Gasonics 101

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Pressures

The pressure of a gas line determines several factors involved in combustion of a flameworking burner. Therefore, we must learn about how pressure can affect the gases.

We are use to thinking of capacity as being a fixed rate. You cannot fit more product into a shipping box by pushing on it. However, gas works differently. The amount of pressure in the line will exponentially increase the capacity of a burner. By taking a look at some of the charts supplied to you, you can see that where a 71 drill size orifice will only produce 1 cubic foot per hour of natural gas at 1" of water column, by raising the pressure of the line to 1 pound of pressure you can get 5.30 cubic feet per hour from the same orifice size.

Pressure is also directly equal to force. The more force the gases have, the longer the flame will be and the louder the torch will run. Although, it is important to note that pressure can also cause the flame to become unstable and even blow out if raised to high.

Specific Gravity of the Gases

The specific gravity of a gas determines the amount of cubic feet per hour that will result from a given orifice at a given pressure. The chart that designates the flow through a given orifice at different pressures is specifically rated for a specific gravity of 0.60, which is equal to natural gas. However, if propane was used instead of natural gas, you will find that the propane will produce less cubic feet per hour than the natural gas through the same orifice at the same pressure. By looking at the Specific Gravity Correction Factor Chart, you can see that the multiplier is 0.63. For example, if you had an orifice and pressure that produced 100 cubic feet per hour of natural gas, propane under the same specifications would only produce 63 cubic feet per hour.

This is most easily explained as the specific gravity being a direct relation to the mass of the molecule. This means that the smaller the specific gravity, the smaller the molecule. Therefore, the more cubic foot that can pass through the orifice. Although, this is a rather rough scientific explanation, it serves our purposes for the scope of this document.

British Thermal Units

British Thermal Units, or BTU's as they are more commonly known, are a measurement of heat potential. When coupled with flameworking, this becomes a difficult concept to master.

BTU's of a burner are directly relational to the cubic foot of gases burned. Following are some of the more popular fuel gases and their BTU ratings:

Approximate BTU per cubic foot ratings

Natural Gas: 1040
Propane: 2460
Hydrogen: 780

The first thing you may notice is that hydrogen is only 780 BTU's per cubic foot. If you remember that specific gravity determines the amount of cubic foot through a given orifice at a given pressure, than you will notice that hydrogen will produce 3 times the amount of cubic foot per hour than natural gas and 4.76 times the amount of cubic foot per hour than propane will through the same orifice. This means that if you multiply the 780 by 3 and 4.76 respectively, you come out with 2340 and 3,712.8. Therefore, the BTU's from hydrogen are made up not in the heat of the gases, but in the volume of the gases.

Air vs. Oxygen

Of course, one of the big mysteries for flameworkers is "why is it so much hotter when I use oxygen instead of air". That one is actually pretty simple. Oxygen, whether it be pure oxygen or oxygen as a part of air, is necessary to burn the gases. In fact, what you usually see in action movies is someone shooting a gun at a propane tank and the whole thing bursting into a ball of flame. This is one of the fictions of film. In reality, since the propane is stored in a container pure and without air or oxygen, a spark would not cause it to burn. It needs the oxygen to become a flame.

Air is only made up of approximately 20% oxygen. Therefore, pure oxygen is capable of combusting fuel gases at 5 times the efficiency, so therefore you get more BTU's as a result of more fuel gas reaching combustion.

The second thing to know about BTU's and oxygen is that the BTU's are only truly effective if they are focused on the object you wish to heat. 50 pounds of propane is not going to do very much to a Pyrex rod if it's BTU's are spreading all over the room. But if you take all 123,000 BTU's and focus them into one area, they can have an incredible effect on a Pyrex rod, even melting it into a puddle of goop. Oxygen is a more efficient accelerant than air and thus is also a much better focuser.

Below is listing of the oxygen requirements of some of the more popular fuel gases:

Approximate Ratio of Fuel Gas to Oxygen for 'Perfect Combustion'

Natural Gas: 1 to 2
Propane: 1 to 5
Hydrogen: 2 to 1

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BTU vs. Flame Temperature

BTU's are a measurement of the heat potential where as flame temperature is a measurement of the heat of the flame itself. The flame temperature does not ensure that the piece being heated will reach a certain temperature. In fact, flame temperature is a very poor method of measuring the heat potential of a flame.

Flashback

Flashback is when the flame burns down into the burner and possibly even through the lines. This is mostly only seen in pre-mix burners. Surface mix heads deliver the gas and oxygen separately and therefore have little or no chance of a flame burning back into the torch since there is no mixture of the necessary gases until the exit the burner. However this does not make it an impossibility.

Maybe now you are asking, "how can it burn in a gas line if there isn't any oxygen present"? You have to recognize that certain systems are not designed to handle backpressure. If the pressure in the oxygen line were to feed into the gas line, there would be the possibility for combustion to occur in the line. The same is also true of the head of a surface mix burner. Although the likelihood of this is almost nonexistent since this would have to occur in the atmosphere rather than a confined space like piping.

Flashback normally occurs when the speed of propagation becomes dramatically faster than the speed of the gases. The speed of propagation is a measurement of how fast a flame can burn back on a gas. Different fuel gases will have different rates of propagation. Below is a listing of the speeds of propagation of some of the more common fuel gases when mixed with oxygen.

Approximate Speed of Propagation in Feet / Second

Natural Gas and Oxygen: 14.11
Propane and Oxygen: 14.26
Hydrogen and Oxygen: 29.20

So now you can see why Hydrogen can be so dangerous. The flame propagates so quickly, that it can easily burn back into the torch and has the greatest potential to make it back to the tanks.

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