



EDELSTAHL GMBH J.P. SCHUMACHER

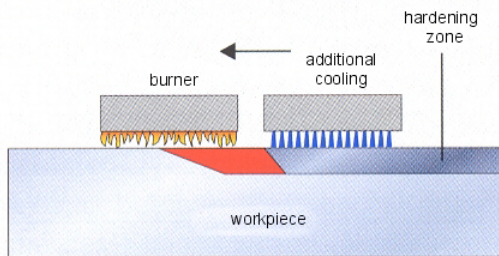
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Flame hardening

During edge-zone hardening with a flame more thermal energy is applied to the surface by a burner (see picture 1 below) than can be discharged into the core zone by heat conduction.

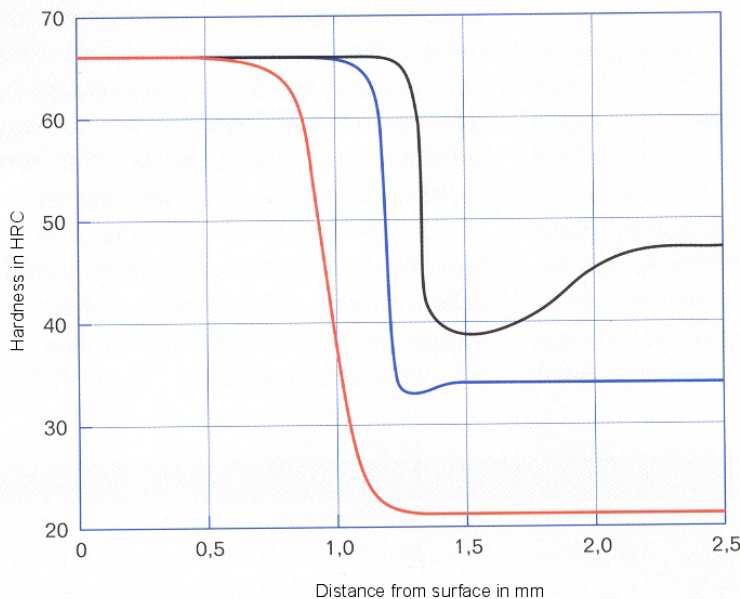
Flame hardening



Pic. 1
Drawing of flame hardening

This creates an heat accumulation in the edge-area which leads to a quick rise of temperature up to the austenitizing temperature necessary for hardening. When the burner moves on an heat transfer into the cold zone takes place. This is the so called self-quenching. Depending on the chosen steel grade and the geometrical proportions (hardening zone, residual wall thickness) high hardness values can be achieved (see picture 2 below), which should be reduced by a following tempering process.

Hardness shape



Pic. 2
Hardness Shape

- soft annealed
- annealed
- hardened and tempered



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The following are additional factors influencing the hardness results:

- burner settings,
- burner position,
- feeding speed,
- and perhaps preheating.

Basically flame hardening allows a successful hardening of the contact edges. But it must be noted that it needs a great amount of experience to reach the requirements. The difficulty lies in meeting the appropriate hardness temperature, which mainly depends on burner position and feeding speed. So the skill and experience of the hardening shop staff is very important. The measurement of the hardening temperature is mostly done with optical equipment which depends on the environmental conditions (brightness) and therefore the results are inaccurate. If the feeding speed is too high, a partial austenitizing can take place which leads to low hardness values. If the feeding speed is too low it causes an overheating of the edge zone which results in a toughness loss and stress cracks during the cooling process. Therefore flame hardening should be reserved to specialised firms with the necessary experience, since a weld repair always means a loss of time and problems during the etching process.