The Nature of Fighting Fires with Water Mist Sprays

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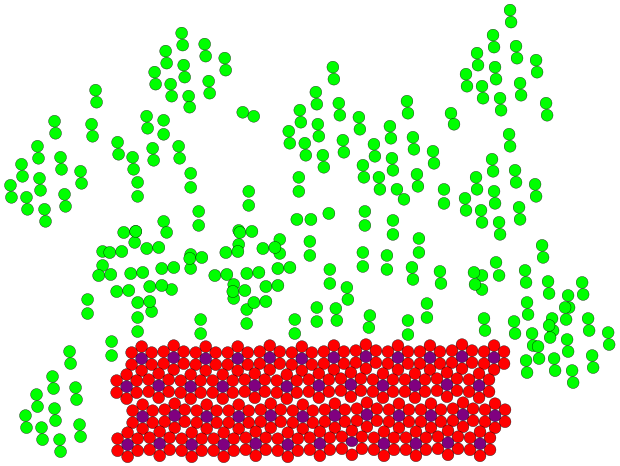
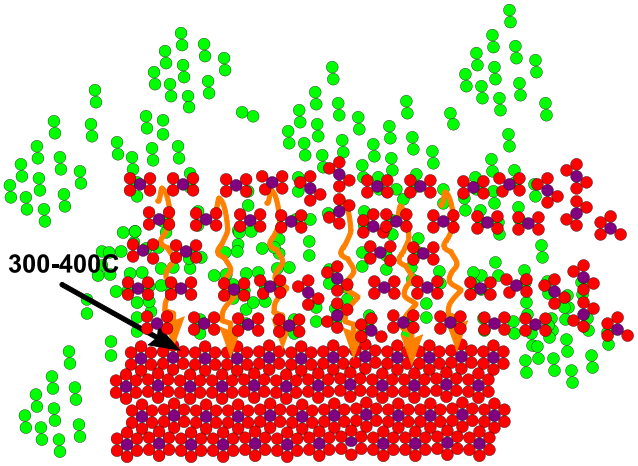
Distribution:

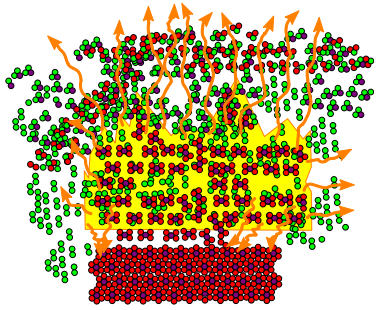
90% of Water in droplet of diametres < 1mm

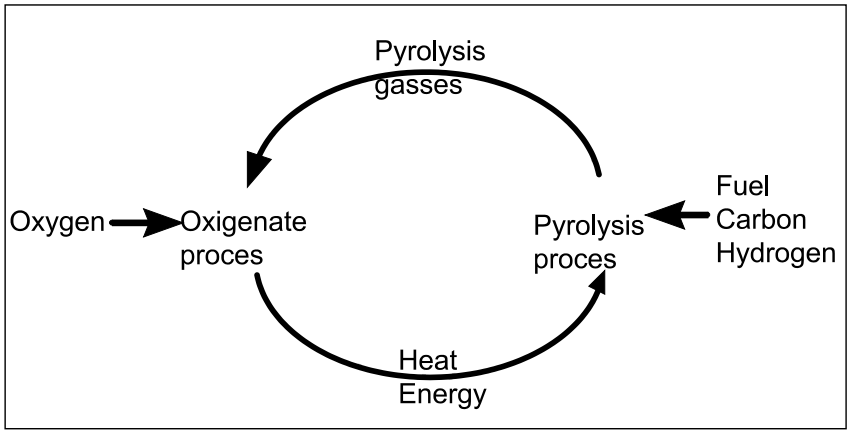
What is a Fire



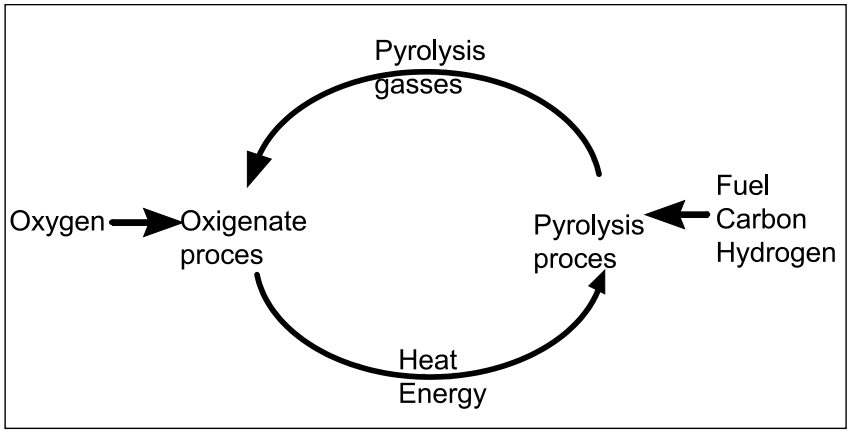


Fire





Fighting Fires



Control of fires

- Fire stop accelerating
- Fires stop spreading

Suppression of fire

- Heat output reduces
- Fire is contained.

Extinguish

- No combustion processes

Water

H(1)

O (16) **Mole**

H (1) 18g

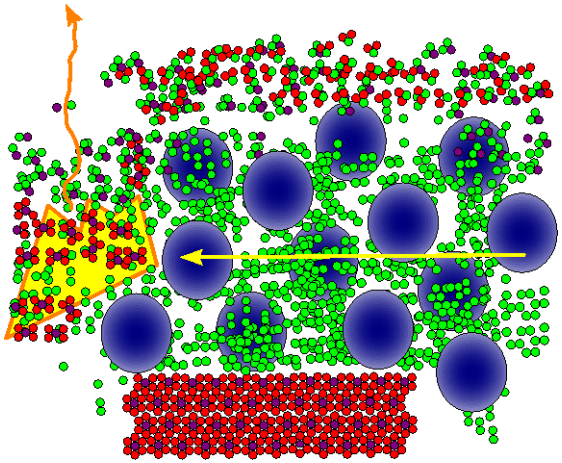
- Water = Liquid H_2O
- 1 mole Water Vo=18 ml
- Steam = Gas H_2O
- 1 mole steam V_o =0,0224m³ (0°C, 1 bar)

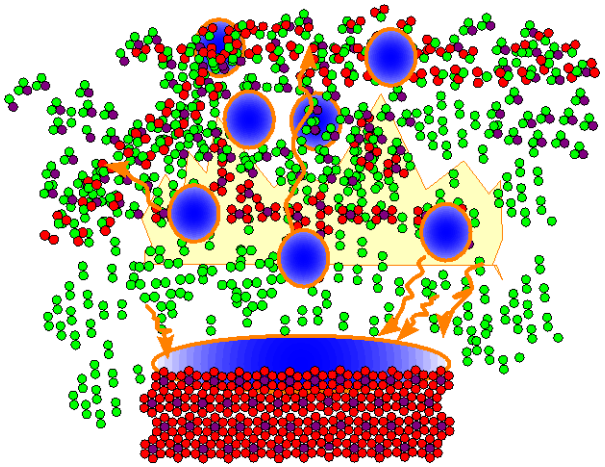
Phase change

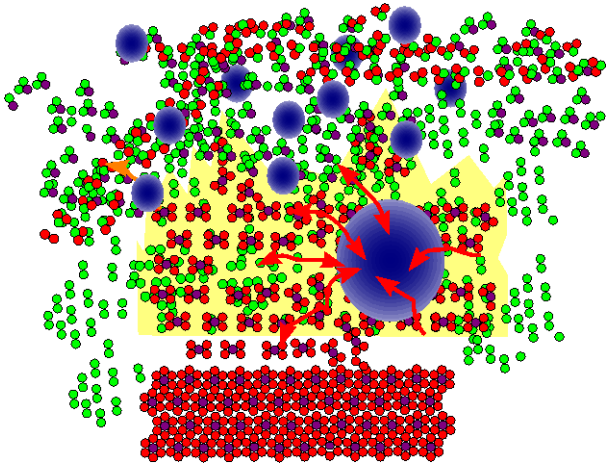
1mole Water + 43000 Joule

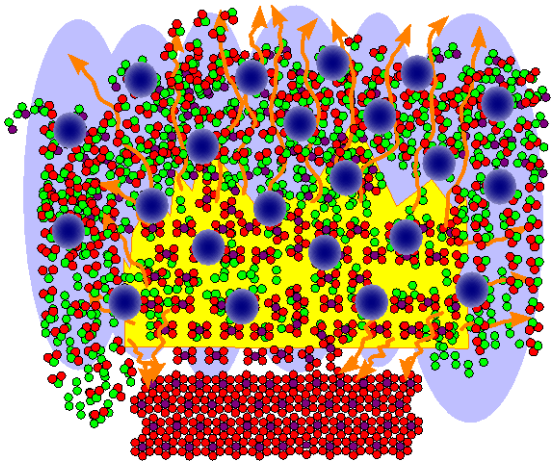
=> 1mole Steam

Methods of Fighting Fires









Chemical fire processes

Oxidation of

Hydrogen-Carbon fuels

1kg O_2 (31,25 moles)

=> heat out put HRR

13.000.000jouls

O_2 concentration > 13%

Ep > Ec => HRR > 0

Fire

O_2 concentration < 13%

Ep < Ec => HRR = 0

Ep = Energy production

Ec = Energy consumption

No Fire

Atm. Gas concentration

N_2 : 78,5%

O_2 : 21%

Co, Co, H_2O_g,< 0,5

Inert gas production

Oxidation processes connects atm.oxygen to hydrogen and carbon from fuel, nitrogen remains in atmosphere =>

CO_2, CO, H_2O (conbustion) + N_2

Inert gases from fires

Nitrogen and combustion reduces O_2 % in the vicinity of oxidation processes

Steam

Steam is an inert gas

Nitrogen is an inert gas

Combust gasses are inert

Calculation examples

Fire size

HRR:13 MW

(8m² hydrocarbon)

Evaporation of water

Max.moles H2O

HRR/47000 = 277 moles/sec = 5 kg/sec

H_2O_g = 6m³/sec (1bar,0ºC)

Oxygen consumption

HRR/13MW = 1 kg/sec =

31,25 moles/sec

Combustion gases

CO_2 ,CO, H_2O: 47 moles/sec

=> 1,04m³/sec (0ºc)

N_2: 118 moles/sec =>2,6m³/sec (0ºC)

Conclusion

Water mist spray primarily fight fires by cooling chemical processes and inerting ambients of oxidation processes.

=>

1. Water mist is most effective in locations with
    1. Large fires => large steam production
    2. High heat => Large steam production & little steam condensation
    3. Enclosures => Reduced oxygen supply => fast oxygen depletion
    4. Little ventilation => increased oxygen depletion effect.

2. Water mist spray mainly fights fires by
    1. Cooling pyrolysis processes
    2. Inerting ambients where the oxidation processes occur.

3. Water Mist sprays may in some situations be applied to blow fires out.

Thank you

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