Lead: making high-performance machining more efficient and cost-effective

Advanced Machining Centre - Operation of CNC lathe

Photo taken as part of a video shoot with the green space department of Strasbourg

An alloy of iron and carbon, steel has played a major role in modern societies since before the industrial revolution. A unique combination of low cost and high tensile strength has seen it become one of the world's most important engineering and construction materials, used in everything from large scale construction to the manufacture of a wide range of appliances and vehicles.

In 2018, this demand for steel saw the EU produce 177 million tonnes worth over €148 billion, making it the second largest manufacturer in the world. Further, applications for steel have a significant impact on the wider European economy. The machine tool industry, for example, employs 147,000 people in region, and has a turnover of €26 billion.

Small parts of complex machinery, like cars or lawn mowers, could not be machined without steel. But there is another material involved that plays an essential part in the process. By adding small amounts of lead to steel, the resulting compound, known as 'machining steel' is optimised for use in the creation of a wide range of finished metal articles, including engine components where precision machining is required. More specifically, by embedding lead into steel as tiny globules, it acts as a lubricant during high speed cutting and machining procedures. Melting of lead in the cutting zone during machining reduces friction between the cutting tool and the steel workpiece. This in turn, stabilises the built-up edge, increases the longevity of cutting tools, reduces the energy needed for the machining process, and provides a better surface finish on the product. The embrittling action of lead reduces the length of the chips produced reducing the risk of the chips becoming entangled in the machine tool, thereby reducing downtime to remove entangled chips.

While theoretical alternatives to lead use in the manufacture of complex machinery exist, in practice they fail to provide the same levels of performance or cost effectiveness. Bismuth is viable from a technical perspective, but is prohibitively expensive, particularly for large-scale applications. Similarly, while calcium works economically, particularly when using carbide tools at high

cutting speeds, it is not as versatile as lead, and can only be used in certain cutting conditions. Higher sulphur-free cutting steels can also offer acceptable machining performance in certain operations but do not perform as well as leaded grades in complex, fine scale operations at low cutting speeds.

Strict risk management processes are observed when using lead, with workers making, casting and using leaded steel protected by a framework of existing legislation and industry best practice. Moreover, many industrial processes are highly automated. Where manual activity is involved, workers are protected from exposure to lead, for example for machine operators, by engineering controls and directives like the restriction of hazardous substances (RoHS), both designed to minimise exposure.

Importantly, there is no risk to the end user as elements featuring lead are typically paint coated or inaccessible. Handle areas and operational controls containing lead tend to have additional covers made from protective materials like rubber. It takes only small amounts of lead in steel to realise machining benefits: typically just 2g per kilogram of steel.

Without lead, the energy requirements and carbon footprint of machining increase, as does the amount of downtime required, and the frequency of tool replacement. The resulting products – often referred to as turned parts – are essential for many industries such as automotive, electronics, construction, as well as aviation and medical technology. Many customer industries are therefore dependent on products such as machining steels. These factors can have significant economic ramifications.

In the case of lawn mowers and other garden machinery, producers employ more than 120,000 people in the EU, and the industry sells over 18 million units across the continent every year. As such, using the most effective materials for manufacturing benefits not just the individual vendor, but the wider European economy as a whole.

Fact file

- EU steel demand grew by 3.3% in 2018. The region produced 177 million tonnes worth a total Gross Value Added of over €148 billion
- The machine tool industry in Europe – 147,000 employees, €26 billion turnover and €20 billion total exports
- **Garden machinery producers employ over 120,000 people in the EU, selling more than 18 million units across the continent every year**
- Besides increasing the production rate of a component by up to 40%, the addition of lead in steels offer a potential reduction in energy usage of approximately 27% when machining parts compared to the non-leaded steel
- European suppliers with machining technologies (e.g. turning, milling and grinding) employ between 200,000 to 250,000 employees, with a turnover volume of 20 to 25 billion euros

Developed in conjunction with the European Garden Machinery Federation, the German Steel and Metal Processing Industry Association and Liberty Speciality Steels, this case study highlights just one of the many essential uses of lead that provide societal benefits and boost the EU's economy.

For Europe's future, lead matters.

Lead Matters