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Industrial Furnaces - Status and Research Challenges

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Abstract

The modern Industrial Furnace Technology is characterized by the design of new furnaces for high strength metals and carbon fibers for the light weight construction concepts in automotive industry. The furnaces for the annealing of modern high strength metals (steel, Al), are characterized by innovative cooling sections, with high cooling rates and a concomitant homogeneity, which are controllable for different steel or aluminum grades, variable widths and thicknesses for high productivity strips plants for products used in automotive industry. Resulting from this intensive research and development concerning the improvement of the local heat transfer knowledge for extremely high heat fluxes with gas, mist and/or water cooling is necessary. This research is driven by a competitive situation between steel and aluminum and since a few years also carbon fiber reinforced plastic (CFRP). On the other hand steels with a cheap alloying concept are used successfully in combination with the press hardening technology. The furnaces for the different applications in light weight design are very different between the materials (steel, Al, CFRP) due to different temperature ranges, principles of heat transfer and thermal operations.
The environmental aspect of industrial furnaces requires the reduction of the specific CO_2-Emissions which can be realized with advanced technologies improving the energy efficiency of fuel heated furnaces (high temperature air preheating with recuperative and regenerative burner concepts). For the overall CO_2-emission reduction of 90 % up to 2050 related to 1990 actually no proved concepts are available.

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Keywords: Industrial furnaces; High strength steels; Press hardening; High strength aluminum; Carbon Fiber Reinforced Plastics; RFCP; Reduction of CO_2-emissions; Electrification of large industrial furnaces

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1. Introduction

Process and plant technology, which can be classified as a part of thermo-process technologies, spans a wide arch covering the different materials with temperatures from low to very high temperatures. Figure 1 shows by trend the energy consumption and process temperatures for the most important fields of the extractive industry and the basic primary industry. The maxima are in the temperature range of up to 400 °C and from 900 °C to 1500 °C. The industry sectors chemistry, textile, and sugar are to be found in the lower temperature range. Typically, the energy intensive branches, such as non-ferrous metals, iron and steel, glass, refractories and ceramics, are to be found in the temperature range T ≥ 600 °C. All these industry sectors need the exact adjustment of the necessary process parameters (e. g. temperature, time and atmosphere) for the thermal treatment of the materials in order to achieve a production of goods with high quality properties.

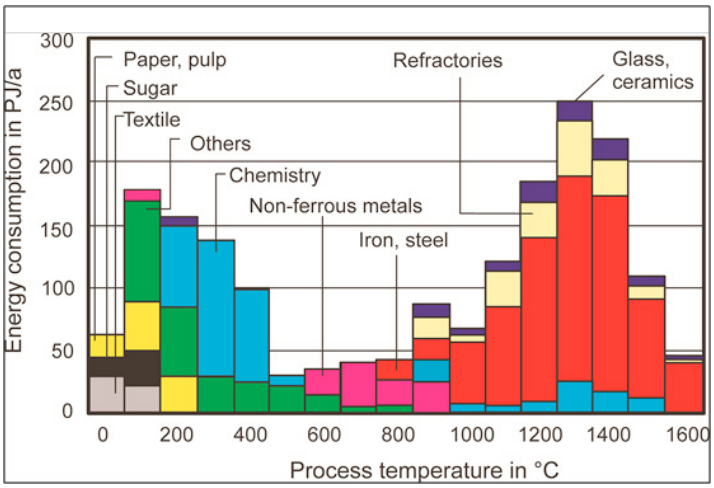

Fig. 1. Energy consumption and process temperatures for industrial sectors, acc. to [1].

For the generalized term Thermo-process Technology, the definition can be: „Process- and plant-technology for the thermo-chemical and the thermo-physical treatment of materials in such a way, that the perfect product quality will be reached by the targeted adjustment and control of loads temperature and the process atmosphere under economical boundary conditions" [2].

The main topics at present of the "Industrial Furnace" community are shown in Figure 2 and separated in

- Technology,
- Environment and
- Society.

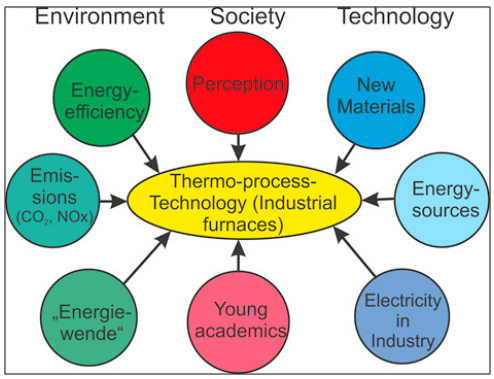

Fig. 2. Arc of suspense „Thermo-process Technology".