Surface Finishing Technology

Hydrogen Embrittlement

All components made from steel which are subject to chemical or electro-chemical treatments in the course of the coating process may absorb hydrogen which is evolved during these processes. This absorbed hydrogen could cause premature failure if the component is made from high tensile steel. We should like to remind customers of the risk of hydrogen embrittlement of parts made from high tensile steel and that baking treatments cannot be guaranteed to prevent all hydrogen embrittlement. Parts are usually considered to be at risk if they have a tensile strength equal to or greater than 1050 MPa, 1000 N/mm or 65 tons/sq.in. (T class imperial fasteners and above) or have a hardness greater than 320vickers (HV). (10.9 fasteners and above).

Baking parts after coating will minimise the risk of failure, but this process can never be assumed to be 100% effective.

Embrittled parts usually fail when in use under stresses well below their normal failure level and most embrittlement failures occur in a relatively short time after assembly, between a few minutes and up to eight weeks.

Although many studies have taken place into hydrogen embrittlement failures, the exact reasons for the phenomenon have not been explained.

The higher the tensile strength, the more susceptible to embrittlement a component becomes, but also the presence of phosphate (not removed prior to heat treatment) and other elements can alter this susceptibility considerably.

If hydrogen embrittlement is identified as a risk, the use of a non-embrittling cleaning and coating process such as zinc flake or mechanical zinc should be considered.

Specifications

Most electroplating specifications give procedures to minimise the risk of embrittlement of high tensile parts. See the table below:

USUAL REQUIREMENTS TO LIMIT HYDROGEN EMBRITTLEMENT

Parts heat treated or cold worked to a surface hardness of	TENSILE STRENGTH OF PART	
	320HVto 390HV	390HV and above
Fasteners property classes	9.8, 10.9	12.9 and above
Process Requirements Clean parts to remove phosphate coating prior to hardening heat treatment	Advisory	Mandatory
Use special wet cleaning methods	Advisory	Forbidden
Use abrasive cleaning methods		Mandatory
Electroplate	Allowed	Only allowed under special circumstances
Use non-electroplated coatings	Advised	Very strongly advised Mandatory with Auto Manufacturers
Baking times (at 180-210°C) if electroplated	4-12 hours	24 hours (or longer)

Information presented in this data sheet is considered reliable, but conditions and methods of use, which are beyond our control, may modify results. Before these product are used, the user should confirm their suitability.
We cannot accept liability for any loss, injury or damage which may result from its use.
We do not warranty the accuracy or completeness of any such information whether orally or in writing.
We reserve the right at anytime and without notice to update or improve products and processes and our information concerning the same.

Warning

The following points should be considered when specifying electroplated finishes on higher tensile parts:

1. Susceptible parts subject to an embrittling process can never be guaranteed to be completely free from embrittlement, even after extensive baking treatments (ref. ISO 4042; BS 7371 Pt.1).
2. The removal of phosphate from higher tensile parts before hardening heat treatment can reduce the risk of embrittlement (mandatory requirement for 12.9 grade fasteners and above).
3. The risk of embrittlement increases with increasing tensile strength. and with the use of higher tensile loads.
4. Changing the coating already applied to fasteners, i.e. stripping and replating, can be a high risk area that we will only undertake under certain circumstances. Discussion with the customer and end user is essential.
5. The use of non-embrittling processes such as mechanical plating, zinc flake or organic coating, should be considered for susceptible work.
6. There is a slight possibility that work mechanically plated and used within six hours of processing can exhibit early failure due to transient embrittlement. This transient embrittlement dissipates completely after six hours. If use is envisaged within six hours of processing, please discuss with us.
7. Due to these risks and the availability of risk free processes, it is not our policy to electroplate 12.9 grade fasteners and above, and we would encourage you - our customer - to follow this course of action also. If it is still required that we should electroplate 12.9 grade and above, we will do so only provided we receive written acknowledgement that our customers understand and accept these risks. We would also point out that most OEM's forbid the electroplating of fasteners of grade 12.9 and above.
8. It should be noted that de-embrittlement by the baking process becomes less efficient when high thicknesses of metals are applied due to the porosity of the deposit becoming significantly less with higher thicknesses. Some specifications acknowledge this and expect thick coatings (e.g >12μm) to be applied in two stages with a baking process after the application of 5-8 μm.
9. It is our general policy to bake work within 1 hour of processing to minimise the risk of embrittlement.

Note: Phosphating can cause hydrogen embrittlement but it is generally considered that this disappears if the components are not used for 48 hours after processing otherwise a de-embrittlement baking of a minimum of 4 hours at 200°C is recommended.

Anochrome Group