Industrial Technology
Virtual Learning

The science of Oxy-fuel cutting

April 16th, 2020

Objectives

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Virtual Learning

: Look at Oxy-fuel process and safety from a scientific view.

- The difference between Temperature and BTU.
- Alternate Fuels and how they work.
- The effects of pressure as it relates to performance and safety.
- Tip Charts and how they work.
- Oxygen and Fuel consumption.
- Acetylene safety tips.

THE SCIENCE OF CUTTING

Oxy-Fuel cutting, when compared to the GMAW welding process, exhibit some similarities. While the GMAW welding process involves voltage, amps, travel speeds, and distance from the work, Oxy-fuel cutting involves temperature, BTU’s, travel speeds, and distance from the work.

BTU'S

British Thermal Unit (BTU):

A unit of heat equal to 252 calories; *quantity of heat required to raise the temperature of water 1 degree Fahrenheit*. (POWER)

Temperature:

***The degree of hotness or coldness of anything, usually measured on a thermometer.* (HEAT)**

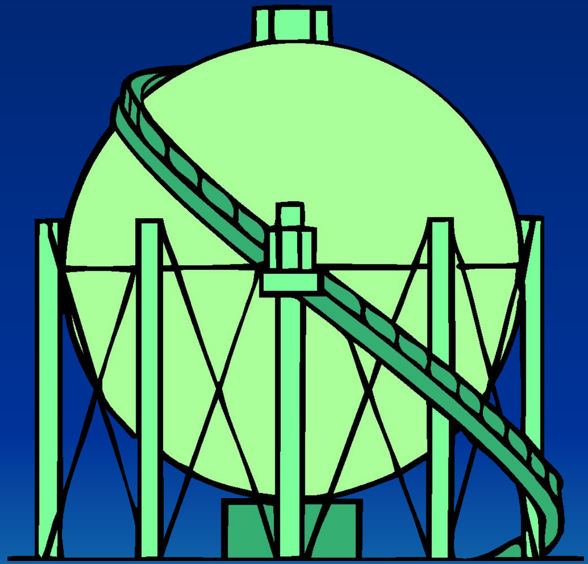
TEMPERATURE

Understanding temperature is critical in relating to the fuel behavior when used for cutting materials. For example; as a fuel burns in a free burning state, the speed at which it burns affects the temperature it produces. When comparing the burning rate of gasoline to wood for instance, the gasoline produces a much higher temperature than wood burning. Applying this to the different fuel gases we use in the cutting process, we find that this is case as we compare burning rates to temperature.

BTU'S

BTU's represent the power or value of a gas as it is mixed with oxygen and in a free burning state. The value can be illustrated again by considering the example of wood burning but for the sake of understanding Temperature verses BTU, lets consider using a fireplace as an example for producing heat for your home. If paper is put into the fireplace it produces a very high temperature but little value in terms of a practical way to heat your home. However, placing wood into the fireplace produces a lower temperature but far more heat value, (power), in terms of providing heat for your home.

Understanding Fuel Gases



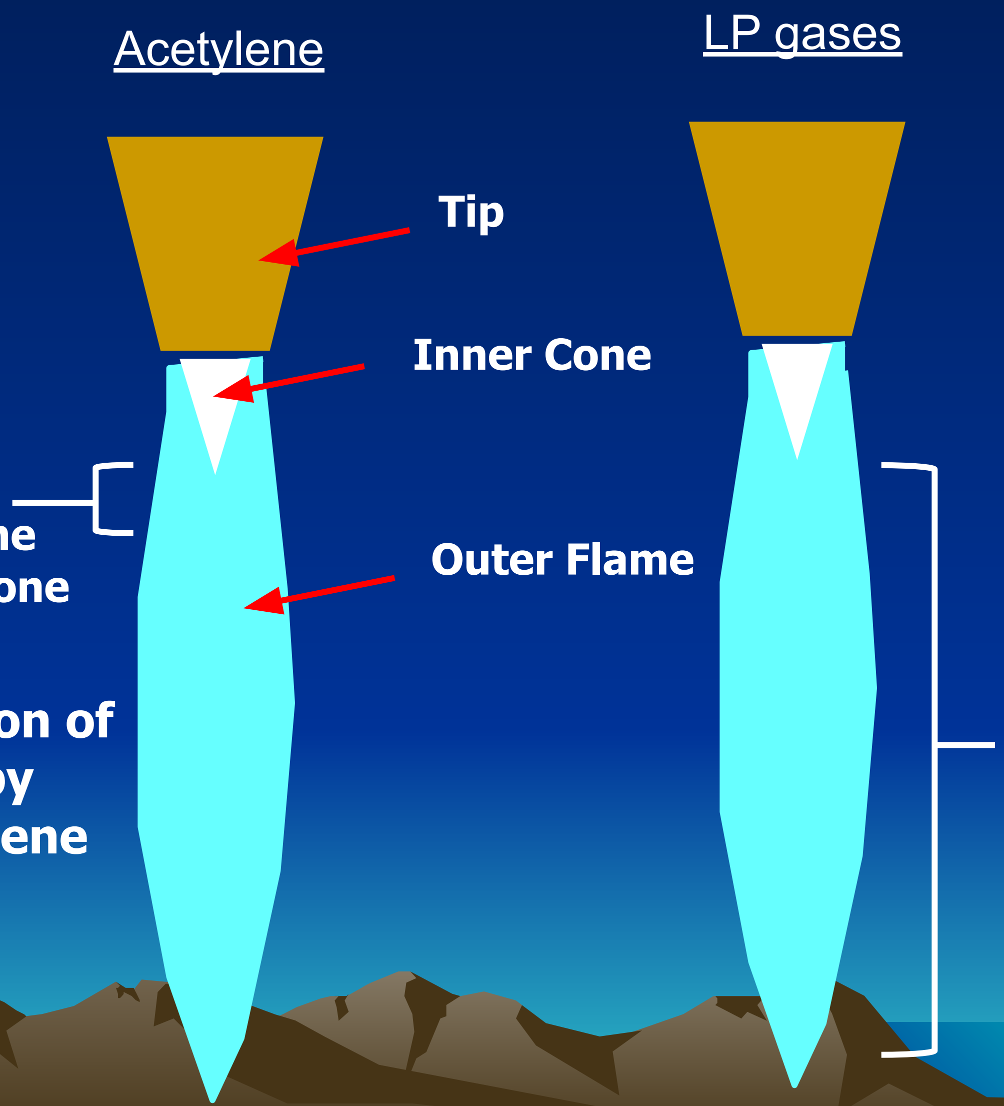
BURNING RATES, BTU'S, AND TEMPERATURES

GAS	BURNING RATE	BTU	TEMPERATURE	
Acetylene	29 FPS	1,450	6,000º	1:1
MAPP	15 FPS	2,400	5,400º	2.5:1
Propylene	13.5 FPS	2400	5,200º	3.5:1
Propane	11.5 FPS	2,600	5,000º	4:1
Natural Gas	10 FPS	1,050	4,800º	2:1

TRAVEL SPEED = TRAVEL SPEED

Travel speed is just as important in the cutting process as it is in the welding process. Using the example of GMAW, we often tell a student to listen to the sound of the GMAW process and notice that it should sound like bacon frying. Likewise in the cutting process you can hear a chattering sound as you reach the proper cutting speeds. This is particularly noticeable when cutting heavier steel.

BTU Location in Flame



Majority of BTUs produced are concentrated at the end of the inner cone

The concentration of heat produced by oxygen & acetylene enables fusion welding

Majority of BTUs dispersed through outer flame

Comparison TO GMAW?

we can see a parallel between Amps and Volts, and Temperature and BTU's.

AMPS = Temperature
VOLTS = BTU's (Basic Energy)
TRAVEL SPEED = Travel Speed
WIRE FEED SPEED = Gas Velocity
DISTANCE FROM WORK = Distance from work

VOLTS & AMPS, TEMPERATURE & BTU'S

Just as *Voltage* provides *heat* to the welding process, *pre-heat temperature* is our heating function in the cutting process to bring the base metal to the kindling point.

Likewise *Amperage* provides the *power* of the arc transfer to accomplish a desired result and *BTU's* provide the *energy value* to the cutting process.

WIRE FEED SPEEDS = GAS VELOCITY

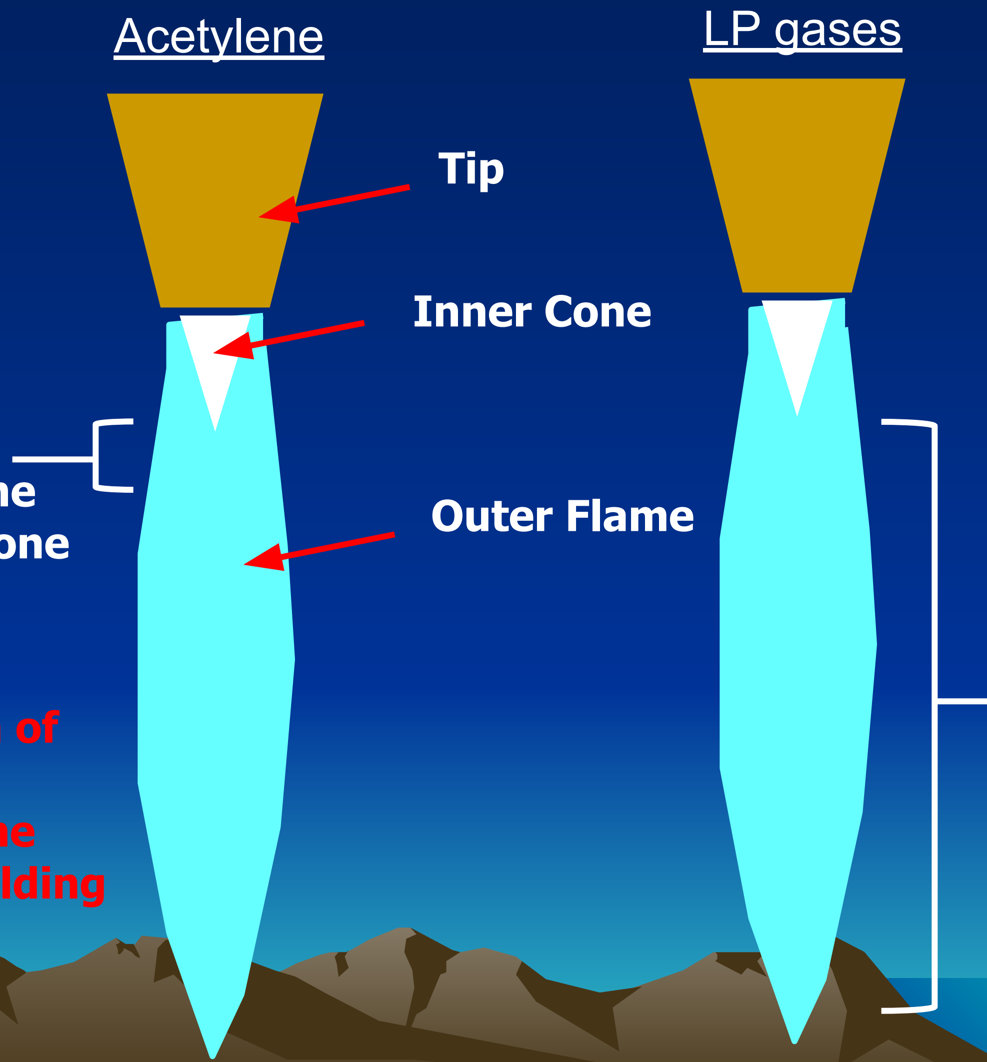
As we consider the wire speed in the GMAW process, we understand the importance of providing the ideal amount of wire that is introduce into the weld puddle. Too little or too much wire feed speed has a negative affect on the integrity and quality of the weld. We find the same condition occurs if the gas velocity is either too strong or too weak. The quality and cleanliness of the cut will suffer.

DISTANCE FROM THE WORK

As the distance from the work determines how well the filler metal transfers into the weld, the distance from the surface has a very great affect on how well the cut is accomplished. As we look again at a previous slide, we can see why distance is important to the quality of the cut.

BTU Location in Flame

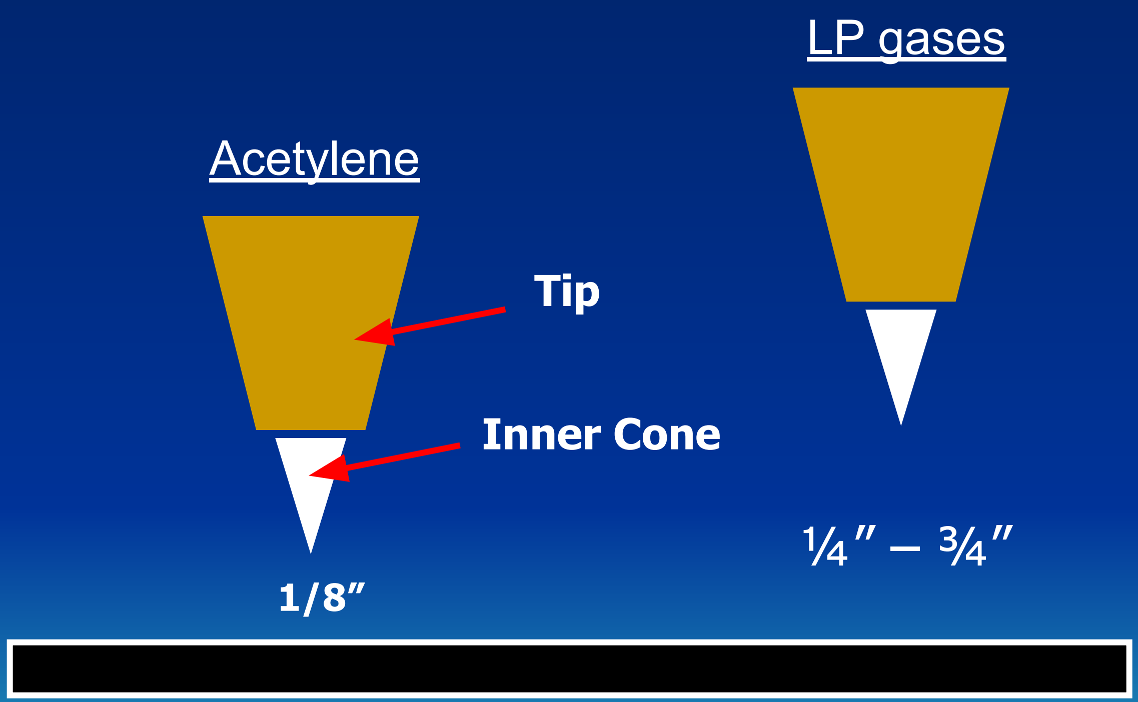
Majority of BTUs produced are concentrated at the end of the inner cone



Majority of BTUs dispersed through outer flame

The concentration of heat produced by oxygen & acetylene enables fusion welding

Pre heat stand-off distances



area MATTERS!

The circle on the left represents a 3” circle and the one on the right represents a 6” circle. How much more area does the circle on the right have than the one on the left?..........................

WHY DO I NEED TO KNOW?

Our first impulse is to answer "two times the area." But if we do the math on this we discover the area to be four times greater.

Pi X Radius Squared = Area

3" Circle

3.14159265 X 1.5 X1.5 = 7.06 Square Inches

6" Circle

3.14159265 X 3 X 3 = 28.26 Square Inches

Lets look at how this applies to cutting

GAS FLOW DYNAMICS

As gas flows through the hose line toward the torch, resistance occurs along the inner-lining of the hose known as turbulence.

This condition is normal and is considered when tip chart recommendations are listed regarding pressure settings. However, our normal reasoning process sometimes causes us to overlook very important considerations as we set-up for cutting.

Often we make changes in our regulator settings or torch valves in order to cut different metal thickness, rather than selecting the proper tip size and consulting the tip chart for recommendations.

CRITICAL VELOCITY

Critical velocity occurs in a hose when the gas flow pressure exceeds the carrying capacity of the hose line. As we increase the gas pressure in our system, the turbulence along the lining of he hose increases and begins to obstruct the "free flow" column which normally exists in the center portion of the hose. The extreme case of this condition is an obstruction, which can actually create starvation resulting in a flashback. The minor result of this condition results in a "cold" flame and very poor quality cut.

OTHER SIZE ISSUES

CONSIDERATIONS REGARDING HOSES

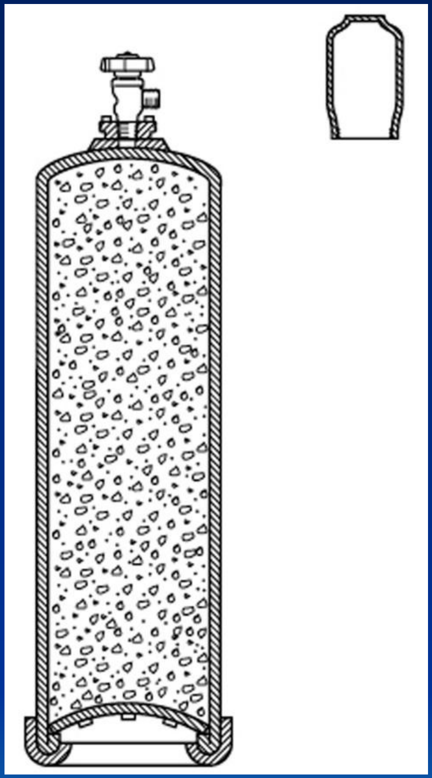
- Application
- Diameter
- Length
- Number of fittings
- Bends or Coils
- Over-all condition and age
- Type of Gas
  (Grade "R" or Grade "T")

TIP CHART

LET'S LOOK AT SOME EXAMPLES ON A CHART

ACETYLENE CYLINDER

- **Fusible Plugs**
- **Shock Sensitive**
- **Calcium Silicate Filler**
- **Flammable**



Average 130 Cu.Ft.

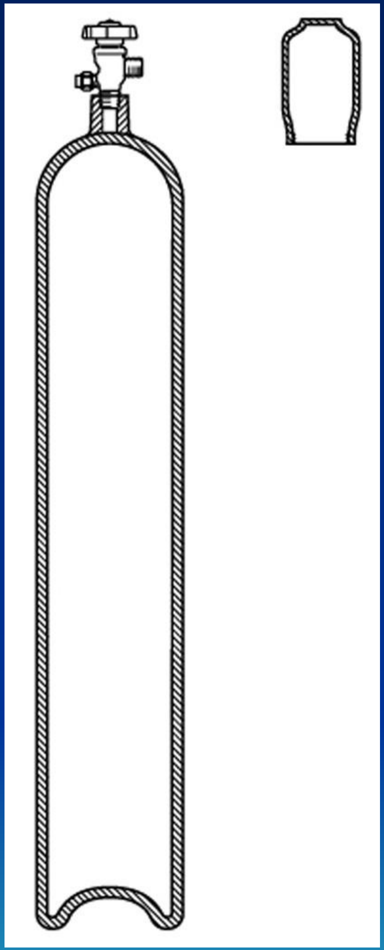
1/7th Rule

Approximately 19 SCFH

HIGH PRESSURE OXYGEN CYLINDER

- Safety Disc
- Hollow
- High Pressure Hazard

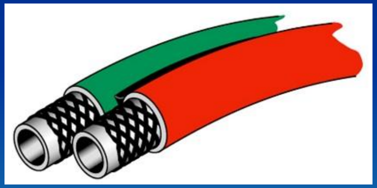
  Vigorously Supports Combustion



Standard 260 Cu.Ft. Capacity

PRESSURE DROP IN HOSES WHILE OXY-FUEL CUTTING

PRESSURE DROPS IN NOMINAL HOSE SIZES FOR OFC				
Possible Pressure Drop is given in Pounds per Square Inch (PSI)				
Hose Diameters	Up to 25 Feet	25 - 50 Feet	50 - 75 Feet	75 - 100 Feet
3/16 Inch	2.6	4.2	6.8	10.6
1/4 inch	- -	- -	2.2	3.4
5/16 inch	- -	- -	- -	- -
3/8 inch	- -	- -	- -	- -



FLASHBACK

A flashback may a occur as a result of conditions which allow the gas to burn inside, rather than outside the torch. When flashbacks occur, an audible “whistling or hissing” is emitted from the tip and sparks can be seen exiting the tip.

Unless immediate attention is given to arresting the flashback, injury to the operator, and or severe damage to the torch may result. In case of a flashback the fuel valve should be close immediately.

Several types of flash arrestors are now available which provide protection against injury to the operator and damage to the equipment. Some are integrated into the equipment and others can be added as optional appliances.

Cross-Section of Flashback Arrestors

Understanding Flashback Arrestors

- Understand flow capabilities
- Increase outlet pressures to compensate for flow restriction
- Torch mount & regulator mount options, best applications
- Auto reset & manual reset designs
- Integrated check valves
- Causes for failure

SMITH STYLE

INOVATIVE FLASH ARRESTOR

SMITH'S EXCLUSIVE DUAL GUARD DESIGN

Victor "VANGUARD" System

Incorporates Flashback Arrestors in the handle

ENGINEERING AT WORK!

Some Engineers have it, some don't.

Special Purpose Tips

For cutting assemblies & hand torches

- **Gouging**
- **Riser & Bulk Head Cutting**
- **Heating**
- **Cylinder & Boiler Tube**
- **Thin Plate Cutting**
- **Welding**

Available in acetylene or LP versions