that occur where oxygen, heat, and fuel merge into that phenomenon we call “fire.”

In the research world, even flame “types” are described differently: there are “premixed” flames and “diffusion” flames. A premixed flame occurs when the fuel gas and oxygen or air are mixed before ignition. A familiar example is the flame from an oxyacetylene cutting torch. The acetylene and oxygen are mixed at the nozzle and ignited by a spark or other source to produce a concentrated, high-temperature, and efficient flame. Other examples in day-to-day life include laboratory Bunsen burners and the burners for a hot water tank or a gas-fire stovetop.

On the other hand, diffusion flame occurs when fuel gases and oxygen meet in different and varying concentrations in the zone where the chemical reaction exists and creates fire. The amount of oxygen and the variety of the fuels that contribute to the chemical reaction result in instantaneously changing conditions that result in different flame heights, turbulence, color, and smoke output.

Diffusion flames are the most common flames fire protection personnel may observe. They occur in room-and-contents fires, wildland fires, motor vehicle fires, and many other environments.

For additional information, refer to *Principles of Fire Behavior* by James G. Quintiere, Ph.D.



This two-story dwelling fire is an example of diffusion flames.