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Title: Effect of different cooling methods and heat treatments on the toughness of thick wall extruded duplex stainless steel tubes

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Duplex stainless steel S32205 seamless tubes, with a Chromium content of 22,5%, Nickel content 5,5%, Molybdenum 3,2% and 0,17% Nitrogen, are commonly used in the petroleum, petrochemical and natural gas industries. Production of thick wall tubes is often challenging because the narrow window of process parameters allowed to obtain a clean biphasic microstructure with the right mechanical properties.

One of the most critical operations in the production of thick extruded duplex stainless steel tubes (WT > 30 mm), is the last heat treatment which main objective is to obtain the target balance ferrite-austenite and the solution of any type of precipitation (intermetallic phases, Chromium nitrides, carbides…). In the case of extruded tubes, the last cooling after extrusion is also critical to obtain the right microstructure and consequently, the final mechanical properties after the later heat treatment.

In this work, different cooling media and later final heat treatments have been applied to produce a duplex stainless steel OD240 mm x WT31,8 mm tube by extrusion. After each production step, microstructure has been characterized by optical microscopy on the longitudinal and transversal section and over the thickness. Ferrite content, secondary austenite presence, austenite spacing and grain size of each phase has been determined for each condition. Precipitation presence has been analyzed by both optical and scanning electron microscopy.

In addition, pitting corrosion resistance according to ASTM G48A has been performed in samples taken at different locations over the thickness of tubes produced by the different routes. Finally, impact test has been carried out on specimens taken at mid-wall thickness along the longitudinal and transversal orientation for the different routes as well. Results in toughness have been analyzed and explained depending on the previous corresponding microstructural features.

Consequently, and taking into account all the findings, it has been defined the most appropriate heat treatment process to obtain the microstructural and mechanical behavior of the extruded tube that fulfills with the international standard ISO 17781 requirements.