Development and characterization of hydrogen sensor for brass alloys

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Abstract

In the frame of EUROFUSION project a hydrogen permeation sensor for Li-Pb was developed at ENEA Laboratories in Brasimone (Italy) to measure the concentration of hydrogen isotopes in the liquid metal. ALMAG objective is to adapt the sensor for brass alloys to investigate the influence of hydrogen for the production of high-pressure resistant products.

The sensor developed could find promising applications in the field of brass metallurgy, as well as other industries that are interested to measure hydrogen content for purification purposes. In liquid copper alloys no commercial solutions are available to directly measure hydrogen concentration. The solution developed will be adapted for the application with brass alloys with melting temperature up to 950°C instead of 550°C in Li-Pb.

In order to adapt the sensor for the new environment ALMAG in collaboration with ENEA carried out a series of activities.

A new material had to be chosen due to the higher temperature and chemical aggressivity of the molten brass. Several tests were conducted inside the furnace to assess the lifespan of each material option.

An inertization system was developed to guarantee an oxygen free environment in the insertion phase and to protect the high wear near the molten metal-air interface.

To measure the hydrogen in the bath a sensing system was assembled. The measuring unit connects the sensor with proper piping to a turbomolecular pump in order to reach a high vacuum. The vacuum is needed to let the hydrogen to permeate trough the sensor and flow through a mass spectrometer properly calibrated with a fixed flux hydrogen leak tank.

Multiple blank tests were conducted before the installation of the sensor to detect any leaks and to measure the background noise. Furthermore, all the steps of the insertion phase were previously simulated to detect any flaws left in the procedure.

Two tests were carried out. The first lasted for 6 hours. The sensor head after the extraction showed no sign of corrosion nor oxidation. A second test was subsequentially arranged with positive results to assess the reusability. The test lasted for 30 hours, and the sensor was still able to withstand a further use.

The acquired data shows the presence of hydrogen in the molten brass and that the developed measuring system has the capability to detect it. Future large-scale tests will better understand the influence of hydrogen on the performance of the produced pieces for high pressure applications.