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Technological conversion applicable for manufacturing elements from Nickel superalloy H282

Z. Pirowski [1], K. Jaśkowiec [1], A. Tchórz [1], I. Krzak [1], J. J. Sobczak [1], R. M. Purgert [2]
[1] Instytut Odlewnictwa, 30-418 Kraków, ul. Zakopiańska 73,Polska
[2] Energy Industries of Ohio, Cleveland, OH, USA

Nickel alloys are ones of the most resistant materials designed to work in extremely harsh conditions at high temperature. The majority of working elements, made from those alloys is being manufactured using very expensive erosive treatment, based on material that has been pre-plastically reworked. The application of metal casting processes for manufacturing Ni alloys poses a number of difficulties, the scale of which is rising equally to expected increase of performance of those alloys.

The aim of the proposed study was to optimize the casting process of manufacturing of Ni alloy with properties comparable to alloys manufactured by squeezing method with associated plastic forming. The study also involved the execution of experimental utility castings based on the example of Haynes superalloy 282 (H282).

Keywords: *nickel alloys, computer simulation, computed tomography, technological conversion*

1. Introduction

Nickel alloys plays the key role, where materials are designed for elements with the largest thermal load, including also stress and corrosion conditions. Such alloys, including those crawling resistant, are used among others in energy sector facility, chemical and petrochemical industry, aviation and space. Many of those alloys are used as materials plastically fabricated and elements made from such alloys are manufactured by costly erosive treatment. In the following study the trials of melting and casting of H282 has been presented. Actually the Haynes superalloy H282 is being manufactured only using the plastic fabrication method. It was assumed that the result of the study will be manufactured experimental utility castings.

2. Material investigation

For the purpose of experimental work the H282 superalloy has been chosen, additionally reinforced precipitation of phase γ'. This superalloy is an outstanding material designed to work at high temperature, in very aggressive environment, including large loads [1-5]. Up to now it is only used and manufactured by plastic fabrication method. The attempt to use such material as casting encountered the number of problems. Those problem has been identified in the area of both – melting processes (high reactivity of the melt with ceramic shells and the atmosphere appeared above metal bath), and the casting process itself (low fluidity, large casting shrinkage).

The trials of melting and casting of H282 superalloy in laboratory conditions were focused on optimization of melting technology in the open induction furnace, as well as the evaluation of acquired properties using the method of gravity casting in sand moulds.

Casting alloys are characterized by decreased mechanical properties at ambient temperature, than their plastically fabricated equivalents. This is due to the lack of reinforcement of the structure by squeeze of the casting alloys. Those differences are being decreased while the temperature of investigation is going higher. And in sufficiently high temperature, the level of strength properties of alloys often exceeds the appropriate level for materials manufactured forging, rolling, and drawing techniques. Appointed in the following study temperature for conversion of H282 is equal to about 920°C (Fig. 1).

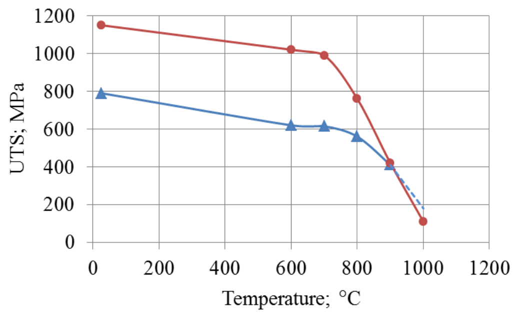

Fig. 1. Dependence UTS=f(T) for alloy H282:
▲ - casting alloy (own invesigations),
● - plastically fabricated (literature data) [6, 7]

3. Prototype castings

After carrying out the computer simulation of the technological process, there has been made utility castings of burner nozzle for ladle preheating. The quality of manufactured castings was compared to the results of numerical analysis. Estimated potential distribution of porosity in the casting nozzle flooded by the riser was confirmed in the experimentally-made casting, and further proved by computed tomography (CT). The prevalence of similiar porosity was not found in the case where metal was introduced into the mould through the bottom of the gating system (Fig. 2). The results has confirmed that numerical analysis was stated correctly.

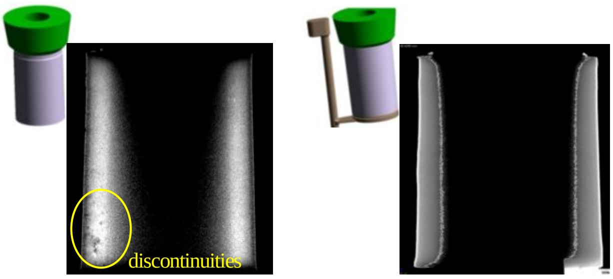

Fig. 2. Computed tomography of burner nozzle casting made from H282 in different melting technologies

Additional experiments attempting to perform experimental casting showed that from H282 super-alloy shaped casting can be manufactured with satisfactory quality of the surface, flared shape, and a low degree of occurrence of internal discontinuities. The working nozzle, mounted in the burner is shown on Fig.3. Measured temperature of its working conditions locally exceeds 800^{o}C.

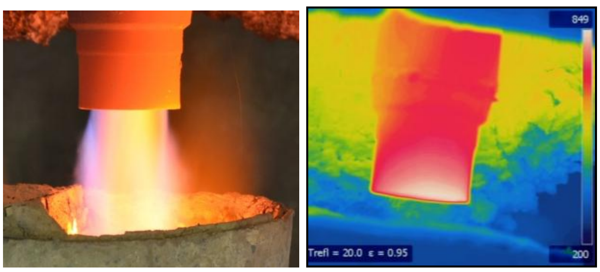

Fig. 3. Working burner nozzle during the heating ladle: left – overall view, right – thermal picture

4. Summary

Knowledge related to level of properties: mechanical, thermo-physical, technological, functional, as well as process development of macro- and micro-structures of H282 allows to propose the melting technology of H282 in an open crucible induction furnace. The technology of gravity casting has been performed, allowing to manufacture of good quality castings to operate in extreme conditions, i.e. in the temperature that significantly exceeds 700^{o}C. The basic condition necessary to obtain the output of casting alloys, without defects is the strict adherence to the developed manufacturing technology.

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