Fire Dynamics: Oxygen-Enriched Atmospheres

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Learning Objective: *The student will be able to explain the impact of oxygen-enriched atmospheres on fire behavior.*

Materials that normally do not burn in atmospheric oxygen may burn vigorously in an enriched environment.

The "fire tetrahedron" is one of the elementary topics we learn in fire protection: Heat, fuel, oxygen and an uninhibited chemical chain reaction in appropriate combinations are needed to sustain combustion. We also learn that the atmosphere we breathe includes about 20.5 percent oxygen by volume.

Oxygen-enriched atmospheres, on the other hand, are those environments that the United States Occupational Safety and Health Administration describes as containing more than 23.5 percent oxygen by volume. Health care facilities, industrial operations and research laboratories are just a few of the places where liquid or gaseous oxygen may be used in large quantities, and environments may be oxygen-rich.

Materials that normally do not burn in atmospheric oxygen may burn vigorously in an enriched environment. Materials become easier to ignite because their flammable ranges expand and their autoignition temperatures drop. Even materials that we think of as noncombustible — such as the metal pipe that delivers the oxygen — can ignite in these atmospheres. All organic materials will burn in oxygen, as well as most metals and metal alloys.

Oil and grease are particularly hazardous in the presence of oxygen because they can ignite easily and burn with explosive violence. In oxygen equipment, oil and grease ignition often causes a chain reaction that results in the oxygen container melting or burning with a subsequent release of more oxygen into the fire.

In oxygen-enriched environments, fires can be ignited without sparks or open flames. Something as simple as a contaminant in a high-velocity oxygen gas jet can create enough friction in the gas stream to ignite nearby materials. The reaction continues to increase not only with the increased oxygen concentration but also with pressure or temperature. Oxygen contacting a material at 2,000 pounds per square inch gauge (138 bar) is more likely to react with the material than at atmospheric pressure. When the temperature increases, it lowers the amount of energy needed to initiate a reaction.

For more information, take the NFA Online course "Foundational Concepts of Chemistry" (Q0228) at http://www.usfa.fema.gov/nfa/nfaonline/browse/index.shtm.