Massachusetts Firefighting Academy

Liquefied Petroleum Gas (LPG)

Objectives

- Discuss propane and its properties
- Show examples of common D.O.T. Cylinders
- Discuss overfilling of 20lb cylinders
- Discuss overfill protection/safety changes

Objectives

- Common A.S.M.E. Containers
- Propane in transportation
- Discuss BLEVE’s and how to anticipate them
- Discuss CGI’s and metering considerations
Pre - Test

Identification

Propane (LPG)
LPG is composed of both propane and butane.
### Properties

**COLOR**
- Propane is colorless

**ODOR**
- Propane is odorless
- Propane is odorized by adding Mercaptan

### Toxicity

- Propane is non-toxic
- However, it is an asphyxiant
- It will displace the oxygen in the air

### Specific Gravity

- 0.509
- Water is assigned the value of 1.0
- Any liquid with a specific gravity less than 1 will FLOAT on water
- Any liquid with a specific gravity greater than 1 will SINK in water
- Therefore propane in its liquid form would float on water
Weight

- Liquid propane weighs approximately 4.4 pounds per gallon
- In comparison, water weighs approximately 8.3 pounds per gallon

Water Soluble

- Is propane water soluble?
- No, it will not mix with water

Vapor Density

- 1.6 - it is heavier than air since:
  - Air is assigned the value of 1.0
  - Any gas less than 1.0 is lighter than air and will rise
  - Any gas more than 1.0 is heavier than air and will collect in low spots such as ground level or basements, etc.
Expansion Rate

- The expansion rate of propane is 270:1
- Thus, storing and transporting propane as a liquid is more economically sound
- Example: one 10,000 gallon road transport full of liquid equals 270 transports full of vapor

Temperatures

- Boiling Temperature
  - -44°F
- Ignition Temperature
  - 920°F to 1120°F
  - Impurities in the propane may affect the ignition temperature

Flammable Range

- 2.2% to 9.5%
- Can be rounded off to 2% to 10%
- What if the atmosphere is less than 2%?
  - Said to be too lean
- What if the atmosphere is more than 10%?
  - Said to be too rich
- Which would be potentially more dangerous?
Flame Spread

- Approximately 900 feet per minute
- Similar to Gasoline

Storage Temperature

- Propane is stored at ambient temperature
- Ambient temperature is the temperature of the day

Storage Pressure

- 120 PSI at 70°F
- At higher temperatures the pressure will be greater
- At lower temperatures the pressure will be less
Transport Pressure

- 120 PSI at 70°F
- Placing LPG in transport does not change the pressure
- Temperature is the factor affecting pressure

LPG Vapor Pressures

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Propane</th>
<th>Butane</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 44°F</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0°F</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>32°F</td>
<td>54</td>
<td>0</td>
</tr>
<tr>
<td>70°F</td>
<td>120</td>
<td>31</td>
</tr>
<tr>
<td>100°F</td>
<td>187</td>
<td>59</td>
</tr>
<tr>
<td>130°F</td>
<td>286</td>
<td>97</td>
</tr>
</tbody>
</table>

Specific Dangers

- Flammable
- Explosive — in confined spaces
- Asphyxiating — will displace oxygen
- Frostbite
Extinguishment

AGENT
➢ Dry chemical agent

METHOD
➢ Stop the flow of gas

Review Pretest

Video
Portable Extinguishers
Common D.O.T. Cylinders

- One pound
  - Hand torches, small camping appliances
- 20 pound
  - Recreational vehicles, grills, torches
- 33 - 43 pound
  - Industrial trucks (forklift / zamboni) may run on either liquid OR vapor

Common D.O.T. Cylinders

- 100 pound
  - Residential, usually in pairs, tar kettles
- 200 pound to 400 pound
  - Residential or commercial applications

Common D.O.T. Containers

1,000 - 14,000 Gallon
  - Bobtail delivery and Road transports

30,000 - 40,000 Gallon
  - Rail transports
Safety Relief Valve Operating Pressure:

D.O.T. Cylinders - 375 PSI

Note: At 160° F the Vapor Pressure of Propane is 390 PSI

The 20 Lb Cylinder / Gas Grills

Cylinder Overfilling
Cylinder Overfilling

At 80% full and at 60° F, a 20 LB. cylinder must be heated to 160° F for anything to happen to it.

Cylinder Overfilling

At 95% full and at 60° F, a 20 LB. propane cylinder would need only a 22° temperature increase to become liquid full.

Cylinder Overfilling

At 99% full and at 60° F, a 20 LB. cylinder would need only a 4.4° F temperature rise to cause a pressure great enough to operate the pressure relief valve.
Safety Changes

- Changes to gas grills
- Changes to D.O.T. cylinders

Safety Changes

Gas Grills
Quick Release Coupling

Adaptor With QRC
Overfill Protection Device (OPD)

Video
Overfill Protection Device

Common A.S.M.E. Containers

500 - 5,000 Gallon
- Normally found in commercial applications

10,000 Gallon and above
- Storage facilities
Storage Facilities

Safety Relief Valve Operating Pressure:
A.S.M.E. Containers - 250 PSI

LPG in Road Transportation
The Bobtail Delivery Truck

Bobtail Emergency Shutoffs

- Manual shutoff behind cab on drivers side of truck
- In the event of an emergency will close the main liquid discharge valve
- Cable runs to rear of tank
Bobtail Emergency Shutoffs

- Newer units are equipped with remote control shut off
- Device is activated by a garage door type control kept with the driver

Bobtail Emergency Shutoffs

- Fusible link in cable can also shut down liquid valve in the event of a fire

LP Gas Transports
Emergency Shut Offs

B.L.E.V.E.
- Boiling
- Liquid
- Expanding
- Vapor
- Explosion

Video
Bleve Update
**The Vapor Space Is the Danger Area**

- Cool the vapor space of a heated cylinder
- Shut the gas off by the control valve if possible
- If the flow of burning gas cannot be shut off, allow the propane cylinder to burn itself out

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**When to Anticipate a BLEVE**

- Activation of PRV
- Sounds from PRV increase
- Pitch from PRV becomes higher or louder
- Space between flame and PRV increases
- Water hitting the tank turns to steam

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**Combustible Gas Indicators**
Combustible Gas Indicators

CGI’s, also referred to as “explosive meters” or “explosimeters,” are used to test atmospheres that may contain a sufficient concentration of combustible vapors to cause an explosion or support combustion.

Combustible Gas Indicators

There are three different scales used on various CGI models:

- Percentage of lower explosive limit (LEL)
- Percentage of gas in air
- Parts Per Million (PPM)

The most common is the percentage of LEL meter.

CGI Response

- A properly set low level alarm on a CGI meter is 10% of the LEL for the calibration gas.
- The reason this percentage is fairly low is that it serves as a safety factor.
CGI's and Oxygen

- Oxygen concentrations will effect meter readings

Oxygen Meters

- Oxygen meters are used to detect the percentage of oxygen in atmosphere
- Most oxygen-sensing devices are calibrated to indicate concentrations between 0% and 25%
Combustible Gas Indicators

- If a meter reading is 50% LEL, this would be equivalent to 2.5% vapor in air

<table>
<thead>
<tr>
<th>Too Lean</th>
<th>0%</th>
<th>50% of lower explosive limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2.5% volume in air</td>
</tr>
</tbody>
</table>

Too Rich FR 5-15%
Too Lean 0 % 100 %

Carbon Monoxide (CO) and Hydrogen Sulfide (H₂S) Meters

- These instruments utilize a detector that operates by chemical reaction with the gas
- Like the oxygen meter, these meters are subject to interference from other gases or vapors

CGI

All CGI readings are relative to a calibration gas. When measuring another gas or vapor, the instrument still responds to the increased temperature of the filament.
### Conversion Factors

<table>
<thead>
<tr>
<th>Combustible Gas/Vapor</th>
<th>Correction Factor when Instrument is Calibrated on Propane</th>
<th>Correction Factor when Instrument is Calibrated on Methane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>0.83</td>
<td>1.11</td>
</tr>
<tr>
<td>Methane</td>
<td>0.55</td>
<td>1.0</td>
</tr>
<tr>
<td>Propane</td>
<td>1.0</td>
<td>1.82</td>
</tr>
<tr>
<td>n-Butane</td>
<td>1.0</td>
<td>1.82</td>
</tr>
<tr>
<td>n-Pentane</td>
<td>1.22</td>
<td>2.22</td>
</tr>
<tr>
<td>Methanol</td>
<td>0.80</td>
<td>1.18</td>
</tr>
<tr>
<td>Ethanol</td>
<td>0.80</td>
<td>1.94</td>
</tr>
<tr>
<td>Acetone</td>
<td>0.40</td>
<td>0.83</td>
</tr>
<tr>
<td>Toluen</td>
<td>1.57</td>
<td>2.86</td>
</tr>
<tr>
<td>Gasoline</td>
<td>0.85</td>
<td>1.94</td>
</tr>
</tbody>
</table>

### Explosive Limits

- **Propane / LPG**
  - 2.2% - 9.5%

- **Methane / LNG**
  - 12.5% - 74%

- **Carbon Monoxide**
  - 5% - 15%

- **Acetylene**
  - 2.5% - 80%

### Summary

- Vapors are HEAVIER than air and will collect in low spaces
- Liquid leaks are 270 times worse than Vapor leaks
- CGI’s are the only way to tell where the vapors truly are
- LPG is found EVERYWHERE!