3.1 Flame cutting

Flame cutting, using a combination of a fuel-gas and oxygen, is a commonly used method for both cutting and edge preparation of a range of steel plate qualities. Conventional flame cutting utilises a cutting torch equipped with a tip that enables the dual functions of preheating the steel to ignition temperature and directing a stream of high-pressure oxygen through a centrally located orifice to perform the cutting.

Acetylene and LP gas are the most commonly used fuel gases for the preheating flame, although natural gas and town gas are also used. Oxygen is fundamental to the process as it chemically combines with the preheated steel (at around 700°C). This chemical oxidation reaction liberates considerable amounts of additional heat, which melts the oxide formed. The high-pressure oxygen jet has the combined functions of reacting with the steel, generating heat, and sweeping away molten products of the reaction from the cut section (kerf). This thermal cycle will also produce a hardened heat-affected zone adjacent to the cut edge, the width and hardness of which will vary with cutting speed, steel thickness and steel chemistry. For many applications, removal of the hardened heat-affected zone may not be required, however if the cut face is to be welded, light dressing of the cut surface with a grinder is recommended to remove the thin carbide layer formed during flame cutting.

The process of flame cutting involves chemical oxidation and the physical removal of molten oxide. It is the inter-relation of these two factors that dictates the gas flow rates, nozzle design, cutting speed, etc appropriate for satisfactory flame cutting. Equipment manufacturers can provide information on cutting procedures for a wide range of applications. The Welding Technology Institute of Australia (WTIA) Technical Note 5 "Flame Cutting of Steels" provides comprehensive coverage of the subject.

Flame cutting

MILD AND MEDIUM STRENGTH GRADES

XLERPLATE® steel in this category is typified by the structural grade AS/NZS 3678-250, and the AS 1548-PT460NR grade used in pressure vessel manufacture. These grades exhibit relatively low hardenability by virtue of the deliberately low carbon equivalents used. Flame cutting of 'mild' XLERPLATE® steel presents little difficulty regardless of fuel gas used. The hardened heat-affected zone adjacent to the cut edge is usually only of significance where subsequent, severe cold forming of the edge is envisaged, or in particularly critical applications where a risk of brittle fracture or fatigue exists.

HIGH STRENGTH GRADES

XLERPLATE® steel structural grades such as AS/NZS 3678-350 and pressure vessel grades such as AS 1548-PT490NR are also readily flame cut without the need for special precautions in most applications. The increased hardenability of these grades means they are more susceptible to hardening of the cut edge, and this may be unacceptable for certain critical applications. Reduced edge hardening may be facilitated by either reduction in cutting speed, and/or initial preheating of the plate. Both of these procedures serve merely to slow down the cooling rate at the cut edge.

MEDIUM TO HIGH CARBON GRADES

Where carbon content exceeds about 0.3%, XLERPLATE® steel may require both preheating and reduced cutting speeds in order to obtain acceptably low hardness levels in the heat-affected zone. Preheating is particularly important for heavy sections where uniform preheating will assist considerably in reducing the chilling effect of the surrounding steel as well as ensuring a consistent cut. Machining of the cut is also facilitated by the softer edge produced by adherence to the above procedures. Post-heating immediately after cutting may be desirable to ensure even slower cooling of the flame cut edges of heavy thickness, hardenable steels. Furnace cooling or insulation after cutting may be appropriate in such cases.

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