Burning Velocity:

- The burning velocities are important because flames are stable only in certain ranges of gas flow rates.
- If the gas flow rate does not exceed the burning velocity, the flame propagates itself back in to the burner, giving *flashback.*
- As the flow rate increases, the flame rises until it reaches a point above the burner where the flow velocity and the burning velocity are equal. This region is where the flame is stable.

TABLE 9-1 Properties of Flames

Fuel	Oxidant	Temperature, °C	Maximum Burning Velocity, cm s^{-1}
Natural gas	Air	1700–1900	39–43
Natural gas	Oxygen	2700–2800	370–390
Hydrogen	Air	2000–2100	300–440
Hydrogen	Oxygen	2550–2700	900–1400
Acetylene	Air	2100–2400	158–266
Acetylene	Oxygen	3050–3150	1100–2480
Acetylene	Nitrous oxide	2600–2800	285

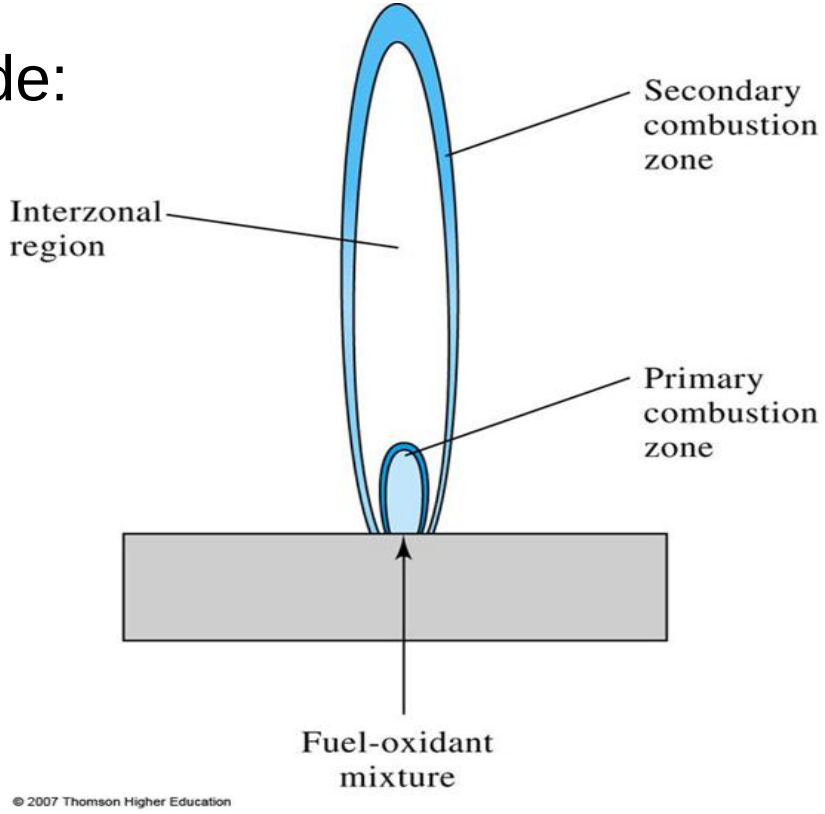
- At higher flow rates, the flame rises and eventually reaches a point where it blows off of the burner.
- With these facts in mind, it is easy to see why it is so important to control the flow rate of the fuel-oxidant mixture. This flow rate very much depends on the type of fuel and oxidant being used.

Flame Structure:

Important regions of a flame include:

1. *primary combustion zone*
2. *interzonal region*
3. *secondary combustion zone*

The *appearance and relative size* of these regions vary considerably with the *fuel-to-oxidant ratio* as well as with the *type of fuel and oxidant.*

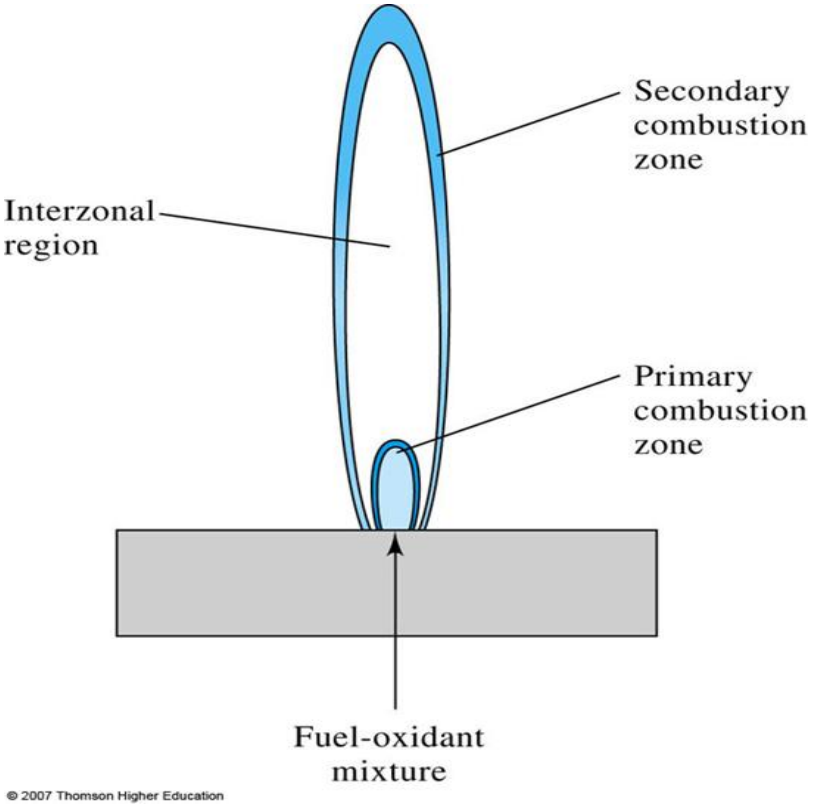


1. Primary combustion zone:

➢ is recognizable by its blue luminescence arising from the band emission of C_2, CH and other radicals, in a hydrocarbon flame . Thermal equilibrium is usually not achieved in this region, and it is therefore, rarely used for flame spectroscopy.

2. Interzonal region:

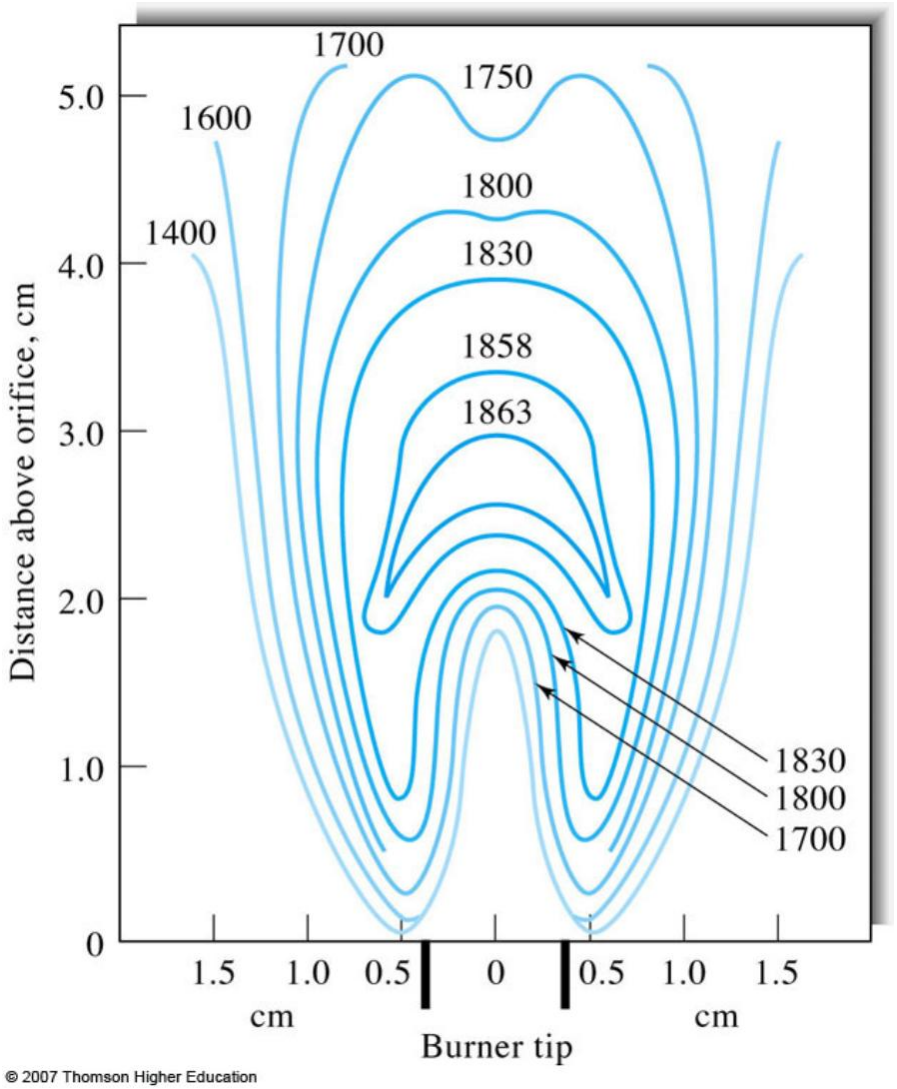
- This area is relatively narrow in stoichiometric hydrocarbon flames, may reach *several centimeters in height* in fuel-rich acetylene-oxygen or acetylene-nitrous oxide sources.
- Since it is often rich in free atoms, it is the most widely used part of the flame for spectroscopy.



3.Secondary combustion zone:

- In the secondary reaction zone, the products of the inner core are converted to stable molecular oxides that are then dispersed into the surroundings.

Temperature Profiles:



- The maximum temperature is located in the flame about 2.5 cm above the primary combustion zone.
- It is important– particularly for emission methods – to focus the same part of the flame on the entrance slit for all calibrations and analytical measurements.

Fig. 9-3. A temperature profile of a typical natural-gas air flame for atomic spectroscopy