EFFECT OF LONG-TERM AGEING AT 475 °C ON PROPERTIES AND MICROSTRUCTURE OF CUSTOM 465 STEEL

ROŽNOVSKÁ, Gabriela¹, VODÁREK Vlastimil², KUBOŇ, Zdeněk¹

¹Materiálový a metalurgický výzkum s.r.o., Pohraniční 693/31, Větkovice, 703 00 Ostrava, Czech Republic
²VŠB–Technical University of Ostrava, 17. listopadu 15, 708 33 Ostrava-Poruba, Czech Republic

Abstract

The steels with high chromium content are known to suffer embrittlement at elevated temperature induced either by decomposition of the microstructure into two arranged solid solutions $\alpha + \alpha'$ (embrittlement at 475 °C) or by precipitation of chromium-rich brittle phase $\sigma$. Martensitic precipitation hardening steels belong among materials having chromium content close to the minimum embrittlement concentration and in some circumstances there could be possibility of prolonged exposure of these steels at elevated temperatures. The effect of long-term ageing (1,000, 2,000 and 3,000 hours at 475 °C) on the material properties, microstructure and substructure of precipitation hardening martensitic stainless steel CUSTOM 465 was analysed and the additional precipitation of very fine particles of intermetallic phases and also decomposition of solid solution $\alpha$ into chromium-rich particles of the phase $\alpha'$ with nanometric size was found. Despite expectations a slight decrease of strength and impact energy was detected after ageing at 475 °C as a result of stabilization of reverted austenite, which completely compensated the effect of the additional precipitation hardening of martensite. The total content of reverted austenite even doubled after ageing in comparison with the as-received state, although the ageing temperature was significantly lower than the temperature $A_{c1}$ of the steel.

Keywords: precipitation hardening steel, CUSTOM 465, long-term ageing, mechanical properties, reverted austenite

1. INTRODUCTION

The selection of materials for the extremely demanding operating conditions such as components of landing gear has been ultra-high tensile strength (UHTS) steels such as AISI 4340 and derivatives including 35NCD16THQ and 300M. These low-cost materials provide excellent tensile strength, fatigue resistance, and good fracture toughness [1], but their disadvantage is poor corrosion resistance. The recent development of high-performance structural stainless steels offers a promising alternative material, precipitation-hardened corrosion-resisting steels that have tensile properties approaching the current UHTS steels and moreover provide excellent corrosion resistance. One of these new steel grades is CUSTOM 465 with comparable tensile strength and fracture toughness, better ductility, and very good general corrosion and stress corrosion cracking resistance. As it belongs to the group of high chromium steels that are known to suffer embrittlement at elevated temperature, the aim of the presented work was to analyse the effect of long-term ageing (1,000, 2,000 and 3,000 hours at 475 °C) on the material properties and microstructure changes.

2. STEEL CUSTOM 465 AND ITS PROPERTIES

CUSTOM 465 is a trademark of Carpenter's steel grade; it is martensitic precipitation hardenable stainless steel for use in demanding applications, such as air transport or oil and gas extraction where a tensile strength of more than 1380 MPa is required. A unique combination of high strength, toughness, fatigue