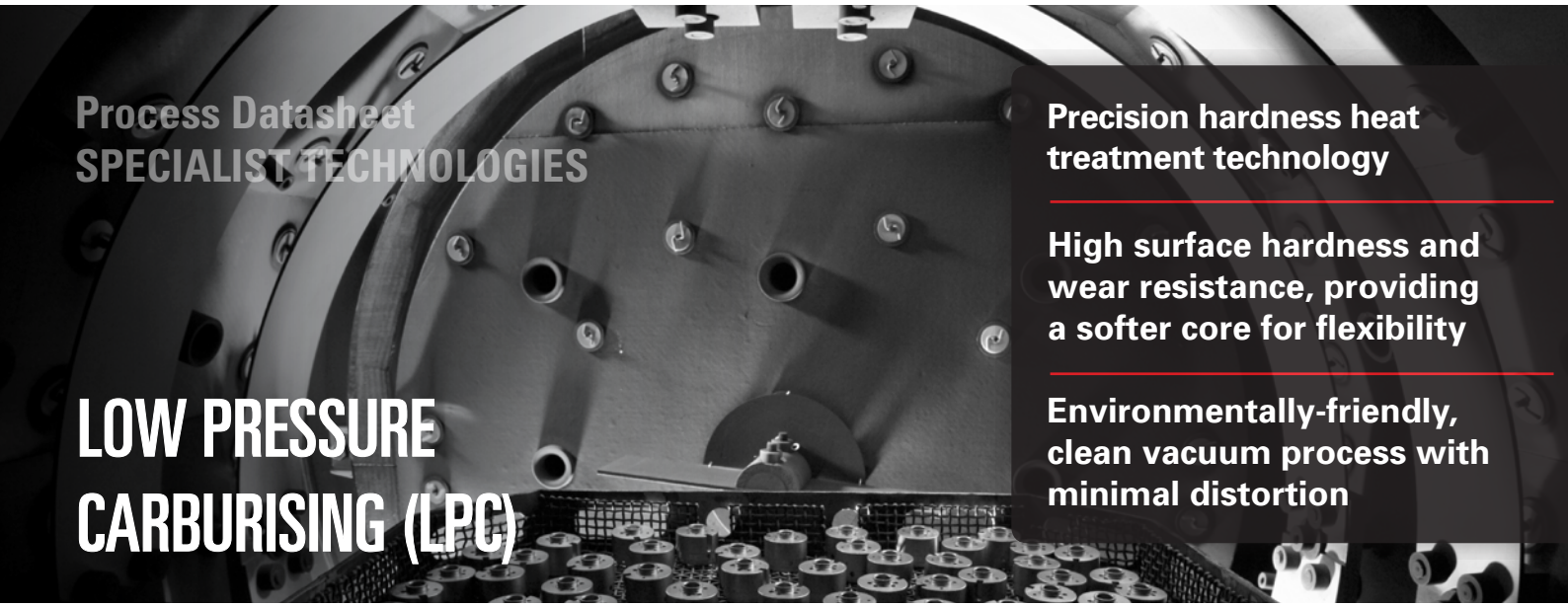
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Process Datasheet
SPECIALIST TECHNOLOGIES

LOW PRESSURE CARBURISING (LPC)

Precision hardness heat treatment technology

High surface hardness and wear resistance, providing a softer core for flexibility

Environmentally-friendly, clean vacuum process with minimal distortion

BENEFITS

- **Increased durability:** High surface hardness, resulting in improved wear resistance, bending fatigue resistance, resulting in a longer product life. Zero intergranular oxidation, which results in improved wear and fatigue resistance properties.
- **Precise control of case properties:** ability to tailor case carbon content and case depth to improve component performance.
- **Reproducibility:** ability to repeat case depth within tight tolerance bands.
- **Lower distortion and more dimensionally consistent:** ability to repeat case depth within tight tolerance bands.
- **Cleaner components:** no post-treatment cleaning required, reducing total overall cost.
- **Processing of difficult component geometries:** excellent penetration into spaces (e.g. blind holes) within components where traditional gas atmospheres can't reach.
- **Allows for use of advanced carbon-fibre-composite (CFC) fixtures:** The LPC process under vacuum allows the use of lightweight CFC fixtures that are dimensionally stable at high temperatures resulting in reduced component distortion in comparison to traditional alloy fixtures used with atmospheric carburising.

WHAT IS LPC?

LPC is an advanced technology that offers the design engineer an alternative to atmosphere carburising for improved case depth uniformity, dimensional control, part cleanliness, and process flexibility.

LPC is a method of pure carburisation combined with pure diffusion and is used to obtain a hardened surface and tough core, giving increased wear resistance and fatigue life, with minimal risk of treatment distortion.

The process gives high hardness below the surface compared to conventional carburising treatments, and allows precise control of case depth, microstructure and hardness, even for complex shapes and blind holes.

The process doesn't create inter-granular oxidation on the surface of steels due to lack of oxygen in the atmosphere and eliminates the post grinding operations for parts that require higher surface quality and hardness.

LPC is a clean process carried out under vacuum, and has signifcantly lower environmental impact than atmospheric heat treatment technologies.



MATERIALS

Low to medium carburising grade alloy steels are suitable for the LPC process. Typical steels used in LPC are SAE grade, 8620, 8630, 5120, 5130, 4320, 4120 and similar steels.

Low to medium alloy steels respond much better than low carbon mild steels metallurgically during heat treatment.

LPC requires close control of the DI and J values of the steels to maintain consistent metallurgical results and the required strength. Steel chemistry (DI, Jominy) needs to be matched with desired carburising properties.

PROCESS CONSIDERATIONS

Material
Material selection is key in obtaining desired heat treatment properties in parts. Steels with the proper hardenability need to be selected based on desired heat treatment properties. Higher hardenability typically means higher core hardness, lower hardenability means lower core hardness.

Quenchant
LPC can be performed with both oil and gas quenching. Material requirements are different for both processes. Gas quenching is more suitable for steels with controlled chemistry and wall thickness, whereas oil quenching can be performed on conventional carburising steels.

Temperature
LPC can be performed up to 1000ºC and the cycle time is much shorter than conventional carburising.

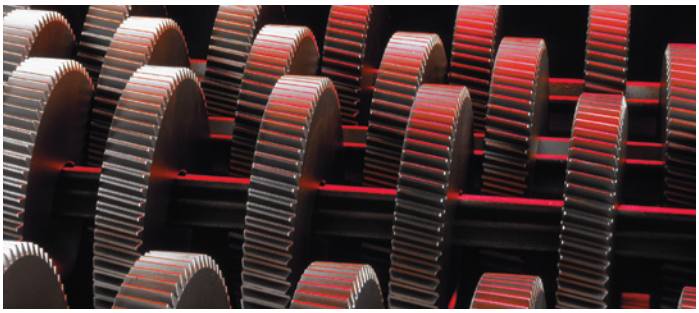
Incoming part cleanliness
Cleaner parts provide more consistent heat treatment results.

Post heat-treatment processing

Gears that require high fatigue strength and durability are shot peened to achieve higher residual stresses to further improve material properties. Both conventional (atmospheric) carburising and LPC benefit from shot peening. This is mainly used for transmission gears to improve warranty.

Acid pickling operations are not recommended as they can result in premature failure due to hydrogen embrittlement.

Thermal operations such as welding or other post-heat treatment operations that can over-temper the component that result in a degradation of the heat treatment properties should be avoided.



SPECIFYING THE PROCESS

All of the following information should be included if possible. If you are uncertain, call our experts before producing a specification.

- **Instruction:** case hardening – low pressure carburising.
- **Steel specification:** identify the material used as accurately as possible.
- **Required case depth and acceptable range:** clearly define whether the case is measured as total case depth (measured visually, or sometimes to a core hardness), or effective case depth (measured to a specified hardness level, usually 550Hv/52.4HRc or 513Hv/50HRc). Where a test piece is supplied for case depth measurement, ensure that it is of the same batch of steel and section size as the component to be treated.
- **Acceptable surface and core hardness ranges:** stating type of hardness test and any special position for measurement.
- **General quality standards applicable:** supply drawings if possible.
- **Material removal allowance:** state whether the case depth includes a material removal allowance or specify the allowance to be added.
- **Selective treatment requirements:** a variety of procedures can be applied to leave selected areas of the surface of a component soft. If required, specify precisely, stating what is mandatory and what is optional (e.g. area which must be hard and area which must be soft).

POTENTIAL POST-TREATMENT ISSUES

Potential heat-treat distortion can be minimised by carefully controlling the quenching parameters by measuring before and after dimensions. Normally the customer can target the green size to compensate for the distortion, thus ensuring virtually zero post-machining.

As with all case-hardening applications, care should be used when performing post-heat treatment machining operations. Overly aggressive machining operations can damage component properties, and therefore result in premature failure.

Oxidation (rust) can be avoided by properly protecting parts post-heat treatment with a rust inhibitor.

Bodycote is the world's largest provider of heat treatment and specialist thermal processing services

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