Economics of Air Plasma Cutting — Myth and Reality

S. Ghoshal* & GL. Mukhopadhyay*

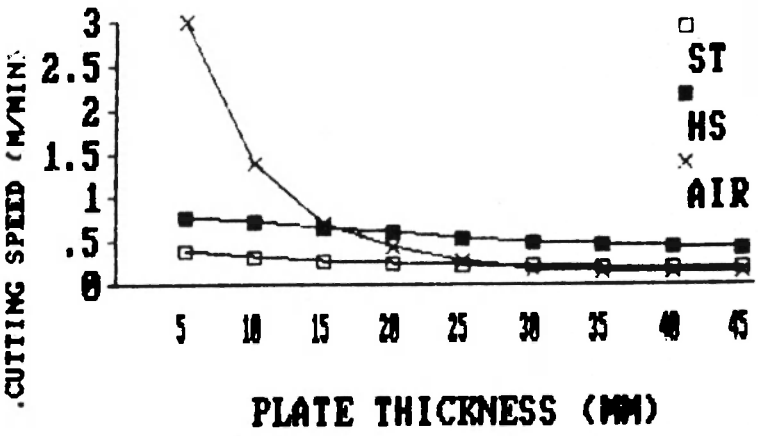
INTRODUCTION

Air-plasma cutting is becoming popular and a practical alternative to oxy-cutting for cutting of mild steel in many fabrication industries. The main advantage lies in the fact that air-plasma cutting is much faster than oxy-cutting. It is therefore expected that it will reduce the cutting cost by accomplishing the cutting much faster. This is unfortunately, not necessarily true. This paper analyses the truth behind this and attempts to identify the conditions which will ensure maximum benefit from air-plasma cutting.

CUTTING SPEED

Figure 1 shows the cutting speeds of oxy-cutting with standard nozzles, oxy-cutting with HS (High Speed) nozzles and air-plasma cutting, plotted against different plate thicknesses.

From the graph, it is seen that the cutting speed of air plasma for cutting 5 mm MS sheet is approximately 3 m/min which is about 4 times faster than HS oxy-cutting. However, the speed of air-plasma cutting drops sharply with increase in plate thickness and it is seen that above 15 m thickness air-plasma is not faster any more compared to HS oxy-cutting. Therefore, air-plasma cutting of MS plates of thickness 15 mm and above can give no advantage over oxy-cutting as far speed is concerned.



ST = OXY-CUTTING WITH STANDARD NOZZLE
HS = OXY-CUTTING WITH HIGH SPEED NOZZLE
AIR = AIR-PLASMA CUTTING

Figure 1 : Cutting Speed

TOTAL CYCLE TIME

Table 1 shows a typical example of cutting with a CNC machine. taken from the shop floor. Here we can see that the cutting speed (or the cutting time) is not the only ☞

TABLE-1

	Activity	Oxy-cutting (Standard)	Oxy-cutting (High Speed)	Air-Plasma
1	Plate loading & positioning	5	5	5
2	M/C set up & call program	10	10	10
3	Cutting time	75 (@ .3 m/min)	29.6 (@ .76 m/min)	16 (@1.4 m/min)
4	Unloading of plate & scrap	10	10	10
5	Nozzle mtc & operators pers. time	5	5	5
6	Total Cycle Time	105	59.6	46
7	Reduction in Total Cycle Time compared to oxy-cutting (standard)	x	43%	56%
8	Reduction in Total Cycle Time compared to oxy-cutting (High Speed)	x	x	22%
	Plate Thickness = 10 mm Total Cutting Length = 22500 mm Note : All times in minutes			

The authors are presently associated with ESAB India Ltd.

factor which decides the productivity — it is the Total Cycle Time (TCT), and it includes many other factors besides the cutting speed. Taking all these into consideration, we can see from the table that for a plate thickness of 10 mm, although the actual cutting time is about half compared to HS oxy-cutting, the TCT has come down only by 22%. In other words it is clear that the cutting cost does not go down in the same proportion as the cutting time as is often thought. Instead, it depends on the TCT. And the reduction in TCT is not so dramatic like the reduction in cutting time.

The above findings now can be presented in the form of a graph as shown in Figure 2. Here we can see that the TCT of air-plasma cutting is reasonably lower than HS oxy-cutting in the lower thicknesses, and the advantage reduces sharply with increase in thickness, disappearing at 15 mm thickness. It must be noted that the advantages, even at lower thicknesses, quite contrary to the normal expectation, is not so spectacular like the difference in cutting speeds.

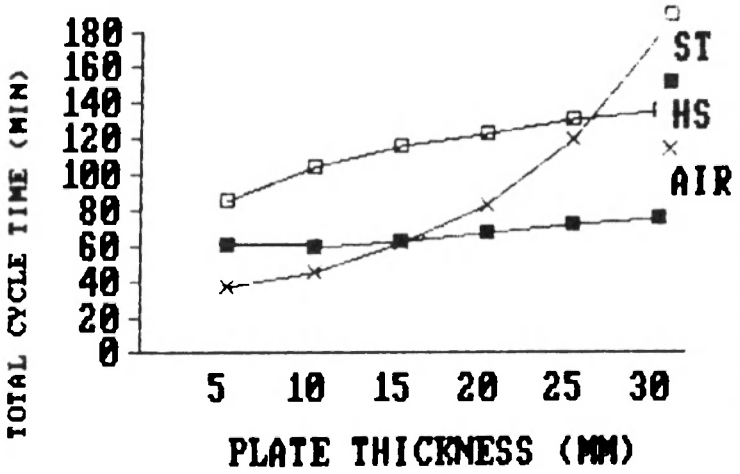


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Figure 2 : Total Cycle Time

It may be mentioned here that similar exercise with optical cutting machine will result in even poorer improvement in TCT with air-plasma since the "machine utilisation factor" of optical cutting machines are much lower because of much higher setting up and positioning time required. Furthermore, the high speeds required for plasma cutting of smaller thicknesses are generally not possible with optical control. This is precisely the reason why plasma cutting of mild steel is becoming popular only after the advent of CNC machines.

COST OF CUTTING

Because of higher cutting speed in air plasma it is expected that the cutting cost would be much lower because much less man-hour will be required to accomplish the same job. However, we have seen earlier, the reduction in man-hour required to accomplish the job is directly related to the reduction in the TCT and not the cutting speed.

Therefore, as we see from Figure 2, that in lower thicknesses air-plasma cutting can result in reasonable reduction in cost of cutting. The benefit reduces with increase in thickness and disappears at 15 mm thickness.

However, it must be borne in mind that the cost of consumables and power are much higher in air-plasma cutting compared to oxy-cutting, and the cost goes up further with increase in job thickness. Therefore, in practice, the benefits above 10 mm are offset by the higher cost of consumables. Experience shows that there is no practical advantage to be gained by air-plasma cutting above 10 mm.

It would be interesting to note from the above graph that the reduction of TCT in case of HS oxy-cutting compared to standard oxy-cutting is more consistent over a wider thickness range. In other words, it is possible to gain more effectively in terms of reduction in cutting cost by switching over to HS oxy-cutting, if standard nozzles are presently being used.

QUALITY OF CUTTING

Generally the cut quality in plasma cutting is inferior to oxy-cutting. Like all types of plasma, air-plasma produces a taper cut and in practice this taper can go upto 14° depending on the quality of the torch used and setting of the operating parameters. Therefore, in order to get the advantage of lower cost of cutting, one must be prepared to accept the inferior quality of cut.

Table 2 shows a comparison of cut quality between oxy-cutting and plasma cutting as per DIN 2310. It is

COMPARISON OF CUT QUALITY (TABLE-2)

DIN 2310 (CLASS 1)

	THK	OXY -CUT	PLASMA-CUT
PERPENDICULR TOLERANCE μ in MM	10	0.17—0.5	1—1.3
	40	0.3—0.8	1.7—2.2
R_z IN μM	10	45—80	55—90
	40	65—115	70—120

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CONCLUSION

The man-hour required to accomplish a cutting job and consequently the cutting cost depends on the Total Cycle Time. Therefore the TCT in each case must be calculated in order to assess the exact amount of benefit to be expected in shop floor by switching over to plasma cutting. It must be remembered that the cost of consumables in air-plasma cutting is higher than oxy-cutting.

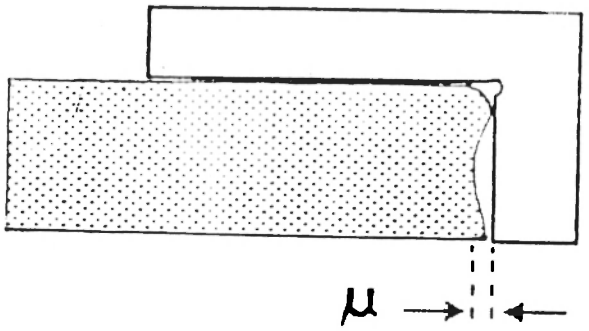

Fig. 3

In view of this, air-plasma cutting can be of practical advantage only put to 10 mm thick MS. Beyond which, inspite of the marginally higher cutting speed, higher cost of consumables make it uneconomic and it is seen from experience there is hardly any practical advantage to be gained in terms of reduction in cutting cost. In fact, the maximum advantage of air-plasma cutting is in cutting of sheet metals, i.e., thicknesses below 3 mm put to gauge thickness where oxy-cutting becomes difficult.

The quality in air-plasma cutting is always inferior to oxy-cutting and therefore one should be prepared to make a compromise in quality to get the benefit of lower cutting cost.

It may often be more worthwhile to switch over to HS oxy-cutting if presently standard nozzles are being used and most of the jobs involve plates of thicknesses 10 mm and above. This is because HS oxy-cutting will give effective reduction of TCT over a wider range of thicknesses. ■

PRESS RELEASE

Mr. Gulu H. Malkani, Chairman, Advani-Oerlikon Limited has been re-elected as Chairman of Welding Consumables and Equipment Division, Association of Indian Industry, Delhi