Codes and Standards Analysis

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Background

The lean limits of flammability currently used in safety analysis originated in the 1940's and 50's

Textbook values for flammability

- 4.1% hydrogen upward propagating lean limit of flammability
- 10% hydrogen downward propagating lean limit of flammability

The lower-limit mixture of hydrogen in air produces far too little heat to raise the mixture to it's ignition temperature…

The tests were conducted with quiescent mixtures of hydrogen and air in containers 6 to 15 feet tall and 2 to 12 inches in cross section

Findings for 4.1% mixtures

- A ring of flame is formed initially
- Upon breaking it forms a “cloud”, a “collection of small balls of flame” or a “pencil of flame”
- The flames traveled steadily to the top of the container

Findings for 10% mixtures

The hydrogen was not completely consumed until 10% concentration was reached

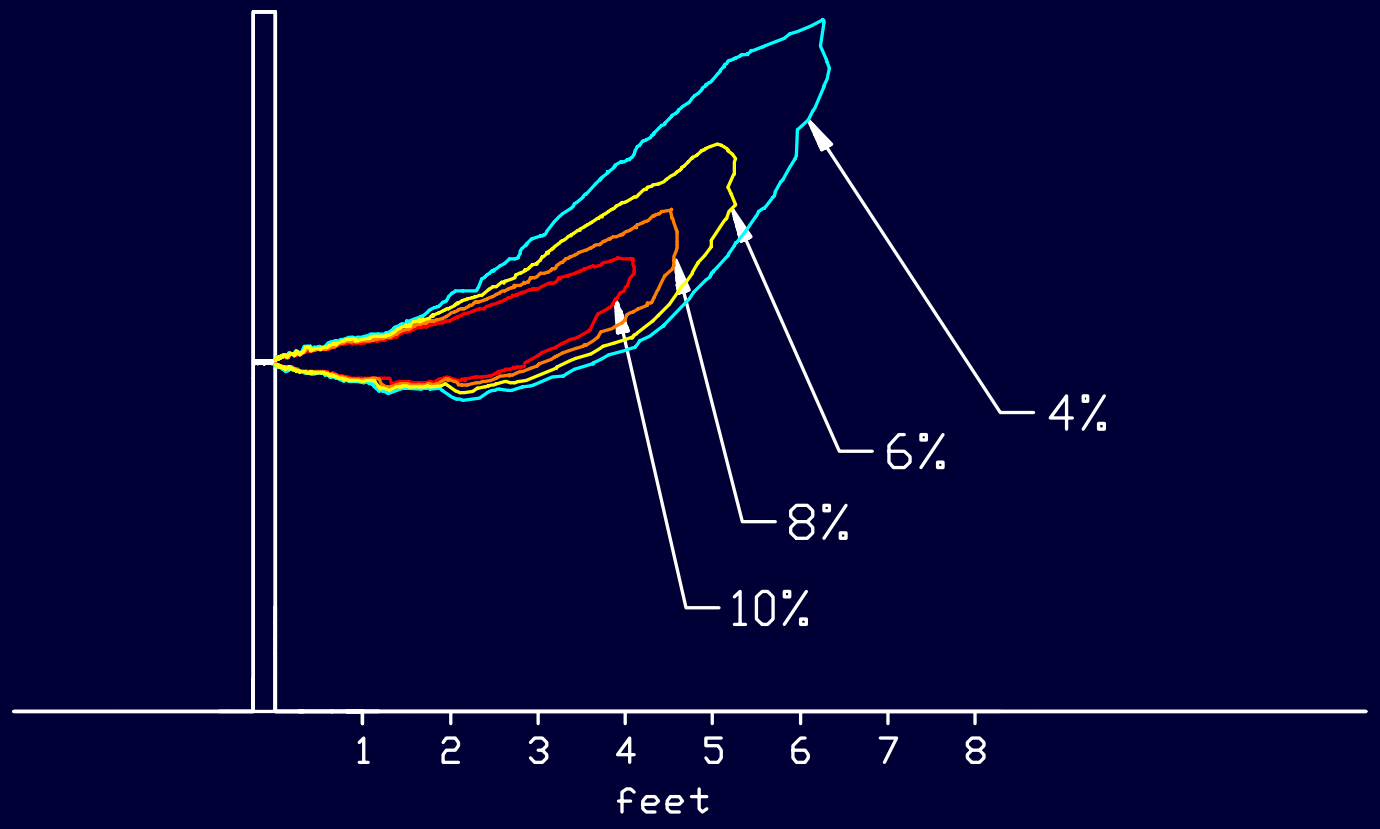
Very lean hydrogen flames are possible because of hydrogen's high diffusion rate. As the hydrogen is consumed fresh hydrogen diffuses into the flame more rapidly than other gases, richening the mixture.

The upward propagating lean limit of flammability (4.1%), in conjunction with a safety factor of 4 (yielding 1.0%), is still used in safety analyses of mixtures that cannot be quiescent

Project Description

- Task A - Analysis of lean limit of flammability for gases surrounding a hydrogen leak
- Task B - Analysis of lean limit of flammability for gases flowing in exhaust ducts
- Task C - Analysis of electrical grounding needs in a garage with an electrolyzer or fuel cell
- Task D - Analysis of hazards produced by electrical shorts in conjunction with portable fuel cells

20 SCFM Hydrogen leak



Test wall for leaks

Leak test apparatus

Hydrogen sensor apparatus

Calibration apparatus

Ignition of hydrogen plume at 15%

Area tested to date – no ignition