Collaborative Bachelor's Degree Program of Fire Protection and Safety Engineering Technology between Southwest Jiaotong University and Oklahoma State University, U.S.A.

FPST 2023 – Industrial and Occupational Safety

Flammable and Combustible Liquids

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General

- The two primary hazards associated with flammable and combustible liquids are fire and explosion
- Safe handling and storage of flammable liquids requires the use of approved equipment and practices per OSHA standards
  - 29 CFR 1910.106

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Definitions

- Flash point
  - The minimum temperature at which a liquid gives off enough vapor to form an ignitable mixture
  - In general, the higher/lower the flash point, the lesser/greater the hazard
- Boiling point
  - The temperature at which the vapor pressure is equal to the atmospheric pressure

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Definitions

- Firepoint
  - The temperature at which a flame on the top of the liquid is sustained
  - Firepoint is a higher or lower temperature than Flashpoint?
  - This parameter is not being used frequently

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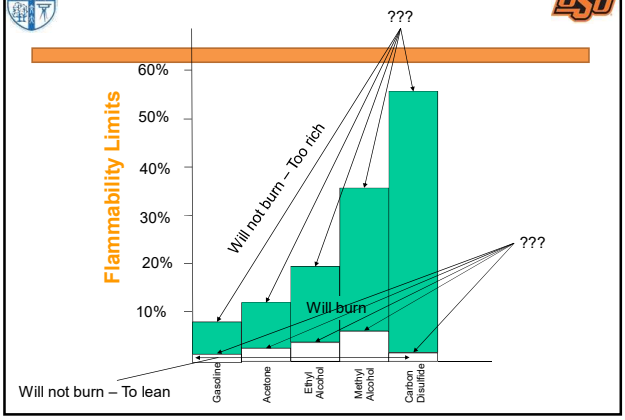

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METHANE SDS (SAFETY DATA SHEET)

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Volatility

- The ability a liquid to evaporate
- It is closely related to boiling point
- Light and heavy refers to high volatility and low volatility, respectively

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Liquids

- What liquids have flash points below 100°F?
- What liquids have flash points at or above 100°F?
- Flammable liquids and are more dangerous than combustible liquids, since they may be ignited at room temperature
- Although combustible liquids have higher flash points than flammable liquids, they can pose serious fire and/or explosion hazards when heated

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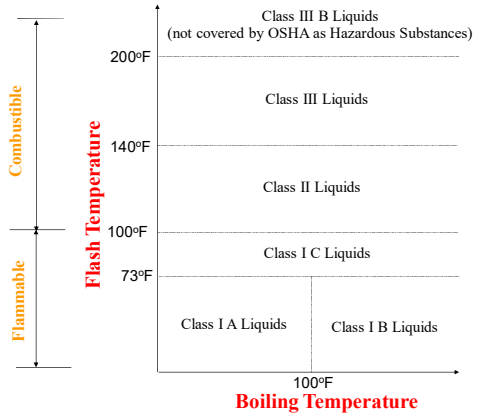

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General Safety Measures

- A good plan for safe use of flammable and combustible liquids contains at least these components:
  - Control of ignition sources
  - Proper storage
  - Safe handling
  - Fire control

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Sources of Ignition

- Open flames
- Smoking
- Static electricity
- Cutting and welding
- Hot surfaces
- Electrical and mechanical sparks
- Lightning

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Sources of ignition

- The instant before a hot light bulb filament burns out after the glass is broken is hot enough to ignite gasoline. Always protect light bulbs in the presence of flammable liquids
- Welding sparks are hot!! Welding near flammable liquids has cost many lives
- Static Electricity discharge

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Static Electricity

- Generated when a fluid flows through a pipe or from an opening into a tank
- Main hazards are fire and explosion from sparks containing enough energy to ignite flammable vapors
- Bonding - installation of electrical interconnection is required between nozzle and container when dispensing Class I liquids
- Grounding of flammable liquid containers is necessary to prevent static electricity from causing a spark

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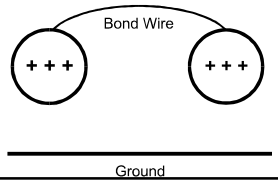
Bonding

- Physically connect two conductive objects together with a bond wire to eliminate a difference in static charge potential between them
- Must provide a bond wire between containers during flammable liquid filling operations, unless a metallic path between them is otherwise present



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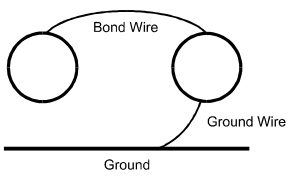
Grounding

- Eliminates a difference in static charge potential between conductive objects and ground
- Although bonding will eliminate a difference in potential between objects, it will not eliminate a difference in potential between these objects and earth unless one of the objects is connected to earth with a ground wire



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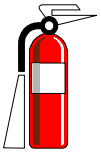
Fire Control

- Suitable fire control devices, such as small hose or portable fire extinguishers must be available where flammable or combustible liquids are stored
- Open flames and smoking must not be permitted in these storage areas
- Materials which react with water must not be stored in the same room with flammable or combustible liquids



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Transferring

- OSHA allows only four methods for transferring these materials:
  - Through a closed piping system
  - From safety cans
  - By gravity through an approved self-closing safety faucet
  - By means of a safety pump

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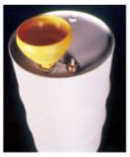
Waste and Residue

Combustible waste and residue must be kept to a minimum, stored in covered metal receptacles and disposed of daily.



Waste drum with disposal funnel

Safety disposal can

Oily-waste can (self-closing lid)

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Self-Closing Safety Faucet

- Bonding wire between drum and container
- Grounding wire between drum and ground
- Safety vent in drum

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Safety Pump

- Faster and safer than using a faucet
- Spills less likely
- No separate safety vents in drum required
- Installed directly in drum bung opening
- Some pump hoses have integral bonding wires

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Handling and Storage

- Identify incompatible chemicals – check the SDS
- Isolate and separate incompatible materials
  - Isolate by storing in another area or room
  - Degree of isolation depends on quantities, chemical properties and packaging
  - Separate by storing in same area or room, but apart from each other

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Safe Handling Fundamentals

- Carefully read the manufacturer's label on the container
- Practice good housekeeping in flammable liquid storage areas
- Clean up spills immediately
- Only use approved metal safety containers or original manufacturer's container to store flammable liquids
- Keep the containers closed when not in use
- Only where there is plenty of ventilation
- Keep flammable liquids away from ignition sources

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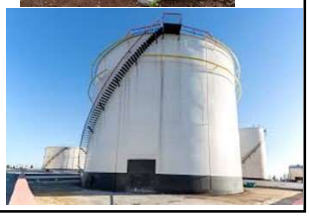
Tank Storage

- Complicated standards.



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Underground Tanks

- EPA standards
  - Monitoring system for tanks and pipe leaks
  - Automatic shutoffs for pressurized systems
  - Spill protection
  - Overfill prevention
  - Coordinating with local and state entities
  - Emergency planning

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Storage of Flammable and Combustible Liquids

- Storage must not limit the use of exits, stairways, or areas normally used for the safe egress of people
- In office occupancies:
  - Storage prohibited except that which is required for maintenance and operation of equipment
  - Storage must be in:
    - closed metal containers inside a storage cabinet, or
    - safety cans, or
    - an inside storage room

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Inside storage room

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Safety Cans for Storage and Transfer

- Approved container of not more than **5 gallons** capacity
- Spring-closing lid and spout cover
- Safely relieves internal pressure when exposed to fire

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Flame Arrester Screen

- Prevents fire flashback into can contents
- Double wire-mesh construction
- Large surface area provides rapid dissipation of heat from fire so that vapor temperature inside can remains below ignition point

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Storage Cabinets

- Not more than **60 gal** of Class I and/or Class II liquids, or not more than **120 gal** of Class III liquids permitted in a cabinet
- Must be conspicuously labeled, "Flammable - Keep Fire Away"
- Doors on metal cabinets must have a three-point lock (top, side, and bottom), and the door sill must be raised at least 2 inches above the bottom of the cabinet to contain leaks

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Common Uses of Flammables

Dip Tanks

Spray Booths

LPG Tanks

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Dip Tanks

- Federal standards address dip tanks with flammable/combustible material, separately
- Three principle problems with dip tanks:
  - No automatic extinguishing facilities
  - No tank covers

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Dip Tanks

- Must be "kept closed when tanks are not in use"
- Ventilation
- Period of time considered as "not in use" is one half of a shift
- Automatic closing dip tank covers are considered among the most appropriate means of automatic extinguishing

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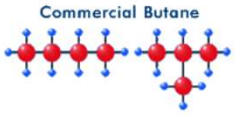
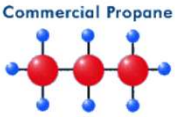
Liquefied Petroleum Gas (LPG)



C_4H_{10}

Flash point: -104°C

Boiling Point: -42°C



C_3H_8

The expansion ratio: 1:270

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LPG

- Heavier than air (1.5 the density of air)
- Extremely cold during liquefaction or expansion process
- LPG tanks are pressure vessels, closed – no connection to the atmosphere, pressure inside depending on temperature
- About 500,000 propane operated forklifts are added to the market annually. Refueling should be done very carefully
- Major hazard: Fires and explosions

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Liquefied Petroleum Gas (LPG)

- When large LPG tanks are on fire, there is a significant probability that the event will be developed to a **BLEVE**
- BLEVE: boiling liquid expanding vapor explosion
  - The boiling and burning liquid behaves as a rocket fuel, propelling vessel parts to a great distance

Video

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Summary

- The two primary hazards associated with flammable and combustible liquids are fire and explosion
- Safe handling and storage of flammable liquids requires the use of approved equipment and practices per OSHA standards
- An excellent reference on this topic is NFPA 30, *Flammable and Combustible Liquids Code*