**FIRE AND SAFETY**

Fire is usually defined as uncontrolled combustion and flame propagation.

Explosion is the rapid release of pressure resulting from the fast physical and chemical energy relased.

**Fire quenching**

Fires in common combustible materials such as wood, textiles, paper ans so on: such fires can be extinguished by quenching or cooling, commonly through the application of water.

Fires of flammable liquid fuels such as gasoline, oil, grease and so on: Such fires can be put out by the application foam, CO2, and dry chemicals.

Fires involving electrical equipment such as electric motors, generators, transformers, and switches, which require a nonconductive extinguishing agents such as CO2.

Fires in combustible materials such as magnesium and powdered Al, which required the use of foam or suitable dry chemicals.

**Different extinguisher types quench different types of fire**

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Above figure is taken from https://surreyfire.co.uk/wp-content/uploads/2015/11/which-type-of-fire-extinguisher-2.png.

Be careful: Never use water, metal tool to stop the fire that comes out from the frying pan.

**Flammability limit**

Flammability limit is the range of composition of the fuels at fixed temperature and pressure between which they are flammable.

Flammability limits are expressed as fuel concentrations (by volume) at a specified T and P.

There are two major zones of for fuel-oxidant mixtures:

Flammability zone – the flammability range that supports sustained flame propagation following ignition from an external energy zone.

Autoignition zone - the flammability range at which fuel-oxidant mixture will self-ignite at the right condition such as high T or high P (like compression in diesel fueled engines).

Autoignition region

Air

Fuel

Fuel lean region Flammability region Fuel rich region

Flammability limits of several fuels at ambient T and P in air (Below table is adapted from the book: Ghazi A. Karim, Fuels, Energy and the Environment, 1st Edition, CRCPress).

|  |  |  |
| --- | --- | --- |
| **FUEL** | **Lean Limit (%)** | **Rich Limit (%)** |
| **CH4** | **5.00** | **15.00** |
| **Propane** | **2.37** | **9.5** |
| **Butane** | **1.86** | **8.41** |
| **H2** | **4.00** | **75.00** |
| **Ethanol** | **3.58** | **18.00** |
| **Gasoline** | **1.30** | **7.60** |

**Change of Flammability limit with T and P**

The flammability limits for any fuel will depend on surrounding’s conditions. Generally, the lean limit widens linearly with temperature. The rich limit rises at a higher rate.

The flammability limit widens with an increase in presure. At low P, those well below Patm  the range becomes narrowed. Even a stoichiometric mixture cannot support combustion. Ex: fuels combustion at sufficiently high altitude.

Reference: Ghazi A. Karim, Fuels, Energy and the Environment, 1st Edition, CRCPress.