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State of the Art Quenching
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The production of hardened cores of hardened surface regions requires for metals a heat treatment process consisting of heating to a sufficiently high temperature and a rapid cooling back to room temperature.

The rapid cooling of metallic components is usually achieved by immersion of the metallic components into a respective quenchant, or by spraying the quenchant onto the surface of the metallic components.

In industrial practice a number of different liquid quenchants are used, of which the main quenchants are:
- water (with or without salt or caustic additions)
- quenching oils
- aqueous polymer solutions
- molten salts

In the last few years, the hardening of steel components by quenching in a gas flow has gained a certain importance with the most common gases used for quenching being air, nitrogen, helium and argon.

As the gases have a much lower density than the liquids, their cooling capability by nature is much smaller. This set-back can be overcome by applying high gas velocity (gas impingement) and/or using pressurized gases with pressures up to 10, 20 or more bar.

Quenching in Liquids
Of the four liquids used for quenching, pure water is hardly ever used because of its stable vapor phase, producing non-uniform heat extraction. The addition of salts or other components speeds up the breakdown of the vapor phase increasing the quenching intensity of water. This addition of salts or other components speeds up the breakdown of the vapor phase increasing the quenching intensity of water. This effect results in very rapid cooling rates in the surface of components, producing large stress gradients with a danger of cracking the components during quenching.

Adding polymers to the aqueous solution produces an insulating polymer skin around the steel components during quenching, reducing the quenching severity considerably.

By varying the concentration and the type of polymer, cooling rates between those of water and quenching oils can be achieved.

Quenching oils of different qualities exist with the quenching severity depending on their physical properties, the most important one being the viscosity.

Oil just as water exhibits a pronounced vapor phase followed by a nucleate boiling phase with a very rapid heat transfer in the temperature range between 600 and 300^{o}C.

Different to this, molten salt baths do hot possess a vapor phase or a boiling, and therefore, just like gases, depict a pure convective heat transfer with the highest heat transfer right at the start of the immersion of the components into the molten salt.

Because of the necessity of melting the salts, their application temperature is by nature higher than those of water and oil. They are normally used in the range between 140 and 350^{o}C. This higher application has the positive effect of reducing the quenching severity in the lower temperature range, where martensitic transformation takes place. This is beneficial for the uniformity of stress distribution produced, resulting in normally very low distortion of the hardened components.

The article in its entirety is available by logging onto www.ipsen-intl.com, click onto Ipsen On Top magazine, and reference page 15. For more information or to speak with a technical person, contact Patrick Weymer at 815-332-4941, ext. 239.