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WHITE PAPER

Supporting the transition to lead-free bearings in large diesel engines: the challenge for foundries

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VESUVIUS

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EXECUTIVE

SUMMARY

The EU has restricted the use of lead-containing bearings in diesel engines. This poses a challenge for engine makers, who traditionally used lead in bearings to achieve satisfactory engine reliability. Its qualities as a dry lubricant protected the bearings from particulate contaminants, such as those left over from the casting process (moulding sand, and residues from the binder and the coating itself).

To support the transition to lead-free bearings, SEMCO IC coatings are designed to significantly improve the removal of such casting debris from even the most complex of castings. In doing so, these coatings continue to set new standards when it comes to the ultra-low number of particles remaining in the as-cast condition.

The latest generation of SEMCO IC coatings is also formulated so that any remaining coating particles are softer than the bearings. This eliminates the risk of wear to the bearing from coating residue.

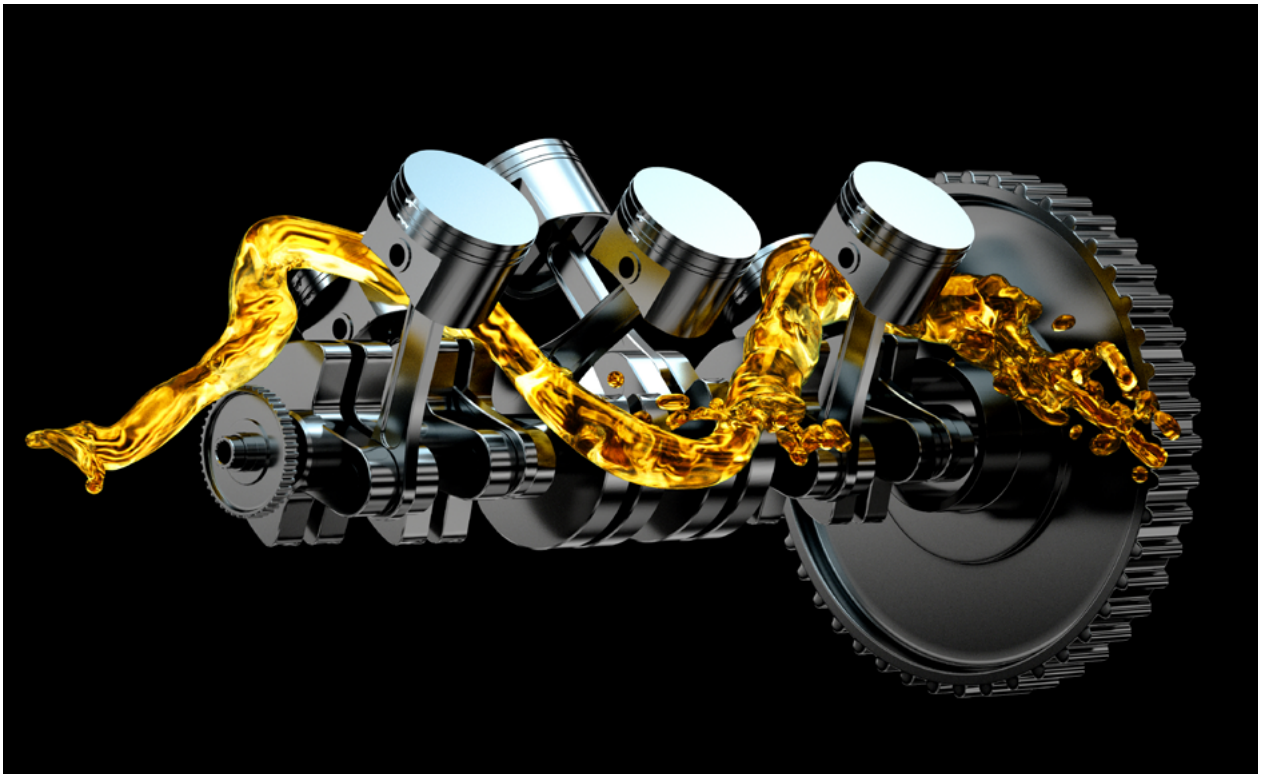
INTRODUCTION
Inner Cleanliness

As greater performance and environmental demands are placed on engines by original equipment manufacturers and regulators alike, so too do the demands placed on component castings by engine makers. One trend has been a growing restriction on the use of lead (Pb) in bearing alloys used within commercial internal combustion engines (ICEs) and associated systems.

Lead has long played an integral part in engine bearings as part of traditional tri-metal bearings. Its relative softness and low melting temperature meant it effectively acted as an integral lubricant, offering a level of protection and flexibility to the bearing. Its use was therefore considered necessary to achieve satisfactory reliability in terms of seizure resistance, conformability, and debris resistance, particularly in larger engine sizes and engines operating in demanding environments.

For all its benefits, however, lead's toxicity has led regulators to progressively restrict its use. Lead-free bi-metal bearings are now the norm in light engines; since January 2022, the EU has also restricted the use of lead in heavy engines.

While it may not be immediately apparent how the banning of lead-based alloys in bearings impacts the casting of engine components, lead's lubricating properties allowed the bearings to tolerate minor defects and residues in the castings, without impacting engine performance. Without the protection that lead provides, there is increased risk that bearings will be damaged by such residues. In today's lead-free world, solutions that improve casting cleanliness – particularly of the complex internal surfaces found in internal combustion engines – therefore offer an important competitive advantage to foundries that cast components for heavy engine manufacturers.



THE LEAD-FREE BEARING CHALLENGE

Coatings are applied by foundries to the sand cores used for casting the complex inner geometries of an engine. They protect the core from the superheated molten metal; facilitate knock-out after casting; and help to reduce the number of particles remaining in those parts of the engines that are inaccessible to post-casting cleaning.

Coatings may however leave a ceramic residue on the surface of the casting. In the past, the use of a lead-based alloy prevented this residue from damaging the bearing. Lead-free bearings, however, are at risk of scratching by the ceramic residue, reducing the lifetime of the bearing and negatively impacting engine performance. To counter this, the latest generation of SEMCO IC coatings from Foseco has been formulated so that any ceramic residue left on the casting is softer than steel. This removes the risk that the bearing will be damaged during engine operation and compromise engine performance.

The benefit is longer engine service intervals and improved engine reliability: key factors for any engine operator, but particularly so when the engine is used in applications that take it considerable distances from service facilities, such as in marine environments.

LOWERING CARBON EMISSIONS

In addition to supporting engine makers transition from lead-containing bearings, the new generation of SEMCO IC coatings also helps reduce carbon emissions generated during the casting process.

During pouring, carbonaceous materials in the coating combust and are released as carbon monoxide or carbon dioxide. The latest SEMCO IC formulation has been engineered to reduce the carbon content of the coating by replacing it with other minerals, and thus reduce the potential for carbon-based gas emissions.

COATINGS FOR INNER CLEANLINESS

SEMCO IC coatings continue to improve overall inner cleanliness of the casting, with one customer going as far to give Semco IC the 'new world record in terms of the super-low quantity of particles found after casting'. This not only ensures a cleaner casting is supplied to the engine manufacturer, but also has important benefits for the operating life of the engine, as particles remaining after casting will accumulate in the oil and coolant system.

SEMCO IC coatings therefore reduce the lifetime contamination of oil and coolant, extending engine service intervals, while improving engine performance (a properly-cooled and lubricated engines runs more efficiently than an engine with blocked channels), and reducing the overall amount of oil and lubricant consumed by the engine.

Moreover, SEMCO IC coatings lower the occurrence of scabbing and veining defects, reducing the need for post-casting cleaning (lowering foundry producing costs and reducing re-working), and creating the option to cast thinner engine geometries without facing casting problems.

THREE PROPERTIES UNDERPIN SEMCO IC PERFORMANCE:[1]

- **Coating flake formation:** SEMCO IC has been engineered to form strong, well-defined ceramic flakes that readily detach from the surface of the casting and act as a carrier for other debris during knock-out. This helps to improve cleaning of the casting, even in the most inaccessible of areas.

- **Improved gas permeability:** during casting gas is released in the sand mould as the binder combusts. Without a sufficient degree of permeability to let that gas through, pressure will build up behind the coating and may result in premature flaking, scabbing defects and scrap. SEMCO IC offers better gas permeability than conventional coatings and thus improved resistance to scabbing.

- **Anti-veining:** standard vein block testing, comparing SEMCO IC with conventional coating products, has demonstrated SEMCO IC has higher resistance to vein formation, reducing the need for fettling.

REFERENCES

1. For more detailed discussion of the properties of Semco IC, see Genzler, C., 'Coating for Improved Inner Cleanliness', Foundry Practice No. 269, pp. 3-10.

THE CONCLUSION

As the demands of engine manufacturers and regulators become increasingly tighter, SEMCO IC coatings offer substantial benefits to the foundry when it comes to inner cleanliness and the need to eliminate the use of lead in bearings and bushings.

They are however just one weapon in the Foseco clean casting arsenal. From linings and slag coagulants to ensure a clean melt; filters, stoppers and nozzles for a clean pour; or coatings to minimize surface defects – Foseco's range of solutions supports foundries in their continuing quest to cast cleaner, improve yield and control costs.

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