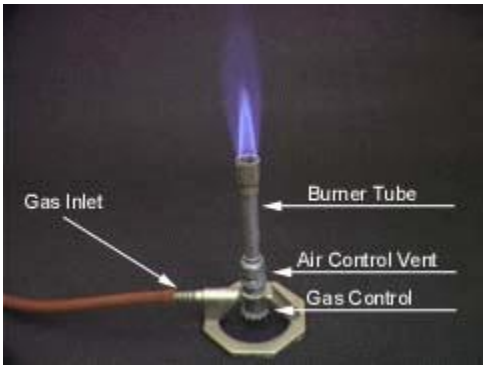
Notes on the Bunsen Burner

The Bunsen burner is one of the most universally used pieces of laboratory equipment. It is named for a German Scientist, Robert Bunsen, who improved the original Michael Faraday device.

It consists of several parts:



The Bunsen Burner burns natural gas (primarily methane, CH_4). The chemical reaction involved (we will learn about equations and combustion later in the class) is:

$$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$$

1 molecule of methane reacts with 2 molecules of oxygen to give
1 molecule of carbon dioxide and 2 molecules of water.

In the absence of enough oxygen, the reaction (incomplete combustion) is

$$CH_4 + O_2 \rightarrow C + 2\ H_2O$$

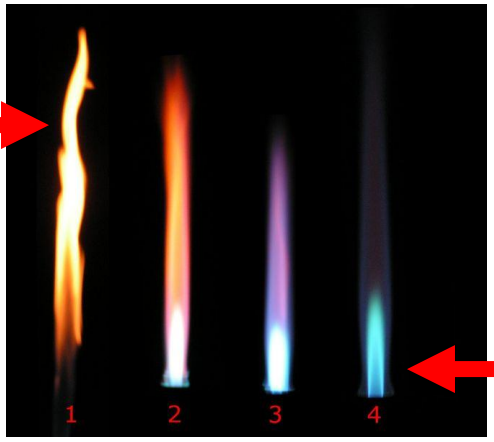
1 molecule of methane reacts with 1 molecule of oxygen to give
1 atom of carbon and 2 molecules of water

This is called a "smoky flame" since the carbon can be deposited as soot on a cool surface. The yellow color in the smoky flame is from glowing bits of pure carbon.

Historically, Thomas Edison used a smoky flame (from numerous kerosene lamps in a small room) to deposit enormous quantities of "carbon black" (i.e. soot) … part of his search for an incandescent bulb filament. The first incandescent light bulbs used this carbon black as a bulb filament.

The appearance of the flame and its temperature are controlled by the ratio of air to fuel that is being burned.

Yellow flame
Incomplete combustion
Color from glowing carbon
Deposits soot
Coolest flame



Blue Flame
Complete Combustion
No soot
Hottest at tip of inner cone
Much of flame invisible from distance

1 = air valve closed
2 = air valve approximately one-half open
3 = air valve nearly totally open
4 = air valve fully open

While the Bunsen burner is a commonly used device in student laboratories, it has been replaced (for safety concerns) in most professional chemical laboratories by hotplates and heating mantles.

Bunsen Burners in Hollywood.

Hollywood, especially in B-Science Fiction movies, typically depicts laboratories as having lots of multi-colored fluids, bubbling beakers (bit of dry ice at the bottom of the beaker), and a lit Bunsen burner. The "Hollywood flame" typically is the most inefficient (large, yellowish, smoky flame, flame 1 above) because this poor quality flame is visible on film. The best (hottest) flames, (translucent blue, flame 4 above), are usually not visible on film.

The Nasty Smell

Natural gas is primarily methane (CH_4) which is both colorless and odorless. Historically, especially in coal mines, large quantities of this undetectable gas posed a major threat of explosion. Miners would carry canaries into the mine. When enough methane was present to pose a danger to humans, the canary would die from breathing the methane. The canary's death was an indication of explosion hazard and the mine shaft would be vacated.

So, to detect gas leaks (and potential explosion threat), a very obnoxious smelling gas, ethyl mercaptan, C_2H_5SH, is added to US gas supplies. This gas is toxic at about 500 parts per million. But, humans are very sensitive to the mercaptan ("rotten egg") smell and most can detect this substance at the part per billion level (a thousand fold safety factor). This nasty smell serves as a reliable indicator that there is a gas leak somewhere in the vicinity.

Using the Burner

There are various mechanical arrangements of Bunsen burners, but the various types all share 2 key components:

1. Barrel
Turning it changes amount of available air
This determines flame quality

2. Valve (on side or bottom)
Controls amount of gas flow
This determines flame height

Barrel:
Turning to left
Opens air slot: flame quality increases

Turning to right
Closes air slot: flame quality decreases

Valve:
Turning to left
Opens valve; flame gets larger

Turning to the right
Closes valve: flame gets smaller