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the future of forging

Sustainability in Forging

Eliminating energy-intense process steps by innovative steel

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Dr Steve Ooi is Group Technical Specialist with Ovako, based at Cambridge University. He obtained his BEng, MPhil, and Ph.D. from Swansea University. His work specialises in alloy and process design in the context of steels for complex engineering applications where component failure can lead to major consequences. Much of his research has, therefore, been focused on critical components in industrial applications.

Steve Ooi

Abstract

The possibility of eliminating the energy-intensive reheating step and reducing production costs through the use of direct-cooling steel is an attractive approach for forging industries. With Ovako Group achieving carbon-neutral production in 2022, our focus has shifted to creating a new direct-cooled forging steel. This initiative aims to help our customers in the forging industry further reduce their CO2 emissions by eliminating the energy-intensive reheating step and increasing productivity.

In addition to the benefit of reducing the energy-intensive reheating step and achieving a significant reduction in CO2 emissions, the total manufacturing cost for the forger can also be reduced when the subsequent heat treatment step is eliminated. This removal addresses both labour and maintenance costs on existing equipment or capital investment when building a new forging plant.

The substitution of direct-cooled forging steel has often faced constraints related to toughness requirements at specified strength levels. Historically, to enhance toughness, direct-cooled forging steels have evolved from micro-alloy precipitation-strengthened ferrite-pearlite to upper bainite microstructures. While successful cases exist using both microstructure types at low strength, many components with a higher demand for strength and toughness are still being produced using conventional quench and tempered martensitic steel through energy-intensive processing routes.

Through new alloy design criteria and innovative approaches, both the strength and toughness of the forged component can be increased. This allows our customers to optimize the use of steel through reduced product size and/or decreased component weight. The alloy design criteria include the carbon

content of the steel and the transformation temperature, calculated through the existing computer program, that would produce a suitable target microstructure.

In this presentation, two innovative alloy steels without expensive alloying will be introduced. The first new alloy achieves its high yield strength and Charpy toughness with direct air cooling at a thickness of 70 mm. This alloy is designed to achieve a low transformation temperature to produce lower bainite and auto-tempered martensite. The second alloy has a lower alloying content but can achieve its high yield strength and Charpy toughness at room temperature when quenched in a well-agitated salt bath. Furthermore, it has been shown that this alloy adapts well to the shot-peening process.