




UNIVERSITY OF
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Department of Fire Protection Engineering




Products of Fires


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Products of Fires




- Fire is a oxidation-reduction chemical reaction accompanied by light and heat
- Products
 - Energy
 - Chemical species



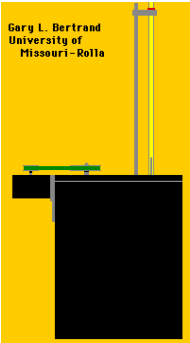
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Heat of Combustion




- Total amount of heat (kJ) generated by the complete combustion of 1 g of fuel




Gerg L. Bertrand
University of
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Heat of Combustion




Fuel	Heat Of Combustion
Wood (oak sawdust)	19.7 kJ/g
Wood (pine sawdust)	22.5 kJ/g
Polystyrene	39.2 kJ/g
Polyurethane	27.2 kJ/g
Polyvinylchloride	16.5 kJ/g
Corrugated carton	13.9 kJ/g
Newspaper	18.3 kJ/g


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Heat of Combustion






- Property used in fuel load calculations
 - Total quantity of fuel present


 - Where mixed fuels are present, combine weights of all fuels through equivalent weight of wood concept:
 - Fuel load = mass of wood that has same heat output as that produced by the mass of another material
 - Example: 10 kg of polyurethane = $(23.2/16.4) \times 10 = 14$ kg wood



Fuel Load



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Fuel Load

- Hospital room experiment:
5 m x 3.2 m = 16 m², Fuel = 64 kg
Fuel load = 4.0 kg/m²
- Basing fire severity *only* on fuel load ignores:
 - Fuel distribution, arrangement
 - Ventilation
 - Compartment construction (insulation)

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Heat Release Rate

- Amount of heat released per unit time (kW)



The graph shows the relationship between Heat Release Rate (Q_h) and Flame Height (h_f) for three fire configurations: Fire adjacent to wall (k=2), Fire in corner (k=4), and Fire away from walls (k=1). The x-axis represents Q_h in kW (top scale, 105 to 10550) and Btu/sec (bottom scale, 100 to 100,000). The y-axis represents Flame height h_f in ft (left scale, 1 to 100) and m (right scale, 0.3 to 30.5). The curves show that flame height increases with heat release rate, and corner fires (k=4) have the highest flame heights for a given heat release rate, while fires away from walls (k=1) have the lowest.

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Heat Release Rate

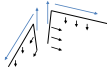
The graph shows the Rate of Heat Release (kW) versus Time (sec) for three furniture items: F32 (sofa), F31 (loveseat), and F21 (single chair). The x-axis represents Time in seconds (0 to 1000). The y-axis represents Rate of heat release in kW (0 to 3000). The curves show that the sofa (F32) has the highest peak rate of heat release (around 3000 kW), followed by the loveseat (F31, around 2000 kW) and the single chair (F21, around 1000 kW). The peak occurs around 200-300 seconds for all items.

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Heat Release Rate

- Ignition scenarios
- Fuel characteristics
 - Type
 - Quantity
 - Orientation
- Enclosure effects
 - Radiation enhancement
 - Oxygen concentration




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Chemical Species

- Organic fuels:
 - For all fuels: CO_2 , CO , H_2O , C , Hydrocarbons
 - Fuel-specific gases: NO_x , SO_x , HCl , Cl_2 , HCN , COCl_2 ...
- Inorganic fuels:
 - metal oxides



Seaside Heights, NJ
Sept 12, 2013

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Summary

- Fires generate energy and gaseous combustion products
- Two important characteristics of fuel packages is their heat of combustion and heat release rate

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