Spontaneous Combustion and Chemically Induced Fires

Presented by:

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Combustion Is a Form of Oxidation

- What is oxidation?
- What are some common oxidation reactions?
Familiar Oxidation Reactions

- $2 \text{Fe} + \text{O}_2 \rightarrow 2 \text{FeO}$
- $4 \text{Ag} + 2 \text{H}_2\text{S} + \text{O}_2 \rightarrow 2 \text{Ag}_2\text{S} + 2 \text{H}_2\text{O}$
- $\text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O}$
- $\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O}$
Familiar Oxidation Reactions

- $2 \text{Fe} + \text{O}_2 \rightarrow 2 \text{FeO}$
  - Rusting of iron
- $4 \text{Ag} + 2 \text{H}_2\text{S} + \text{O}_2 \rightarrow 2 \text{Ag}_2\text{S} + 2 \text{H}_2\text{O}$
  - Tarnishing of Silver
- $\text{C}_6\text{H}_12\text{O}_6 + 6 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O}$
  - “Burning” of sugar in our bodies
- $\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O}$
  - Combustion of natural gas
• “An exothermic, self-sustaining reaction involving a solid, liquid, and/or gas-phase fuel”
  — National Fire Protection Association
The Fire Triangle

(1) **FUEL** plus
(2) **HEAT** plus
(3) **OXYGEN** equals

~ FIRE ~
Organic Materials a.k.a. “Organics”

- Contain carbon
- Many contain some oxygen and nitrogen
- Examples
  - Plant and animal matter
  - Fabrics and paper products
  - Petroleum products, including plastics
Two Classes of Organic Materials

- Hydrocarbon-based
  - Completely unoxidized
  - Basic chemical building blocks contain no oxygen
  - e.g., —CH— or —CH₂—

- Cellulose-based
  - Partly oxidized
  - Basic chemical building blocks contain oxygen
  - e.g., —CH(OH)—
Most Organics Burn Readily

- Combustion of organic materials produces
  - Water (which is, technically, the oxide of hydrogen)
  - Carbon Dioxide
Factors That Determine Whether Oxidation Will Result in Ignition

- Rate of heat generation
- Effects of ventilation
- Insulating effects of material’s immediate surroundings
- Ignition temperatures of the organics and gases produced by oxidation
- “Specific area” exposed to oxidizer
- Amount of moisture present
No Ignition If Heat Escapes Faster Than It Is Generated

- Heat escapes in three ways
  - **Conduction**
    - Direct contact with solids
  - **Convection**
    - Movement of liquid or gases
  - **Radiation**
    - a.k.a. *thermal radiation* or *infra-red rays*
    - Electromagnetic energy (heat)
Spontaneous Heating of Specific Materials:

Drying Oils

• Used in paints and other finishes
• Fatty acids oxidize and form durable natural coating
• Examples
  – Linseed (especially “boiled”)
  – Tung
  – Fish
  – Soybean
Spontaneous Heating of Specific Materials:

Cooking Oils — & Laundry

- Rarely spontaneously combust
- May self-ignite, however, if given a “push” — as when heated in dryer
  - Unlikely to occur while dryer is in use
  - Most common when dryer is interrupted mid-cycle, before normal cooldown
  - Generally takes several hours
  - Use of bleach may increase risk
Spontaneous Heating of Specific Materials:

**Hay, Mulch, Compost, etc.**

- Process is not entirely understood
- Moisture content is key
  - 20-45% supports self-ignition
- Increased risk factors
  - Larger piles
  - Finer or denser product
  - e.g. Mulch is a greater hazard than wood chips
Spontaneous Heating of Specific Materials:

Wood and Sawdust

• Sawdust
  – Properties similar to other moist organics
    • More hazardous when damp than dry
    • Heat of production (e.g. sanding) increases risk

• Solid wood
  – Gradual pyrolysis creates risk
    • Long exposure to elevated temperatures
    • May ignite well below ordinary ignition temperature
Spontaneous Heating of Specific Materials:

**Coal and Charcoal**

- Some types oxidize much more quickly
- Increased risk factors
  - Higher moisture
  - Larger piles
  - Finer particles
- "Activated" charcoal is greatest hazard
  - As little as several pounds may ignite
  - May ignite in just hours
Spontaneous Heating of Specific Materials:

Plastics and Foam Rubber

• Various chemicals used in manufacture can rapidly oxidize

• Residues can turn end-products themselves into spontaneous combustion hazards

Example: Rubber gloves
Spontaneous Heating of Specific Materials:

**Non-Hazards**
- Petroleum products such as gasoline or motor oil, generally do not self-heat
- Humans: Not a hazard!
Two Classes of Potentially Liable Parties

• **Suppliers**
  – Manufacturers, distributors, or retailers
  – **Basis of claim:** Failed to provide adequate warnings
  – **Tough to prove:** Warnings have improved

• **Users**
  – **Basis of claim:** Used or disposed of product in negligent manner
Supplier Liability: Defective Warnings

- Warnings required if product hazards cannot reasonably be eliminated
- Supplier may be found liable if deficient warnings render product defective, i.e., *unreasonably dangerous*
- Supplier is as liable for giving inadequate warning as for giving no warning at all
Adequacy of Warnings

- Highly fact-specific
  - Adequacy is usually a question for the jury
- Must be adequate in
  - Form and
  - Content
Factors for Judging Adequacy of Warnings

- Conspicuity
  - Size
  - Shape
  - Color
  - Contrast
  - Pictures / symbols

- Intensity of language
- Location
- Language (e.g., English vs. Spanish)
Warnings Examples

**RISK OF FIRE FROM SPONTANEOUS COMBUSTION EXISTS WITH THIS PRODUCT.**

Linseed Oil generates heat as it dries. This heat generated as it dries can cause spontaneous ignition of materials contacted by Linseed Oil.

Oily rags or waste and other oily materials can cause spontaneous combustion fires if not handled properly. Immediately after use... **you MUST...**
Warnings Examples
Warnings Examples

Top of Can

DISPOSE OF RAGS AND OTHER WASTE ACCORDING TO SPECIFIC INSTRUCTIONS ON BACK PANEL.
**WARNING:** Do not dry rags or articles coated with gasoline, kerosene, paint, wax, or grease. Fire or explosion could result.

**FIRE HAZARD** – Do not place into your dryer items that have been spotted or soaked with vegetable oil or cooking oil. Even after being washed, these items may contain significant amounts of these oils. The remaining oil can ignite spontaneously. The potential for spontaneous ignition increases when the items containing vegetable oil or cooking oil are exposed to heat. Heat sources, such as your clothes dryer, can warm these items, allowing an oxidation reaction in the oil to occur. Oxidation creates heat. If this heat cannot escape, the items can become hot enough to catch fire. Piling, stacking or storing these kinds of items may prevent heat from escaping and can create a fire hazard.

All washed and unwashed fabrics that contain vegetable oil or cooking oil can be dangerous. Washing these items in hot water with extra detergent will reduce, but will not eliminate, the hazard. Always use the Cool Down cycle for these items to reduce the items’ temperature. Never remove these items from the clothes dryer hot or interrupt the drying cycle until the items have run through the Cool Down cycle. Never pile or stack these items when they are hot.
Other Warnings Issues

• “Warnings dilution” or “warnings clutter”
  – Too many warnings
  – Argument may benefit injured users or suppliers

• Federal Hazardous Substances Act
  – Should not bar spontaneous combustion claims
User Liability: Traditional Negligence Analysis

- Was the conduct reasonable under the circumstances?
- To establish liability, we must prove:
  1. User knew or should have known of risk
  2. User failed to take adequate precautions
Spontaneous Combustion
Subrogation Considerations

- Similar to most fire losses
- Requires early, thorough investigation
  - Particularly difficult to prove as cause because source of ignition is the fuel itself
  - Evidence is often highly circumstantial
- Retain product samples / exemplars
- Perform tests if hazard not well known
- Retain counsel early
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