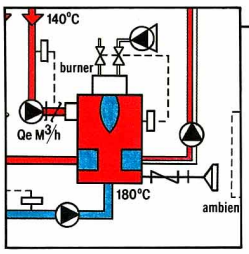


TECHNIQUES AND TECHNOLOGICAL TRANSFERS

OXYFUEL NATURAL GAS CUTTING, A COST SAVING ALTERNATIVE

PROBLEM

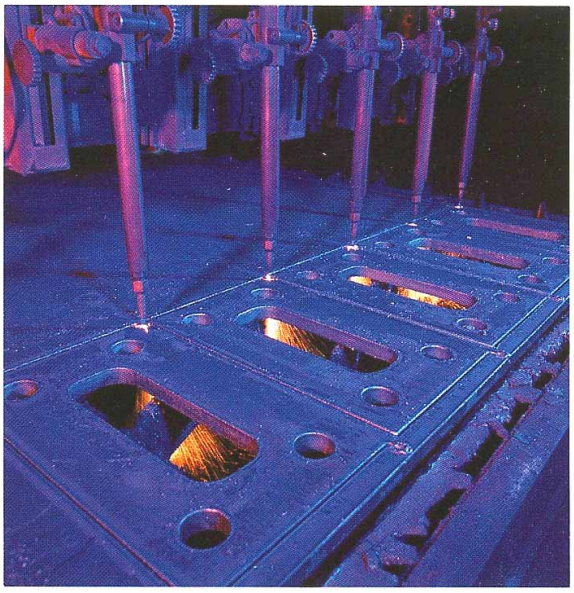
The traditional method used to cut low-carbon steel, oxyfuel gas cutting, is widely spread in the industry. Acetylene, the most extensively used industrial gas about ten years ago, has become a very expensive commodity compared to other options now available.

SOLUTION

Oxyfuel gas cutting using natural gas.

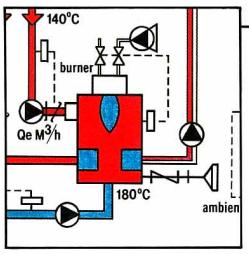
ADVANTAGES

- Possible savings of 25 to 60% on the cost of fuel and oxygen
- Very high quality cutting
- Safer working conditions in plant
- Guaranteed supply directly from the network
- Travel speeds matching those obtained with other gases, such as acetylene



OXYFUEL GAS CUTTING USING NATURAL GAS AT DRUMMOND McCALL

Gaz Métropolitain



DEFINITION OF OXYFUEL GAS CUTTING

Oxyfuel gas cutting is a process used to cut ferrous metals, based on the combustion of iron using pure oxygen.

DESCRIPTION OF THE OXYFUEL GAS CUTTING PROCESS

Oxyfuel gas cutting consists of two successive phases :

- The preheating phase
- The cutting phase

The preheating phase

During this phase, a preheating flame, obtained by burning a mix of gas and oxygen, is used to heat up one point on the iron plate until it reaches ignition temperature in oxygen (i.e. about 1,000 °C.

The cutting phase

A jet of "cutting" oxygen is blown on that particular point and instantly causes the metal to burn, not to melt. This is an exothermic oxidizing reaction, and the heat generated supplements that of the preheating flame. The oxygen blast moving together with the preheating flame cuts the metal through combustion.

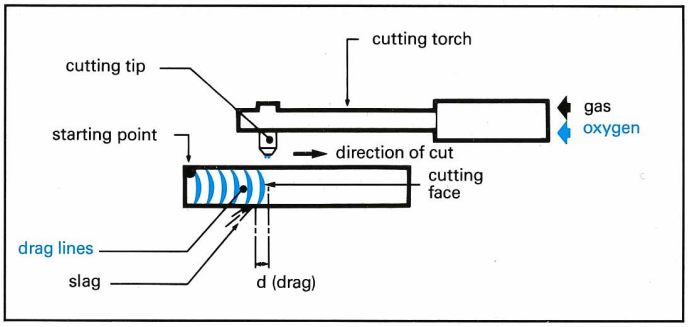


DIAGRAM OF THE OXYFUEL GAS CUTTING PROCEDURE USING NATURAL GAS
(Source: Gaz de France)

END PRODUCT QUALITY

Within acceptable drag tolerances, a cut is considered of high quality when the edge is sharp without any sign of fusion, and there is no tenacious slag on cut surfaces and when surfaces are flat and square.

APPLICATIONS

Alloy composition

- Low-carbon steels: With iron as the main component, they contain less than 0.5% carbon.
- Alloy steels: When the resulting oxides have a melting point higher than that of the metal, they have to be eliminated through a chemical (iron powder) or a physical (sand) process, n addition to the cutting oxygen jet.

Range of applications

The following applications may be performed using an oxyfuel cutting torch:

- shape cutting
- bevelling
- heavy cutting (UP to 1.5 m thick plates)
- riser cutting (after casting)
- scarfing (used in steel mills to condition surfaces of blooms, slabs and ingots)

COMPARAISON OF WIDELY USED GASES

	ACETYLENE	PROPANE	METHYL-ACETYLENE PROPADIENE (MAPP®)	NATURAL GAS
CHEMICAL FORMULA	C_2H_2	C_3H_8	C_3H_4	CH_4
Flame temperature, Practical mix (°C)	3,100	2,820	2,940	2,770
Primary flame (MJ/m^3)	19	10	21	0.4
Secondary flame (MJ/m^3)	36	94	70	37
Total heat (MJ/m^3) (KJ/Kg)	55 50,000	104 51,000	90 49,000	38 56,000
Oxygen required – Stoechiometric mix (vol./vol.)	2.5	5.0	4.0	2.0
Oxygen required – practical mix (vol. (O_2)/vol. comb. gas)	1.5	4.5	3.5	1.8
Explosive limits of mix in air (%)	2.5-80	2.3-9.5	3.4-10.8	4.9-14.9
Volume/Weight ratio at 15.6 °C m^3/Kg	0.91	0.54	0.55	1.4
Specific gravity of gas (air = 1)	0.906	1.52	1.48	0.578

OXYFUEL GAS CUTTING SPECIFICATIONS USING NATURAL GAS

Relevant oxyfuel gas cutting principles remain the same, whether natural gas or any other gas is used to perform the operation.

Minimum preheating time for plate cutting

This is the shortest time required for the preheating blue flame tip to be applied to a specific point on the plate before it is instantly cut by the oxygen cutting jet. (It should be noted that preheating time is very short, or even insignificant, when cutting starts at the edge of the plate).

Depending on the type of cutting tip used, relative preheating time, using natural gas as opposed to commercial propane varies between 1.4 and 1.9. It reaches 3.7 for acetylene and 1.9 to 2.1 for MAPP®.

However, it has also been established fl the industry that the short propane preheating time can be matched with natural gas, provided a special dual speed cutting torch is used :

- a higher flow during preheating
- a lower flow for the cutting process

Preheating time is of relative importance and it would be more appropriate to compare Ibis with cutting time. The lower the ratio, the more natural gas should be considered as cutting fuel.

Maximum travel speed

The cutting fuel has no bearing on the travel speed. Allowing a permissible drag, travel speeds using natural gas match those produced by other means, namely acetylene. This is too often overlooked when considering natural gas. Natural gas is particularly profitable on long cutting operations since it is the cheapest buy.

Cutting quality

Oxyfuel gas cutting using natural gas gives a high quality cut with no edge fusion and hardly any drag line. Moreover, the thin layer of oxides does not stick to the surface, which does not require grinding. From a metallurgical standpoint, a low carburization of the cut edge simplifies the touching up procedures.

NECESSARY FLUID FLOW

SPECIFICATIONS FOR CUTTING CLEAN LOW-CARBON STEEL (manual, machine cutting) SI						
Steel thickness (mm)	Cutting orifice diameter (mm)	Cutting speed (mm/s)	Gas flow (l/min.)(1)			
			Cutting oxygen	Acetylene	Natural gas	Propane
3.2	0.51 - 1.02	6.8 – 13.5	7.1 – 21.2	1.4 – 4.3	4.3 – 11.8	1.4 – 4.7
6.4	0.76 – 1.52	6.8 – 11.0	14.2 – 26.0	1.4 – 4.3	4.3 – 11.8	2.4 – 5.7
9.5	0.76 – 1.52	6.4 – 10.1	18.9 – 33.0	2.8 – 5.7	4.7 – 11.8	2.4 – 7.1
13	1.02 – 1.52	5.1 – 9.7	26.0 – 40.0	2.8 – 5.7	2.4 – 7.1	2.4 – 7.1
19	1.14 – 1.52	5.1 – 8.9	47.2 – 70.9	3.3 – 6.6	7.1 – 14.2	2.8 – 8.5
25	1.14 – 1.52	3.8 – 7.6	51.9 – 75.5	3.3 – 6.6	8.5 – 16.5	2.8 – 8.5
38	1.52 – 2.03	2.5 – 5.9	51.9 – 82.6	3.8 – 7.6	8.5 – 16.5	3.8 – 9.4
51	1.52 – 2.03	2.5 – 5.5	61.4 – 89.6	3.8 – 7.6	9.4 – 18.9	3.8 – 9.4
76	1.65 – 2.16	1.7 – 4.7	89.6 – 142	4.3 – 9.4	9.4 – 18.9	4.3 – 10.4
102	2.03 – 2.29	1.7 – 4.2	113 – 170	4.3 – 9.4	9.4 – 18.9	4.3 – 11.3
127	2.03 – 2.41	1.7 – 3.4	127 – 170	4.7 – 11.6	11.8 – 23.6	4.7 – 11.8
152	2.41 – 2.67	1.3 – 3.0	123 – 236	4.7 – 11.6	11.8 – 23.6	4.7 – 14.2
203	2.41 – 2.79	1.3 – 2.1	217 – 293	7.1 – 14.2	14.2 – 26.0	7.1 – 15.1
254	2.41 – 2.79	0.85 – 1.7	274 – 331	7.1 – 16.5	16.5 – 33.0	7.1 – 16.5
305	2.79 – 3.30	0.85 – 1.7	340 - 401	9.4 – 18.9	21.2 – 44.9	9.4 – 21.2

(1) Preheating oxygen flow (l/min)

With acetylene = 1.5 x acetylene flow
With propane = 4.5 x propane flow
With natural gas = 1.8 x natural gas flow

CUTTING FUEL COST COMPARAISON

	ACETYLENE	PROPANE	MAPP®	NATURAL GAS
Fuel gas flow (l/min)	11	6	7	16
Preheating oxygen flow (l/min)	17	27	25	29
Cutting oxygen flow (l/min)	250	250	250	250
Cutting time for 10 metres (h)	1.63	1.63	1.63	1.63
Fuel gas cost per m^3	$10.60	$1.21	$2.50	$0.22
Oxygen cost per m^3	$1.40	$1.40	$1.40	$1.40
Fuel gas cost per 10 metres cut	$11.40	$0.71	$1.71	$0.34
Preheating oxygen cost per 10 metres cut	$2.33	$3.70	$3.42	$3.97
Total cost per 10 metres cut (Peheating oxygen and fuel gas)	$13.73	$4.41	$5.13	$4.31

NOTES:

This chart contains data calculated from the two previous tables, for a 20cm thick plate.

The data on the cost of gases may vary according to region, monthly volume and supplier.

SUMMARY OF ADVANTAGES

- Substantial cost savings
- Very high quality cutting
- Safer working conditions fl plant
- Guaranteed supply directly from the Gaz Métropolitain network
- Matching cutting speeds

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