Cutting of Stainless Steel by New Type Powder-Oxygen Cutting Method†

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Oxygen cutting, as applied to mild steels, is excellent and economical method to high quality cutting surface. But, oxygen cutting is practically inoperable on stainless steel without this fluidity at the start of cut for chromium oxide formed by the oxidation. During the 1940s, the studies on stainless steel cutting were reported [1),2)]. Those conventional powder cutting methods, in which iron powders are blown into the oxygen stream from the outside of nozzle preheat flame, had the unavoidable problems of evolving fume and dust and cutting efficiency. Therefore, plasma cutting method has usually been used on stainless steel cutting in present day.

In this experiment, a new type powder cutting method, in which iron powders are introduced directly into the cutting oxygen stream from a powder dispenser, was adopted. In this method, three phenomena which assist the cutting of stainless steel may occur; first, the oxidation of iron powder due to oxygen is an exothermic reaction and increases the temperature at cut surface, secondly, the oxide changes the concentration of chromium oxide involved in molten oxide layer allowing a fresh lower chromium oxide surface to be presented to the cutting oxygen stream at all times and thirdly, the abrasive effect of iron powder in higher pressure oxygen stream is recognized.

This investigation is carried out so that we clear the main action of iron powder on cutting stainless steel, and obtain higher cutting efficiency and better cutting surface quality. Photo. 1 shows powder-oxygen cutting stream, and Fig. 1 is the flow chart of both preheating gas and iron powder suppling circuits in this apparatus. As preheating gas, propane is used. The iron-powder is aspirated into the cutting oxygen stream by giving the pressure difference between inlet and outlet of the powder dispenser. Powder amount aspirated into cutting oxygen stream can be controlled by a needle valve equipped to the conductor pipe of outlet. In this powder cutting, various factors, such as nozzle diameter, cutting oxygen pressure, preheating gas flow rate, amount of powder consumption and size of powder particles etc., should be considered for stainless steel cutting ability.

In the first stage of this study, the experiment was made to know the effect of amount of iron powder blown into cutting oxygen on the cutting speed of stainless steel (SUS 304). The relation between the powder amount and the limit of cutting speed, at that the lose cut phenomenon is brought out, is shown in Fig. 2. The other cutting conditions are constant; plate size is 100x

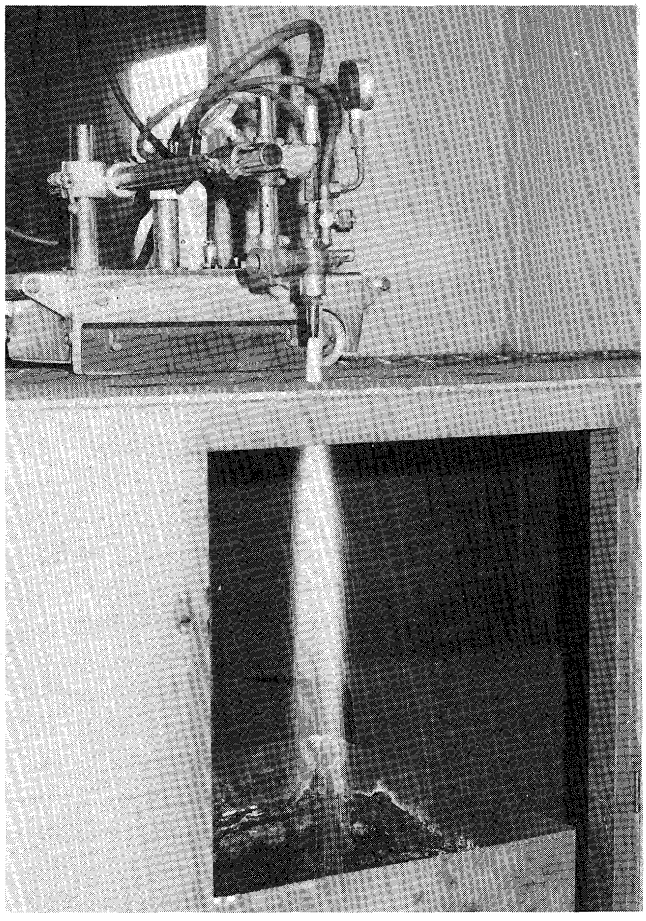

Photo. 1 Jet powder-oxygen stream

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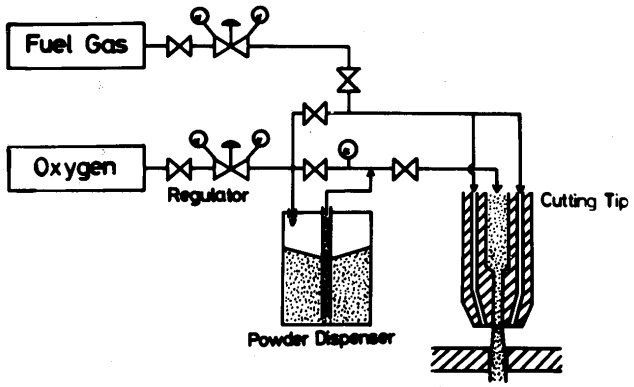

Fig. 1 Schematic diagram of experimental apparatus

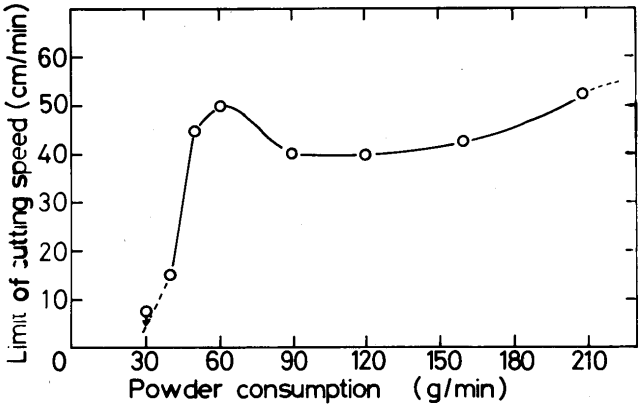

Fig. 2 Relation between limit of cutting speed and iron powder amount used for 12mm thick stainless steel

300x12mm^t, nozzle diameter 2.0mm, cutting oxygen pressure 3kg/cm^2, preheating gas flow rate 300 ℓ/hr and particle size of iron powder 200 mesh. From this result, we note that stainless steel cutting is very difficult by this method, when powder amount used for one minute is less than about 45 gr. However, more powder consumption amount than 50–60 gr are very effective for the cutting of stainless steel. Similar phenomenon is obtain, also in the case of more thicker plates than 12 mm. But the decreasing of speed at 90 gr/min of iron powder amount was not observed for both 32mm and 60mm thick plates. From the above results, we know that the reasonable powder amount is required on cutting effectively some thick stainless steel plate by this method, and its iron powder amount was about 60 gr/min for 12mm, 32mm and 60mm thick plates under tested conditions. Therefore, it is considered that the combustion effect, the lowering effect of chromium concentration in molten metal oxide layer and the mechanical abrasion effect etc. should be recognized clearely at the increasing state of cutting speed. However, at the stage of constant cutting speed, these effects may be saturated for the cutting ability already. In Photo. 2, the resultant cut surface is shown. Quality of the surface may be compared favorably with that obtain in oxy-acetylene cutting of plain carbon steels. The more studies are doing in order to make clear the mechanism of powder cutting.

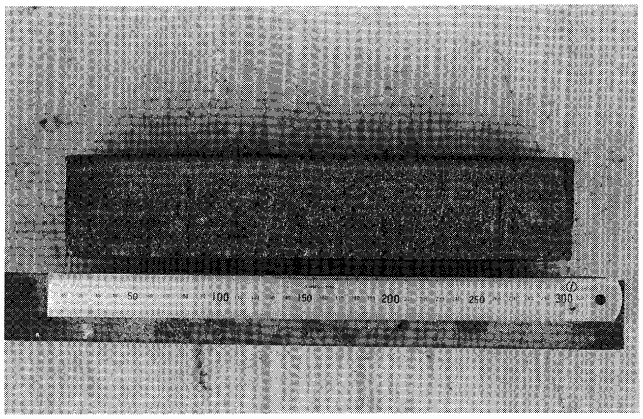

Photo. 2 Typical cut surface of stainless steel (t=60mm)

References

1) Howard G. Hughey: "Stainless Steel Cutting", Welding Journal, Vol. 26, No. 5, P.393, (1947)
2) C. W. Powell: "Powder Cutting and Scarfing of Stainless Steels", Welding Journal, Vol. 29, p. 308, (1950)