PURPOSE-BUILT FORGED PARTS OPTIMIZED FOR ‘END USE’

Forged parts suppliers can determine the appropriate materials, manufacturing processes, and quality standards necessary to ensure that the metal parts perform effectively. (Courtesy: All Metals & Forge Group)

Working with an experienced supplier of open die forgings, seamless, and contoured rolled rings, and complex forged parts that prioritize the 'end use' of the part form in the early stages of the process can help ensure quality, performance, safety, and compliance in critical applications.

By ROYCE LOWE

When forging seamless rolled rings for diverse sectors such as industrial machinery, pulp and paper, turbines, and oil and gas exploration, it is crucial to tailor components for their specific applications or "end use." In the realm of metal parts, this term commonly denotes the ultimate form and state of the final machined part, along with a comprehension of the operating conditions it will face during service.

"By understanding the final application or purpose — the end use — for which these parts are designed and manufactured, forged parts suppliers can determine the appropriate materials, manufacturing processes, and quality standards necessary to ensure that the metal parts perform effectively and reliably in their intended applications," said Jeff Klein, director of sales for All Metals & Forge Group. The ISO 9001:2015 and AS9100D-certified manufacturer produces open die forgings, seamless and contoured rolled rings, and complex forged parts to industry standard specifications in eight to 10 weeks.

CRUCIAL ROLE

According to Klein, open die and forgings and seamless rolled rings play a crucial role as components in gears, turbines, bearings, clutches, couplings, drives, flanges, valves, machines, and rollers for a wide variety of end uses. As such, these items must exhibit exceptional attributes such as strength, durability, precision, and resistance to fatigue, deformation, and harsh environments in saltwater or downhole uses to meet precise performance standards when deployed in the field.

In some cases, failing to consider the end use can even introduce serious risk, including catastrophic failure of a part while in operation.

For example, aircraft engines include seamless rolled rings. If such a part fails catastrophically during takeoff, flight, or landing, the engine can tear itself apart or explode, sending pieces of hot metal at high speed through the engine housing and into the plane wing, compromising structural integrity, or the passenger cabin, causing dangerous depressurization, passenger death, or an airliner crash.

In the oil and gas exploration industry, the failure of a forged part can occur more than a mile underground, causing a well shutdown and the withdrawal of the failed part that may be more than 10,000 feet below the surface. In machinery, a part failure can cripple production and a replacement part may not be obtainable for several months.

CONSIDER END USE, FROM THE START

The consideration and planning to meet end-use requirements should begin with the service requirements outlined during the engineering phase of design and conclude when the part is in its operating position, performing as intended.

"It is vital that the manufacturer specify the end use of each part and ensure it is communicated throughout the production chain, from the design engineer, through purchasing, the forging operation, heat treating, finish machining, and final assembly of the end use, including the mechanical property requirements and the heat or corrosive conditions in which the forged part will perform," Klein said.

Custom forged parts for critical applications assure quality, performance, safety, and compliance. (Courtesy: All Metals & Forge Group)

According to Klein, different industries, such as food processing, paper manufacturing, machinery building, oil and gas exploration, or energy have unique specifications and standards that metal parts must meet. The specific function of the part will dictate its design, dimensions, material selection, forging, heat treating, and finishing processes. In all cases, the part must be manufactured to industry standard specifications such as ASTM, AMS, AISI, or API unless the OEM has developed their own requirements by modifying one of those standards. In short, the finished product must comply with all quality, durability, chemistry, and mechanical properties within

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the selected standard.

Seamless rolled rings can be produced in a variety of alloys, sizes, and shapes specific to fit end-use requirements. However, by collaborating closely with the forging supplier, engineers, buyers, and machinery builders can ensure the ideal selection of chemistry, mechanical properties, heat treatment, machining, and testing ultimately required for each part's end use.

SELECTING THE ALLOY

The process often begins with the selection of the alloy grade used for open die forging or seamless rolled ring production, which can apply to many specific end uses. These range from low- and medium-carbon steels, through-high-carbon steels, aluminum alloys, alloy steels, stainless steels, nickel alloys, tool steels, and titanium alloys. The precise alloy for the intended end use should always be specified and stated in the purchasing process according to final mechanical property requirements and service conditions.

Material properties also can be altered for specific end uses by hot working as well as by using various chemistries, temperatures, heat-treatment times, and cooling methods. This facilitates the production of seamless rolled rings or forged parts with optimized mechanical properties and structural integrity before the part moves on to finish machining.

Each metal possesses unique alloy chemical compositions formed during the steel mill process, along with diverse production procedures for generating ingots or billets of different grades and purities tailored for industry specifications. Consequently, the quality of steel mill output is critical.

With so many options available, a thorough grasp of the end use is vital for establishing the correct material, dimensions, and properties needed during forging to guarantee peak performance in the eventual application.

In the case of All Metals & Forge Group, end use is emphasized from the very beginning in the request for quote (RFQ) process. The company works with its steel mills to purchase the correct starting stock to achieve the specified properties and operating reliability required of every part. In addition, rough machined parts are tested at least three times to prove chemistry, mechanical properties, and soundness before shipping.

According to Klein, there are groups of alloys within each metal material that lend themselves to specific end uses.

High-nickel alloys (I625, I718, I825), for example, are used at high temperatures in applications such as jet engine parts, nuclear-power

AMFG produces open die forgings, seamless and contoured rolled rings, and complex forged parts to industry standard specifications in 8-10 weeks. (Courtesy: All Metals & Forge Group)

generation, and heat-treated fixtures where high oxidation resistance is required. Other alloys within this group find use in the pulp and paper or oil and gas industries where corrosive conditions may be severe.

The Inconel 600 and 700 series were developed for specific end uses. Inconel 600 resists chloride-ion stress corrosion cracking. Inconel 690 resists sulfur-bearing gases. Inconel 718 is a precipitation-hardening alloy designed to give very high yield, ultimate tensile strengths, and resistance to creep rupture at temperatures up to 1,300°F (705°C).

THE IMPORTANCE OF END USE WITH STAINLESS STEELS

End use is equally important with stainless steels, where the various groups of martensitic (hardenable), ferritic, and austenitic cover a very wide range of properties and applications when resistance to corrosion and heat are critical.

Basic type 410 martensitic grade stainless, with about 13 percent chromium, is sufficient for mild corrosive conditions, whereas the ferritic type 430, with 17 percent chromium shows resistance to more severe environments. The performance of the austenitic stainless steels, based on the 18 percent chromium/10 percent nickel in type 304 is selected for certain end uses when correctly heat treated and not subject to carbide precipitation. The various additions to the base 304, such as molybdenum, improve resistance to pitting corrosion. The resultant molybdenum-containing grades are types 316 and 317, normally supplied in the low-carbon versions, 316L and 317L.

The range of stainless steels continues through types 329 and 2205 duplex alloys — austenite and ferrite — that provide good resistance to pitting and stress corrosion cracking, to precipitation hardening grades such as 13-8Mo, 15-5PH, 15-7Mo and 17-4PH. These latter grades reach high yield and ultimate tensile strengths from a single, low-temperature heat treatment following a solution anneal. This makes these types of stainless steels suitable for challenging applications such as oil field valve parts, chemical process equipment, forged aircraft fittings, nuclear reactor parts, and jet-engine components.

With so many options available, a thorough grasp of the end use is vital for establishing the correct material, dimensions, and properties needed during forging to guarantee peak performance in the eventual application.

By collaborating with an experienced seamless rolled ring manufacturer that can tailor the forging process to the specific end use, OEMs can ensure their final product meets all the necessary requirements and industry standards for their specific application.

ABOUT THE AUTHOR

Royce Lowe is a highly qualified troubleshooter when metallurgical failures occur with more than 30 years of experience in metallurgy, sales and marketing of a broad range of carbon and alloy steels, including all stages of their processing. He has coincident experience with stainless and nickel in the suitability of these alloys, based on their metallurgical and mechanical properties, for the end uses. He often writes articles about alloy applications, as well as issues in the industries that use them. For more information, go to www.steelforge.com.