Combustion refers to the rapid oxidation of fuel accompanied by the production of heat, or heat and light. Complete combustion of a fuel is possible only in the presence of an adequate supply of oxygen.

Approximately 1,600 to 2,000 cubic feet of air is required to burn one gallon of #2 fuel oil at 80% efficiency (at sea level). About 15 cubic feet of air is required to burn one cubic foot of natural gas at 75% efficiency (at sea level).

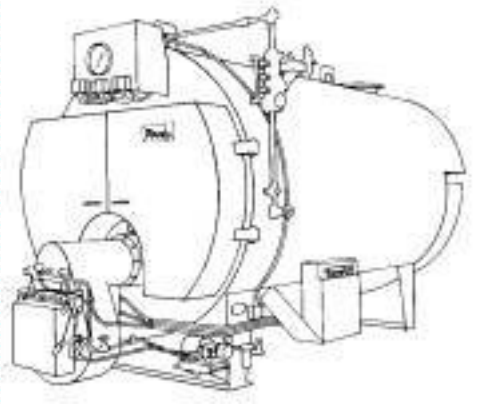
Oxygen (O2) is one of the most common elements on earth making up 20.9% of our air. Rapid fuel oxidation results in large amounts of heat. Solid or liquid fuels must be changed to a gas before they will burn. Usually heat is required to change liquids or solids into gases. Fuel gases will burn in their normal state if enough air is present.

Most of the 79% of air (that is not oxygen) is nitrogen, with traces of other elements. Nitrogen is considered to be a temperature reducing dilutant that must be present to obtain the oxygen required for combustion.

Nitrogen reduces combustion efficiency by absorbing heat from the combustion of fuels and diluting the flue gases. This reduces the heat available for transfer through the heat exchange surfaces. It also increases the volume of combustion by-products, which then have to travel through the heat exchanger and up the stack faster to allow the introduction of additional fuel air mixture.

This nitrogen also can combine with oxygen (particularly at high flame temperatures) to produce oxides of nitrogen (NOx), which are toxic pollutants - more on this later.

Air for combustion is divided into four types depending upon its role and the design of the particular burner. Air will be referenced in this manual and seminar as primary, secondary, excess and dilution air.



- Primary air provides a percentage of the combustion air, but more importantly, controls the amount of fuel that can be burned.

- Secondary air improves combustion efficiency by promoting the fuel to burn completely. Power burners generally do not require secondary air. However, air leaking in through access/clean out doors, burner mounting flanges, boiler sections, etc., dilutes the flame and flue gas temperatures, reducing operating efficiencies as well as our ability to accurately monitor combustion conditions.

- Excess air is supplied to the combustion process to ensure each fuel molecule is completely surrounded by sufficient combustion air. As a burner tune-up improves the rate at which mixing occurs, the amount of excess air required can be reduced.

- Dilution air does not participate directly in the combustion process and is primarily required to attempt to control stack draft and reduce the likelihood that moisture in the flue gases will condense in the vent system --- which directly influences combustion air intake, safety and efficiency.