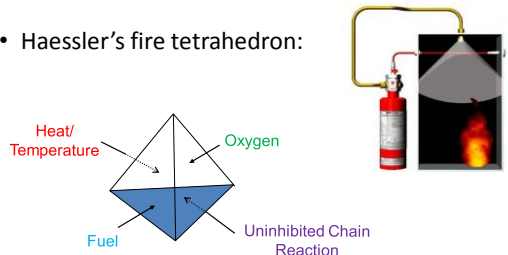


Fire Suppression Systems

A. JAMES CLARK SCHOOL of ENGINEERING • UNIVERSITY of MARYLAND

Mechanisms of Fire Suppression

- Haessler's fire tetrahedron:




The diagram shows Haessler's fire tetrahedron, a four-sided pyramid representing the components of a fire. The vertices are labeled: 'Heat/ Temperature' (red), 'Oxygen' (green), 'Fuel' (blue), and 'Uninhibited Chain Reaction' (purple). To the right of the tetrahedron is an illustration of a fire extinguisher with a hose and nozzle, positioned to suppress a fire.

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Suppression Characteristics: Water

- Cooling
 - Vaporization of water:
 - increase temperature of from 20°C to 100 °C: 330 J/g
 - Heat of evaporation: 2260 J/g
 - 2590 J/g total!
- Oxygen dilution
 - Expansion ratio:
 - Liquid: vapor = 1:1600
 - 1 Liter H₂O → 1.6 m³ steam




A photograph showing a fire suppression test. A large fire is burning in a room, and a fire suppression system is being used to extinguish it. The fire is contained within a structure, and the suppression system is releasing a large volume of steam or gas to smother the fire.

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Special Hazard Suppression Agents





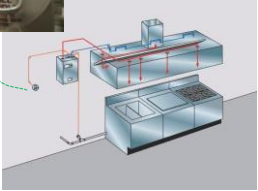


Agent Type	Primary Extinguishing Mechanism	Major Application
CO ₂	Reduces O ₂	Flammable liquids, electrical equipment, record and fur storage
Clean agents	Heat removal	Electronic equipment, water-sensitive objects
Dry chemicals	Interrupts chain reaction, heat removal	Flammable liquids and gases
Foam	Physical separation of air from fuel, suppresses fuel vapors	Flammable liquids

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Manual Suppression




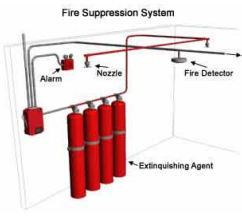
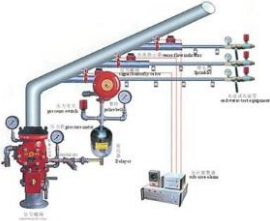


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Automatic Suppression






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Suppression System Design




Suitability for hazard/equipment	<ul style="list-style-type: none"> •Suppression speed/effectiveness •Equipment damage •Agent-fuel interaction
Personnel hazards	<ul style="list-style-type: none"> •Toxicity of agent •Reduced oxygen •Obscuration
Cost	<ul style="list-style-type: none"> •Life cycle cost: design, installation, maintenance •Performance: Direct losses, collateral damage
Fixed agent supply	<ul style="list-style-type: none"> •Agent availability •Recharge availability •Storage requirements
Application methods	<ul style="list-style-type: none"> •Total flooding •Local application

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Special Hazard System Application Examples






- Water **ineffective or hazardous**: e.g. fuel oil tank fire (water may sink to bottom and not float above fuel).
- **Water reactive fuels**: e.g. dry chemical for sodium fire.
- **Collateral damage** by water: e.g. printing press or computer room.
- More **cost-effective** than water: e.g. system for small hazard vs. cost of water main or water tank at remote location.
- **Weight** of water: e.g. aircraft, space shuttle.
- Shipboard **operation**: e.g. machine room on a submarine, flooded space may affect ship balance and/or flotation.

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Clean Agents



<http://www.youtube.com/watch?v=y76c2hQrLEw>

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Foam in Aircraft Hangar




<http://www.youtube.com/watch?v=4EQa4qz8V30>





Summary



- Fire suppression agents act to ‘remove’ one or more sides of the fire tetrahedron
- Fire suppression agents are selected considering:
 - Effectiveness
 - Toxicity
 - Collateral damage
 - Cost

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