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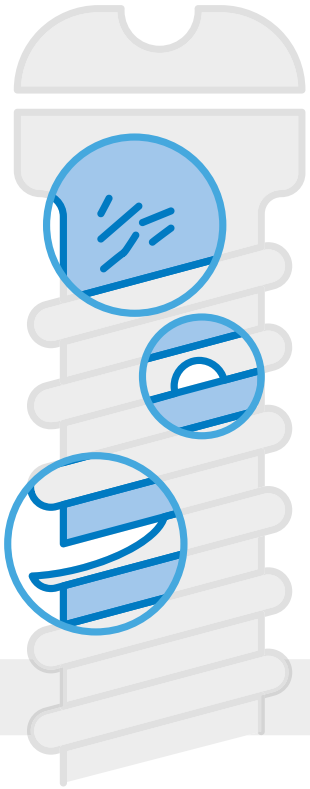

Selecting a Fastener Finish

White Paper

Selecting a Fastener Finish

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The recommendations and advices mentioned must be adequately checked by the reader in practical use and be approved as suitable for its application. Changes reserved.

ASSEMBLY TECHNOLOGY EXPERT

SELECTING A FASTENER FINISH

Introduction

Many engineers will put great thought into selecting the proper type of fastener for their design but overlook the importance of finish. When selecting the best finish for your fasteners, it is wise to consider the following factors:

1. Safety
   The incorrect finish could contribute to a failure of the fastened joint
2. Corrosion protection
   What is the expected service life of the part and the service condition?
3. Resistance to handling damage
   How do nicks and scrapes from handling and wrenching affect the finish?
4. Criticality of the joint
   Will the assembly fail if the joint comes loose? What are the consequences of an assembly failure?
5. Functionality
   Will the finish prevent my fasteners from assembling due to thread or recess fill?
6. Availability
   Is the finish readily available?
7. Cost
   Is the finish cost effective for my assembly?

There are many exotic coatings which have been developed for specific applications, and more are being added every day. This paper will not attempt to discuss all of these options, but will concentrate on the following, commonly available finishes:

- Electrodeposited Zinc ("commercial" zinc)
- Electrodeposited Zinc Nickel
- Mechanical Zinc
- Zinc Flake
- Hot Dip Galvanized
- Epoxy Electrocoat

SELECTING A FASTENER FINISH

Safety

The main safety concern when choosing a finish for fasteners, is to avoid hydrogen embrittlement. Hydrogen embrittlement (HE) is the delayed catastrophic failure of a high-strength fastener that has been induced with hydrogen and put under tensile load.

A high-strength fastener coated with the wrong finish can promote HE. So, what is considered a "high-strength fastener" that is cause for HE concern?

Fasteners that are considered "at risk" for HE have a hardness which exceeds 380HV. This includes, but is not limited to:

- Metric property class 12.9
- Inch alloy grade socket head cap screws
- Case-hardened, externally threaded fasteners with machine screw thread pitch, such as thread forming screws or case-hardened serrated flange screws
- Conical spring washers
- Slotted or coiled spring pins
- Retaining rings

To eliminate the risk of HE in these fasteners, acid pickling and/or electroplating should be avoided if possible. Measures may be taken to reduce risk, such as baking immediately following electroplating, but these measures can only serve to reduce the risk and cannot completely eliminate it.

For more details on hydrogen embrittlement, refer to the white paper "Hydrogen Embrittlement – the Silent Killer" found at www.bossard.com.

SELECTING A FASTENER FINISH

Corrosion protection

What is the expected service life of the fastener and what environment will it be operating in? ASTM B633 defines "Service Conditions" as follows:

SC 1

Mild – Exposure to indoor atmospheres with rare condensation and subject to minimum wear or abrasion. Examples are: buttons, wire goods, fasteners.

SC 2

Moderate – Exposure mostly to dry indoor atmospheres but subject to occasional condensation, wear or abrasion. Examples are: tools, zippers, pull shelves, machine parts.

SC 3

Severe – Exposure to condensation, perspiration, infrequent wetting by rain, and cleaners. Examples are: tubular furniture, insect screens, window fittings, builders hardware, military hardware, washing machine parts, bicycle parts.

SC 4

Very Severe – Exposure to harsh conditions, or subject to frequent exposure to moisture, cleaners, and saline solutions, plus likely damage by denting, scratching, or abrasive wear. Examples are: plumbing fixtures, pole line hardware.

The above recommendations assume a mostly natural environment. If the fasteners will be exposed to a more "industrial" environment where they come in contact with dirt, grime and/or specific chemicals, contact Bossard for a recommendation.

For more information on corrosion, refer to the white paper "Corrosion" found at www.bossard.com.

SELECTING A FASTENER FINISH

Resistance to handling damage and critical joints

Resistance to handling damage

Handling damage, which can be defined as nicks and scrapes resulting from transportation and/or wrenching, can be a concern for some fastener finishes. Softer finishes or very brittle finishes will begin the corrosion cycle much sooner if care is not taken in the handling and assembly of these fasteners. How well the finish adheres to the fastener is also a key factor in maintaining good corrosion protection when subjected to handling.

Critical joints

Will the assembly fail if the joint comes loose? What are the consequences of an assembly failure? Getting a joint tight and keeping it tight all depends on proper clamp load. A well designed joint with the proper clamp load should not come loose. What does this have to do with fastener finishes? Most joints are assembled using torque control, which relies on a consistent joint friction to produce a predictable and repeatable clamp load. Some finishes have known friction values while others do not. If consistent and repeatable clamp load is important to the joints' survival, then coatings with a known friction should be used.

For more detailed information on the torque vs. tension relationship, refer to the contact page at www.bossard.com and talk to a Bossard customer service representative.

SELECTING A FASTENER FINISH

Functionality

Smaller diameter fasteners and threaded fasteners with internal recess drives may not lend themselves well to certain finishes. The type of finish and the method of application may cause excess coating material in threads and/or recesses.

A final consideration that will not be mentioned here is the presence of hexavalent chromium (chrome VI, or hex chrome) in a fastener finish. Many countries now regulate the use of hex chrome, which was commonly used in fastener finishes in the past and can still be found in some areas today. All of the options above are available in "hex chrome-free" versions, but it is important to specify this requirement if it applies.

The guide on the following pages offers information on the most common fastener finishes to help you make an informed decision on which one to use.

Electrodeposited Zinc ("commercial" zinc)

Safety	Hydrogen embrittlement risk for high-strength fasteners
Corrosion protection	Mild to moderate
Resistance to handling damage	Moderate
Critical joints	Difficult to control friction
Functionality	Small sized – no problems with threads or recess fill
Cost	Low
Availability	High
Recommended for	Any fasteners with a mild to moderate corrosion requirement and a hardness less than HRC 38

Electrodeposited Zinc Nickel		
	**Safety**	Lower risk for hydrogen embrittlement than electroplated zinc, but still a risk
	**Corrosion protection**	Severe to very severe
	**Resistance to handling damage**	Good
	**Critical joints**	Difficult to control friction
	**Functionality**	Small sized – no problems with threads or recess fill
	**Cost**	High
	**Availability**	Low
	**Recommended for**	Any fastener with severe to very severe corrosion requirements and a hardness less than HRC 38. May be the best alternative for small, high-strength fasteners less than or equal to M6 if good controls and post-baking is done properly.

Mechanical Zinc		
	**Safety**	No hydrogen embrittlement risk
	**Corrosion protection**	Mild to moderate
	**Resistance to handling damage**	Moderate
	**Critical joints**	Difficult to control friction
	**Functionality**	Poor coverage in recesses or holes – not recommended for threaded parts
	**Cost**	Medium/high
	**Availability**	Medium/low
	**Recommended for**	High-strength washers and pins (greater than HRC 38). Not normally recommended for threaded fasteners.

Zinc Flake		
	**Safety**	No hydrogen embrittlement risk
	**Corrosion protection**	Severe to very severe
	**Resistance to handling damage**	Moderate
	**Critical joints**	Excellent friction control properties
	**Functionality**	Not generally recommended for threaded fasteners less than M8 or for any fastener with an internal drive feature
	**Cost**	Medium
	**Availability**	Medium
	**Recommended for**	Larger fasteners (greater than M6) with severe to very severe corrosion requirements and/or used in joints where clamp load is critical to maintaining joint integrity

Epoxy Electrocoat		
	**Safety**	No hydrogen embrittlement risk
	**Corrosion protection**	Severe to very severe
	**Resistance to handling damage**	Moderate
	**Critical joints**	Excellent friction control properties
	**Functionality**	Small sized – generally not an issue with recess fill or threads greater or equal M4
	**Cost**	High
	**Availability**	Low
	**Recommended for**	Thread forming screws or screws that require a very good cosmetic black appearance

Hot Dip Galvanized		
	**Safety**	Low hydrogen embrittlement risk for high-strength fasteners; do not use for 12.9 or alloy-grade parts as processing temperatures will temper hardness
	**Corrosion protection**	Severe to very severe
	**Resistance to handling damage**	Excellent
	**Critical joints**	Difficult to control friction
	**Functionality**	Not generally recommended for threaded fasteners less than M8 or for any fastener with an internal drive feature – overtapping of nuts/female threads after coating is required
	**Cost**	Medium
	**Availability**	Medium/low
	**Recommended for**	Use in outdoor structural applications

If you need further assistance or have special finish requirements, please check out our contact page at **www.bossard.com** and talk to your nearest Bossard customer service representative.