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Information about addition of lead in various metals

White Paper

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ASSEMBLY TECHNOLOGY EXPERT

INFORMATION ABOUT ADDITION OF LEAD

Preface

The purpose of this white paper is to provide information on the usage of lead as addition to various metals as well as the alternatives and their consequences. Together with information about the requirements of applicable industrial standards, it is intended to display the current situation on the market.

Figure 1: Ancient Egypt lead female figure

History of usage of lead

Lead has been extracted and used since the earliest periods of history. The oldest known lead article is a metal figure, found in Egypt, believed to date from 4000BC. Other finds from ancient periods have been principally statuettes and figures. Later, because of its malleability and resistance to corrosion, lead was used extensively by the Romans for water pipes, aqueducts, tank linings and cooking pots and then by ancient scientists in early cosmetics, paints and pigments, and in lead-rich glazes.

The chemical symbol for lead is Pb, which comes from the Latin word plumbum, meaning "water-works," referring back to ancient times when the metal was widely used in the construction of water pipes.

INFORMATION ABOUT ADDITION OF LEAD

Availability and recovery of lead

Lead is a highly lustrous, bluish-white element that makes up only about 0.0013 percent of the Earth's crust. Lead typically occurs in very small amounts in ores such as galena, anglesite and cerussite. Lead is commonly mined and smelted.

Lead can be recycled as a secondary raw material from lead-acid batteries, from metallic scrap and from several composite consumer products in conjunction with existing recycling loops, for example for steel, zinc and copper, at moderate costs.

Lead is one of the most effectively recycled materials in the world and today more lead is produced by recycling than is mined. Recycling lead is relatively simple and in most of the applications where lead is used, it is possible to recover it for use over and over again.

Figure 2: Galena Crystals

INFORMATION ABOUT ADDITION OF LEAD

Leaded steel, brass,bronze, aluminium and casting alloys

Small additions of lead in bronze and other copper alloys found at archaeological sites, are believed to have been added as a diluent to the more precious copper, and/or to reduce the melting temperature. Modern steel, copper, aluminum alloys use small additions of lead to improve machinability.

The term "machining" of metal covers several operations, including drilling, boring and turning, but generally involves cutting the material towards the desired final shape and size. Machining of ductile materials can be difficult, because a thick swarf (strip of material which is removed from the main body) builds up, obstructing and putting pressure on the cutting tool.

"Free machining" steels (also known as free-cutting steels) contain small additions of lead (up to 0.35% by weight) which form insoluble globules of metal in the steel. These make the swarf break off into small pieces during machining. Friction and wear on cutting tool is reduced, allowing higher feeds and/or speeds.

Lead additions are reported to improve machinability by 30%, allowing higher cutting speeds and 3-5 times longer tool life, and so increased production rates. This also improves the surface finish of the machined material, and the machining consumes less energy and is quieter.

Lead can be found in brass and bronze to ease the process of cutting the brass, adds pressure tightness, and acts as an internal lubricant. Furthermore, lead has a positive effect on brass to its resistance to corrosion.

Lead is added at a concentration of about 2-4%. Some aluminum alloys are formulated with a lead addition of less than 0.4% for improved machinability.

The lead content in the majority of the casting alloys is significantly lower, typically 0.1%. Lead is not an alloying element for casting alloys or for the majority of wrought alloys but is a tolerated impurity. Higher lead content cannot be accepted because it would reduce quality of the final product.

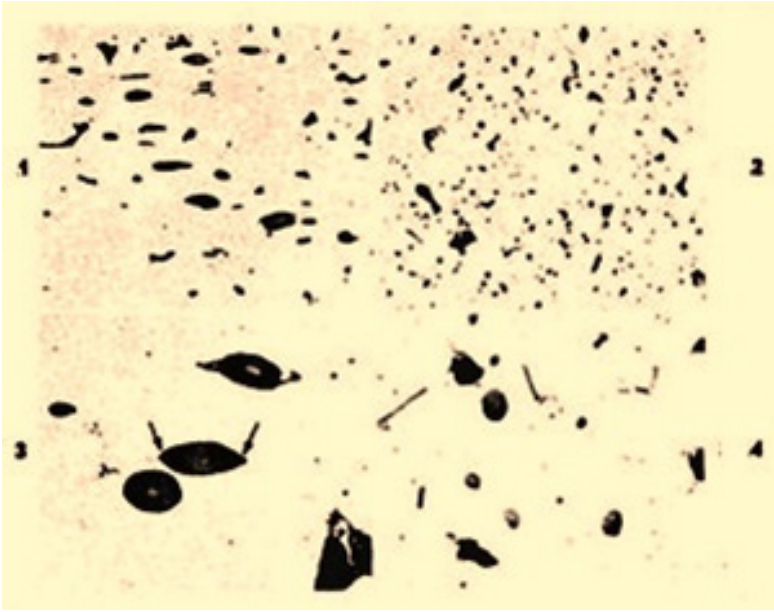

Figure 2: Galena Crystals

INFORMATION ABOUT ADDITION OF LEAD

Alternatives to lead

The steel industry has investigated a number of potential alternatives over a period of more than 20 years. Calcium-treated carbon and low alloy engineering steels can have improved machinability; they are mainly available in Europe, and are being investigated in Japan as alternatives to some leaded steel automotive components. However, calcium additions are not beneficial in all grades of steel (low carbon free-cutting steels).

Bismuth enhances the machinability of steel. However, it has a significant adverse effect on the ductility of steel at hot-rolling temperatures. Its cost is almost ten times that of lead and it arises as a by-product of lead extraction. Another issue is that the current annual world production of bismuth would not suffice if lead in free-machining steels were to be replaced by bismuth.

Resulphurised steel gives good machinability under certain machining conditions. This could potentially replace some, but not the majority of applications of leaded steel. Other elemental enhancers of steel machining include tellurium and boron, but their applicability is also limited. Selenium has been discounted for a number of reasons, including its toxicity. For brass, bronze and aluminum bismuth enhances the machinability, but the cost is as mentioned notable higher.

INFORMATION ABOUT ADDITION OF LEAD

Lead in fasteners and other metalic products from Bossard

Lead might be found as a component in materials intended for machining operations for the reasons previously mentioned.

A range of e.g. machine keys, pins and plugs are made from leaded materials to fulfil the material requirements of given standards. No other material options are available per standards currently.

Figure 4: Machining of bronze

Specific information on lead in ISO 898 for fasteners:

1. ISO 898-1 allows lead in a concentration up to 0.35% for non-heat-treated screws and bolts of property class: 4.6, 4.8, 5.8 and 6.8.

2. ISO 898-2 allows lead in a concentration up to 0.35% for nuts of property class: 04, 4, 5 and 6. ISO 898-5 allows lead in a concentration up to 0.35% for set screws of property class: 14H, 22H, 33H, and 45H. For any other product and property class, ISO 898 does not provide specific information on the lead content.

In fact, the vast majority of fastener standards do not specify the exact material composition of the product. The geometrical shape of the product, the mechanical and physical properties and the selected manufacturing process of the manufacturer, determines the selected material. As most materials are produced by recycling, lead can potentially be present if it doesn't negatively affect the product requirements given by the standards.

Where lead is not added intentionally (materials not intended for machining operations) to the material, it will most often not appear from the material certificate. The likelihood that such materials contain lead in concentrations above 0.1% by weight is low but cannot be ensured without additional investigations and/or tests.

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.