Course Name: Theory of Fire Propagation (Fire Dynamics)

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Week – 07

Lecture – 03

Module 5 – Burning of Solid Fuels

Burning of solids:

With respect to burning of solids the following points have to be understood.

i) Solid-phase **thermal decomposition or pyrolysis** and conditions for sustained flame or ignition.

ii) **Heat and mass transfer** to the unburned fuel causing flame spread.

iii) **Heat released** from the combustion processes that depends upon the **burning rate**.

iv) Conditions for **no flame spread** or **suppression** and **extinction**.

These are helpful in evaluating fire risk, safe separation between buildings, overall assessment of the fire load and consequent impact on the structure and the quantity of water needed to control a given size fire.

Pyrolysis and ignition:

Ignition is defined as observing a sustained diffusion flame in the volatile gases formed over a solid exposed to a heat source. When a solid fuel is subjected to a heat load, molecular bonds break and **volatile gases** are released. This irreversible process is called **pyrolysis**, and the released fuel gases are called **pyrolyzate**. Pyrolysis is different than evaporation. When a vapor of liquid fuel condenses the liquid fuel is got. This is not true about pyrolysis. Typical heat sources are

(i) convective heating from hot gases or flame,

(ii) thermal radiation from surrounding flames and

(iii) conduction from a hot element on the surface.

From the perspective of fire, ignition initiates the fire and is also responsible for its growth. Spread of fire between objects or from one room to another room in a building is also an ignition process.

Time to ignition:

Following Torero (SFPE hand book, 2016), time to ignition is controlled by environmental parameters, listed as:

i) Temperature, pressure, and oxygen concentration and velocity of the gas around the solid.

ii) Magnitude, uniformity, and spectral quality of the incident radiation.

iii) Geometry of the solid, thickness and exposed surface area.

iv) Location and size of the pilot ignition source.

v) Orientation of the surface with respect to gravity vector, exposed to the heat flux, which influences the buoyancy and corresponding flow around the heated object.

vi) In addition, internal factors also control the time to ignition.