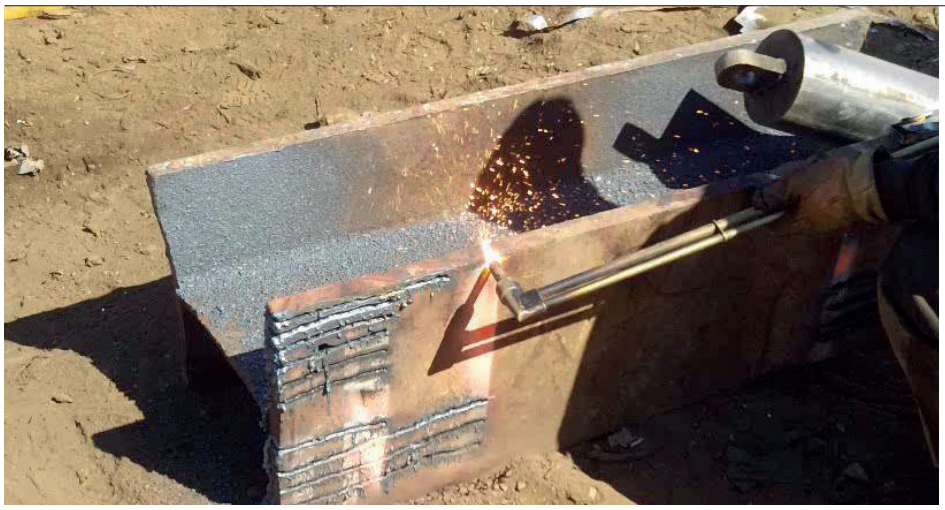


# Oxyfuel cutting

## The effect of oxygen purity

By Erin Meehan and Frank Vonesh

In this article we examine the use of vacuum swing adsorbtion (VSA) oxygen generator producing 95.4% purity in cutting applications in the scrap industry. Typically, cylinder oxygen with 99% purity is used. However, this practice can quickly add up to higher expenses due to cylinder renting fees, higher costs of oxygen, and high delivery fees due to working in more remote locations. With VSA oxygen produced from a deployable oxygen concentrator system (DOCS), there is always a constant flow of oxygen at a pressure of 50-100 psi. It has been noted that when cutting with VSA oxygen, the speed of the cut decreases when compared to cutting with cylinder oxygen.

To better understand this observation, a series of trials were conducted with a total of four fuels and were tested with the different oxygen purities: acetylene, propane, gasoline, and diesel. Typically when acetylene prices are high, other gases are used in place in order to lower overall operating costs. Some customers in South America have also utilized diesel and are successfully cutting their steel material.

Factors other than the purity of oxygen also were observed to have an impact on the cutting speed. For example, more experienced operators were shown to have greater stamina and were able to cut a wider range of scrap with varying characteristics.

When cylinder oxygen was being used, the cylinders would often run out. This would cause a delay in cutting because the operator would need to switch the oxygen source to a new cylinder. This procedure would take up to 10 minutes to switch from an empty cylinder to a full cylinder of oxygen. This does not affect the cutting time directly, but does affect the overall operation time.

**Procedure**

Testing began with using cylinder oxygen to cut through the five different thicknesses of steel in the following order: 0.5", 1.125", 1.5", 2.5", and 3.25". Gasoline was first used for this series, followed by propane, and acetylene. Gasoline and propane were tested because they are used as an alternative in the scrap industry when prices are too high for acetylene.

Multiple torches were used throughout the tests, but all were hand-held torches with adjustable pressure and flow for oxygen and fuel. Once the torch was lit and the operator was ready to cut, time was measured between when the flame of the torch hit the steel until the torch was removed from the steel. This was repeated

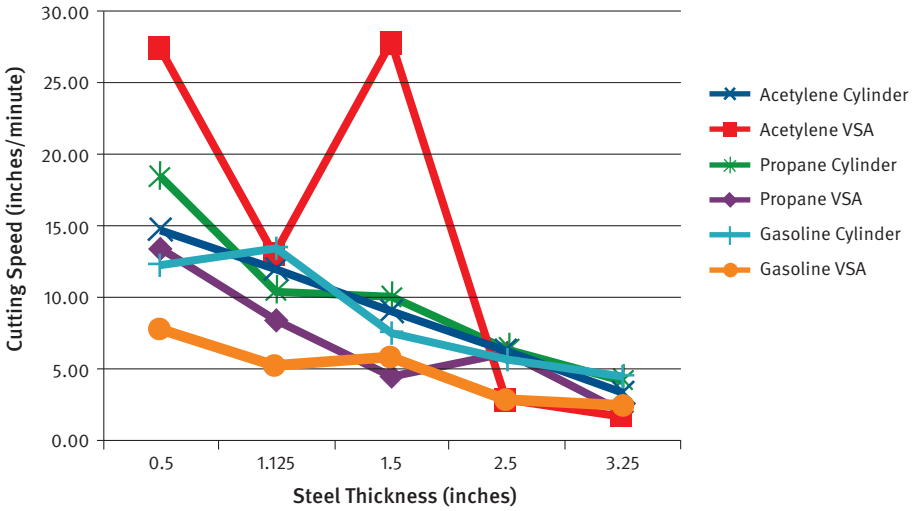
**Figure 1: Cutting Speed of VSA Oxygen Operated Oxyfuel Torch with Different Fuels Testing on Five Different Thicknesses of Steel**
Source: PCI Gases

| | ACETYLENE | | PROPANE | | GASOLINE | | DIESEL |
|---|---|---|---|---|---|---|---|
| Thickness (inches) | Cylinder (inch/min) | 95.40% (inch/min) | Cylinder (inch/min) | 95.40% (inch/min) | Cylinder (inch/min) | 95.40% (inch/min) | 95.40% (inch/min) |
| 0.5 | 13.09 | 26.67 | 16.00 | 11.43 | 9.30 | 6.92 | |
| | 20.57 | 26.67 | 18.00 | 13.58 | 22.97 | 9.00 | |
| | 16.36 | 28.80 | 21.18 | 15.32 | 15.31 | 7.06 | |
| 1.125 | 10.00 | 12.00 | 8.47 | 8.00 | 11.25 | 4.56 | 4.23 |
| | 11.80 | 12.86 | 12.86 | 9.47 | 14.40 | 5.22 | |
| | 14.12 | 14.40 | 10.14 | 7.91 | 15.00 | 5.63 | |
| 1.5 | 9.23 | 8.67 | 5.95 | 5.81 | 6.49 | 4.85 | 2.34 |
| | 10 | 26.67 | 10.00 | 4.09 | 9.35 | 5.89 | 4.54 |
| | 7.91 | 28.80 | 10.14 | 3.77 | 10.75 | 6.67 | |
| | | | 12.41 | | 6.83 | | |
| 2.5 | 4.86 | 2.14 | 5.63 | 5.81 | 4.44 | 2.28 | |
| | 6.99 | 2.75 | 6.21 | 6.55 | 6.05 | 3.31 | |
| | 7.58 | 3.40 | 7.50 | 6.49 | 6.49 | 2.16 | |
| | | | | 2.86 | | | |
| 3.25 | 3.30 | 1.75 | 4.53 | 1.76 | 3.73 | 1.80 | |
| | 3.36 | 1.59 | 3.73 | 2.38 | 4.74 | 2.76 | |
| | | | 4.24 | 1.73 | 5.00 | | |

at least three times for each combination of fuel and thickness of steel. The length of the cut varied from 3" to 12", and was measured after the cutting was completed.

When the cylinder oxygen trials were completed, the same procedure was followed for using VSA purity oxygen. The oxygen purity was monitored before, during, and after cutting. If purity dropped during the cutting, it was noted and removed from the average data series.

**Figure 2: Average Cutting Speeds of Oxyfuel Torch Operating with Both VSA and Cylinder Oxygen, All Fuels and All Steel Thicknesses**
Source: PCI Gases




**Summary**

After the cut times were calculated for each trial, outliers were removed in order to have more accurate comparisons between VSA oxygen and cylinder oxygen. From those times, the average cut times were calculated for each set of thickness, oxygen, and fuel source. This allowed for the percentage difference between the cutting speeds of different oxygen with different variables to be compared directly for multiple trends.

Interestingly, the combination of VSA oxygen and acetylene yielded a faster cutting speed when used on steel plates from 0.5"-1.5", and was most efficient at 1.5". This trend may have continued for the rest of this trial if the correct tip sizes were used based on the thickness being cut. For thicknesses of 2.5" and 3.25" with acetylene, the speed for VSA oxygen was about 50% slower than cylinder oxygen.

For both propane and gasoline, cylinder oxygen consistently performed with faster cutting speeds. This may be due to different values in the heat of combustion between gases. The VSA oxygen used for some of the propane and gasoline trials had also decreased in purity, which would affect the cutting time. VSA oxygen was approximately 36% slower than cylinder when used with propane, and 45% slower when used with gasoline.

**Conclusion**

VSA oxygen that is being used for oxyfuel cutting has the ability to cut through the same thickness of steel that cylinder oxygen can. The difference in the overall time that it takes to cut with VSA oxygen versus cylinder oxygen is dependent on the thickness of the steel being cut, as well as the fuel that is used for the torch. On average, the cutting time decreases by 14% when VSA oxygen is used in lieu of cylinder oxygen. However, VSA oxygen does have the capability of performing at a higher cutting speed than cylinder oxygen when using acetylene and cutting between 0.5" and 1.5". This range could be expanded if the appropriate cutting tip was used based on the thickness being cut.

**"Typically when acetylene prices are high, other gases are used in place in order to lower overall operating costs"**

Cuts made with VSA oxygen on 1.125 inch steel plate. From top left, counter clockwise: gasoline fuel (three cuts), acetylene fuel (three cuts), and diesel fuel (single cut).

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