

## Fire Protection Hydraulics and Water Supply Analysis

FPST 2483 Unit 01

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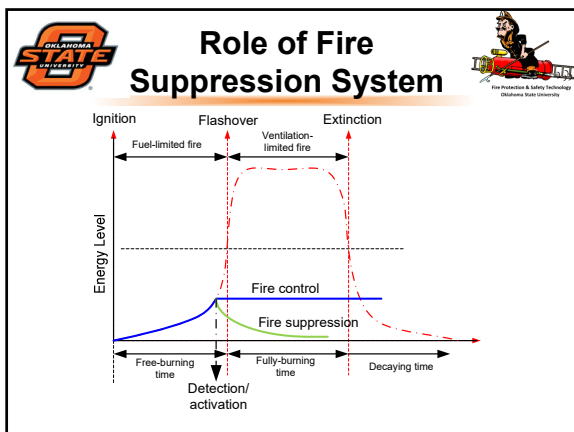
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### Why water ?

- Water is the primary fire suppression agent due to a number of desirable attributes:
  - Low cost                                ---- inexpensive
  - Widespread availability            ---- abundant
  - Relative ease of delivery          ---- economy
  - High heat of vaporization        ---- effective
  - Low toxicity / environmental impact
  - Environmental friendly

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## Extinguishing mechanisms



- Cooling ----- energy
  - Atmosphere / fuel surface
- Smothering ----- energy
  - Expansion of liquid to steam
- Emulsification ----- fuel
  - Immiscible liquids
- Dilution ----- fuel
  - Water-soluble materials
- Covering with foam ----- air

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## How Water Extinguishes Fire



- Cooling the fuel surface, reducing the pyrolysis rate, 'fuel stopping'
- Cooling the flame zone directly, which disrupts the chemical reactions responsible for combustion;
- Volumetric displacement of the oxidant (oxygen), through the product of (inert) water vapor, known as 'flame smothering'

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## Other secondary effects



- Fuel dilution (in the case of water-miscible liquid fuels)
- Fuel blanketing (forming a barrier on the fuel surface)
- Pre-wetting of adjacent combustible surface
- Absorbing thermal radiation through water sprays.

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## Water's Advantages



- Water is inexpensive and readily available in most jurisdictions.




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## Water's Disadvantages



- Reduce surface tension → increase penetrating and spreading abilities. → Wetting agents




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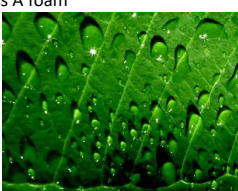

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## Water's Disadvantages



- Water has low viscosity; that is, it flows easily. It does not readily adhere to vertical surfaces. Increase viscosity => increase adhesion → class A foam

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## Water's Disadvantages



Violent reactions can occur when water is applied to certain water-reactive materials, whether they are on fire or not, especially solid metal fire.



Aluminum
Magnesium
Titanium
Zirconium
Sodium
Potassium

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## Water's Disadvantages



- Water freezes at a temperature that is common in many jurisdictions




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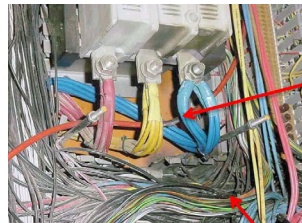

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## Water's Disadvantages



- Water conducts electricity.

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## Summary



- Water remains the most common extinguishing agent. Its physical properties favor fire extinguishment.
  - Cooling the fuel bed --- condensed phase
  - Smothering the flame ---- gas phase
  - Radiation blocking ---- gas phase
  - Separating air ----- condensed phase
  - Emulsion and dilution ----- liquid fuel
- It's inexpensive and readily available.
- It has some disadvantages: freezing, pollution with chemicals, metal fire, electrical fire, control without suppression

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## TEXT CHAPTER 1



### ■ FUNDAMENTAL CONCEPTS

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## Pressure and Force



1. Force is a measure of weight and is expressed in units of pounds.
2. Pressure is force per unit area and is expressed in units of pounds per square inch (psi)
3. Fundamental relationships:
  - a)  $F = P * A$
  - b)  $P = F/A$

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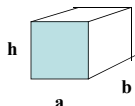
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■ Important to review your basic mathematics, in particular the calculation of various volumes:

■ For a rectangular tank:  $V = a * b * h$




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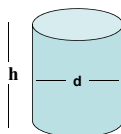
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For a cylindrical tank:



$$V = \pi r^2 h$$

$$r = d/2$$

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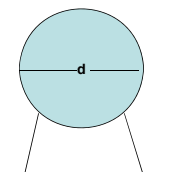
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For a spherical tank:



$$V = \frac{4}{3} \pi r^3$$

$$r = d/2$$

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### Important Conversion factors:



- 1 ft<sup>3</sup>=7.48 gallons
- 1 ft<sup>3</sup>/sec= 449 gpm
- 1 gallon of water weighs 8.3453 lbs

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### Specific Weight and Specific Gravity



1.  $w$  =specific weight = weight density  
where  $w$  is in units of lbs/ft<sup>3</sup>

For water,  $w = 62.4 \text{ lbs/ft}^3$  

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### Specific Gravity



$$S_g = w_a / w_b$$

**The weight density in the denominator is  
Usually for water at 39.2° F which is  
62.425 lb/ft<sup>3</sup>.**

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## METRIC CONVERSIONS



- One gallon = 3.7854 liters
- One GPM = 3.7854 L/M
- One PSI = 0.06805 atmospheres  
= 0.06805 bars  
= 6.805 kilopascals

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## Physical Characteristics of Water



1. Freezing point is 32°F (0° C)
2. Boiling point is 212°F (100° C)
3. For most practical applications water may be considered incompressible. However, its volume will increase when heated above or cooled below 39.2° F.
4. At atmospheric pressure, 1190 BTU are needed to change one pound of water at 32° F into steam.
5. Upon changing to steam, water expands about 1700 times.

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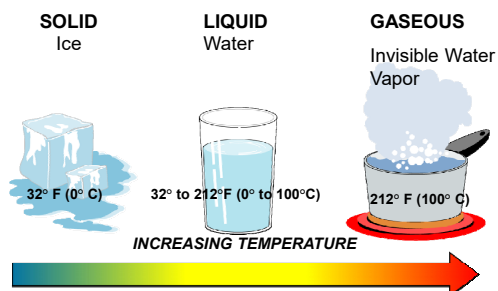
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## Physical Characteristics of Water




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## Specific Heat



- A substance's capacity to absorb heat, every substance has a certain capacity
- Expressed as a ratio between any substance's heat absorbing capacity and that of water
- Water can absorb a large amount of heat.
- Water: 1.0

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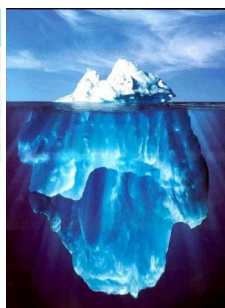
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## Physical Properties



°F	°C	Weight (lb/ft <sup>3</sup> )	SG
32	0	62.416	.9998
39	4	62.425	1.0
50	10	62.408	.9997
80	26.67	62.217	.9967
100	37.78	61.998	.9932




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## Chapter 1 Summary



### ➤ Specific Weight and Specific Gravity

$$S_g = w_a / w_{h20}$$

If  $s_g < 1.0$  floats on water

If  $s_g > 1.0$  Sinks

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- Force may be equated to weight with units of pounds.
- Work is force exerted over a distance with units of ft-lbs.
- Pressure is force divided by the area upon which it acts, with units of psi.
- Unit conversions!!!!
- Metric conversions.

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