Evaluation of Lower Flammable Limits of Fuel-Air-Diluent Mixtures

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Abstract

The lower flammable limit is the minimum composition limit at which a flame can propagate. It is related to the flash point, which is the minimum temperature at which the vapor pressure of a liquid forms a flammable mixture when mixed with air. However, the lower flammable limit is more flexible since different conditions such as different initial temperatures, different oxygen concentrations, and addition of diluents, can be considered. Nitrogen, for example, is an inert that is added to a flammable mixture to adjust the mixture to a safe level by decreasing the oxygen concentration and increasing the lower flammable limit.

Superchems™ is used by industry to perform flammability calculations under different initial conditions. Even though the software is powerful, it is subjective in the determination of flammability limits where a temperature threshold must be selected to calculate flammability limits. In our approach the use of the adiabatic flame temperature at the lower flammable limit is suggested for mixtures of fuel-air and mixtures of fuel-air-diluent. These calculated temperatures can be used as the threshold values in Superchems™, and the lower flammable limit can then be calculated by using the adiabatic flame temperature.

The effectiveness of a diluent in reducing the flammability is an important characteristic from an aspect of safety. This paper will discuss an approach of evaluating lower flammability limits in the presence of diluents such as nitrogen and carbon dioxide. The lower flammable limit will also be evaluated using the Superchems™ software for comparison. The results obtained by both methods will be validated using experimental data at different concentrations of diluents.