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HABILITATION THESIS

RESEARCHES ON THE EFFECTS OF INNOVATIVE HEAT TREATMENTS ON THE QUALITY OF METAL ALLOYS USED IN INDUSTRY

Field: Industrial engineering

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(A) SUMMARY

The habilitation thesis "Researches on the effects of innovative heat treatments on the quality of metal alloys used in industry"consists of an introduction and three chapters.

The first chapter presents research on the use of conventional heat treatments applied to a wide range of metallic materials: constructional and tool steels, aluminium alloys and titanium alloys.

Alloyed and non-alloyed constructional steels underwent quenching and tempering heat treatments, low and high temperature thermo-mechanical treatments, and surface quenching using electron fluxes and laser radiation for heating. Tool steels underwent quenching treatments followed by multiple tempering, quenching at negative temperatures, nitriding thermo-chemical treatments and multiple nitrocarburation, ionic nitriding and plasma nitriding.

Aluminium alloys underwent quenching, natural and artificial ageing and isothermal quenching.

Titanium alloys underwent quenching and tempering heat treatments, natural and artificial ageing, vacuum quenching, nitriding.

Each of these treatments was performed in observance with the parameters of the alloys they were applied to and the objectives were the improvement of the quality of the products obtained following their application and the improvement of the actual performance of the heat treatments. The results highlight the achievement of the objectives proposed by the research. The processing of the results using statistical methods when their conduct so warranted increased their credibility. There can be highlighted some of the results such as heat treatment cycle shortening, economic efficiency, improvement of the properties of materials, wear resistance increase, etc.

The second chapter presents a number of unconventional heat treatments applied to constructional steels and to aluminium alloys: the use of solar energy for the quenching and tempering of alloyed and non-alloyed constructional steels, the use of magnetic field for the artificial ageing of aluminium alloys and the use of the vibratory field for the ageing of aluminium alloys.

In the case of the use of solar energy, in addition to experimental research, computer modelling and simulation of heating and cooling processes were also carried out as a base for a possible extension of studies on the applicability of such treatments. The experimental research was carried out in partnership with CIEMAT (Centre for Energy, Environment and Technology) - Plataforma Solar de Almeria (PSA), Spain, during two joint projects under the EU-DG RTD project: "The European Solar Research Infrastructure for Concentrated Solar Power. The second phase - SFERA-II". This activity is governed by the Contract 312643 concluded between CIEMAT-PSA and the European Commission. The

research clearly highlighted the possibility of using solar energy for this purpose, the ways of controlling the technological working parameters, the performance levels for the quality of the treated products compared to the classical treatments and the economic and ecological benefits.

The use of magnetic fields in the ageing of aluminium alloys was aimed at detecting the effect of such additional energy input on the structural changes and on the precipitation of the hardening phases, implicitly leading to changes in the properties of the materials. There were found significant amplifications of phase precipitations compared to classical treatments applied at the same time. As a result, the properties of the treated materials increased significantly (particularly the hardness). At the same time, significant reductions in treatment times were achieved compared to classic treatments (artificial or natural ageing).

The use of the vibratory field for the ageing of aluminium alloys highlighted similar effects to the magnetic field use, i.e. improved properties of treated alloys and reduced treatment times.

Chapter 3 presents a series of surface-engineering specific researches: surface quenching by laser beam heating and deposition of thin SiC and TiC layers by PLD (pulsed laser deposition).

The objectives of these treatments were to improve the surface quality of the treated products. In the first case, the surface quenching led to very large variations of properties in the cross-section of the material (perpendicular to the surface) on the heat treated depth. In the second case, there were obtained surfaces whose compositions differed from the base material, with highly differing properties as well, pursued for the finished product (very high corrosion, wear, etc. resistance).

Section (B-ii) The career progress and development plans include information on teaching and research, as well as data on the managerial experience and teaching and research development plans.

In what concerns teaching, my aim is to introduce new and attractive methods of teaching for students, in keeping with national and international trends, to prepare materials for the incentive teaching of students and their involvement in research as much as possible, etc.

The research directions I intend to address are related to biomaterials, innovative technologies for obtaining materials with superior characteristics at the lowest costs possible, the development of efficient and viable materials such as the use of environment-friendly processing technologies by employing unconventional technologies.