MECHANICAL MEASURING DEVICE FOR NORMAL HEATING

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Abstract

The project is focused on the manufacture of test equipment for industrial continuous heating furnace. Using this measuring device, you can specify the parameters of the heating for the optimization of the temperature regimes. For an optimal construction of this device, we must take into account the characteristics of each of the materials used and their classification temperature. Their comparison, knowledge of the working environment of the space heating furnaces and side effects in the heat, are to some extent makes it easy to select the materials for the use of the measuring device. He was therefore designed and manufactured physical model for testing insulation materials for the measuring equipment. On the basis of the measurement of the temperature course were established during the transition curve increase in temperatures in the furnace. The aim of the measure was to test various types of insulation materials and determine the dynamic characteristics of the made-up physical model with different locations.

Keywords: Thermo - box barrier, heat transfer, mathematical model, ablative materials, airgel, industrial rating furnace

1. INTRODUCTION

Measuring devices for heating industrial furnaces is used in order to specify parameters of heating for heating modes optimizing.

For optimal construction of this instrument, we must take into account the characteristics of the materials used and their classification temperature. However, we have to take into account some of the parameters of industrial furnaces. [1, 4] Comparing them, knowledge of the working environment and side effects during the heating process itself will help us choose the materials. In the first part were used ceramic materials by company Propec Ltd. Although we used these refractory materials, according to the recorded waveforms temperatures would not be applicable to our conditions. Heating push furnace in its central portion reaches a temperature up to 1200 ° C, the measuring equipment must be constructed of materials which can withstand the temperature and the recorded data can be sent to the receiving device. [2] The materials, however, withstand relatively low temperature and the highest possible recorded time was 10 minutes (**Figure 1, 2**), then the temperature in the inner part of the physical model began to grow to critical limits. The task of the outer protective layer of thermal barrier box is, however, to prevent access of heat to the interior of measuring part. There will be saved measuring and recording device inside of this part.

Therefore it is very important to pay attention to the selection of suitable insulating materials. [1, 3] After excluding the vast majority of materials which are available on the market which do not satisfy for the required parameters, suggests itself the use of certain composite materials. This are in most cases a next-generation materials, which are not mass scale exploited yet. Their production is very complex and complicated, financially are not available for general use.

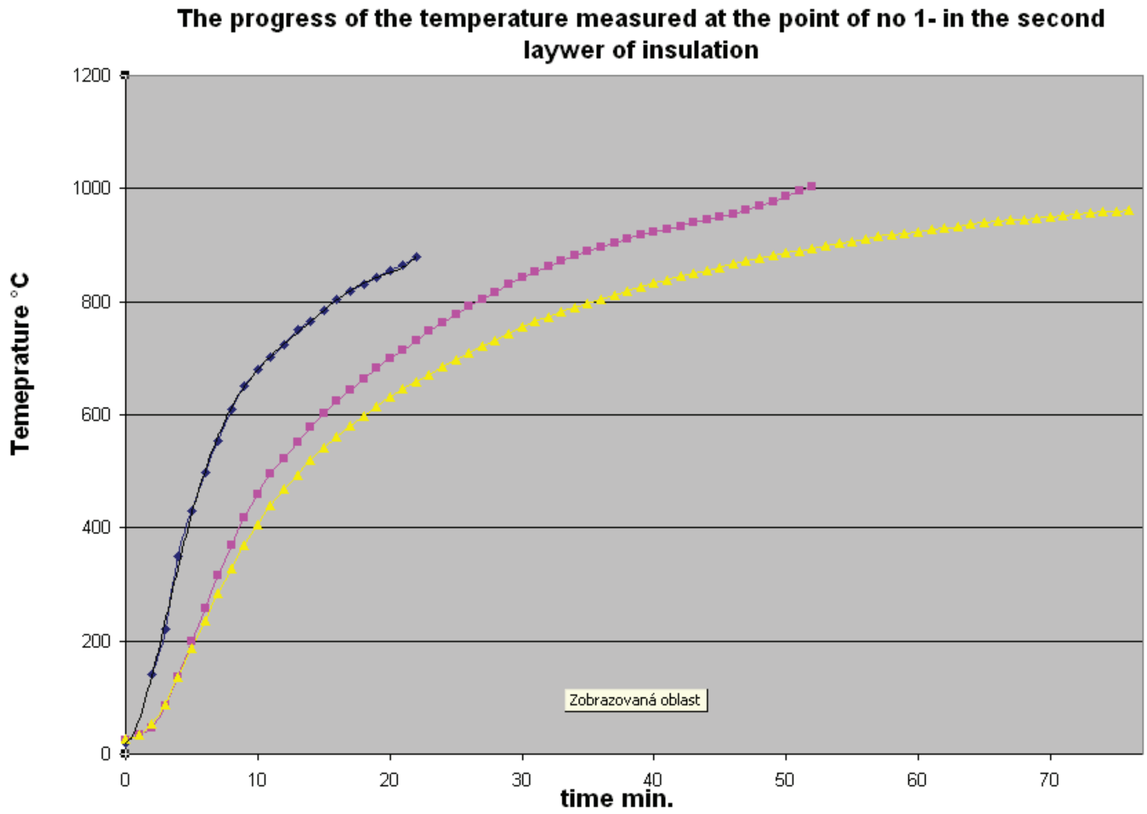

Figure 1 Temperatures in position 1

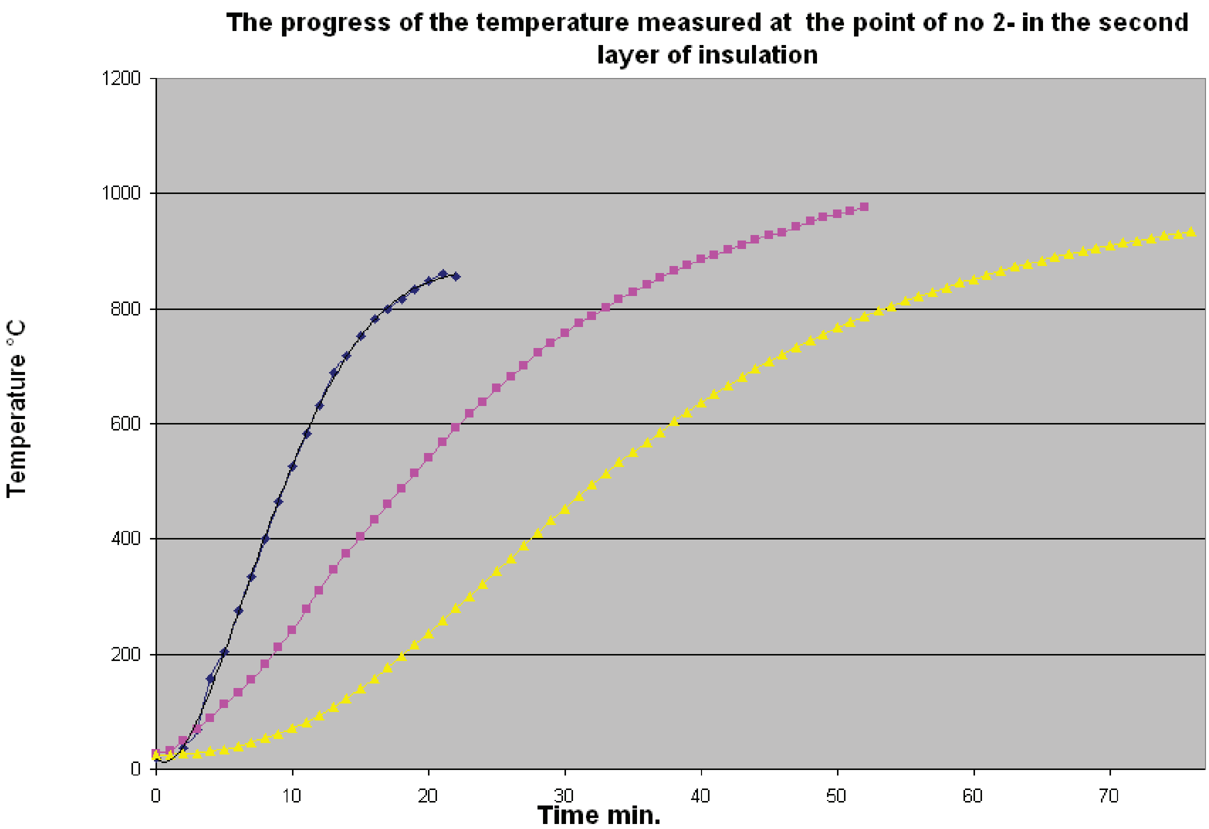

Figure 2 Temperatures in position 2

2. RCC (REINFORCED CARBON-CARBON)

This composite material consists of carbon fiber (**Figure 3**). It creates a carbon matrix. In most cases, is covered with a layer of silicon carbide to protect the carbon from oxidation clean. It is suitable for use in high temperatures [5], especially where heat resistance is required or a low coefficient of thermal expansion. Not fragile, like so many other ceramics, but it is less resistant to impact.

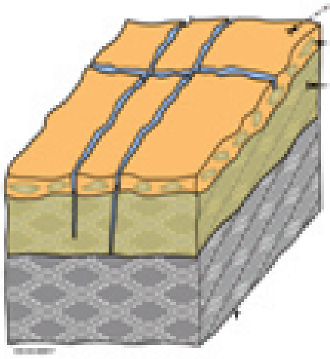

Figure 3 Cut of RCC material. Source: [10]

3. HRSI (HIGH-TEMPERATURE REUSABLE SURFACE INSULATION)

The basic components of this material are the fibers of very pure quartz, which are connected by sintered quartz ceramics (**Figure 4**). The material is very porous, low density (144 kg/m^3), and brittle. It is mostly processed into sheets, the surface of the plates is covered by borumsilicate glass thickness 0.46 mm. This prevents wearing the surface of board, it prevents this porous material of moisture absorption and increases the radiation of heat from the board. At the lower edge is the vitreous surface interrupted and so that the air pressure in the pores could adapt surroundings. Ingress of moisture into these sites prevents the plate surface impregnation with silicone. In areas of higher temperature of the plates have dimensions of 150x150 mm^2 and a thickness of from 20 to 72.5 mm. Damage to the plates due to thermal expansion is prevented by selecting as the material of pure quartz plates. Quartz has a very small thermal expansion.

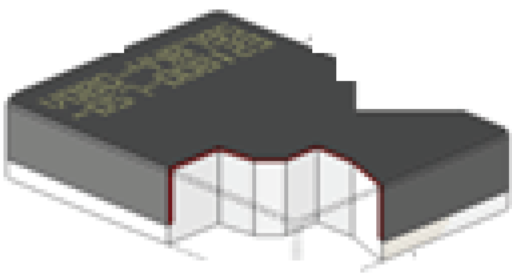

Figure 4 Cut of HRSI material. Source: [10]

4. ABLATIVE SYSTEMS

Ablation is a method of thermal protection on the basis of the physico-chemical transformations of solids depending on convective or radiative heat flows (**Figure 5**). The actual effect of the heat shield is the sum of the heat of phase transformations and chemical transformations of substances and reducing the flow of heat.

It is essentially a kind of sacrificial thermal protection method, since in order to maintain reasonable temperature conditions, the surface layer is partially destroyed. [6] The main advantage is the self-regulation of ablation process, i.e. ablation speed changes depending on the level of pressure and temperature of gas flowing over the surface.

When a material of low thermal conductivity is used in the systems of heat-absorbing, heat from the surface of material is not practically discharged into its volume. [7] Thus arise in the material high thermal gradients and the surface temperature may exceed the melting or sublimation of the material.

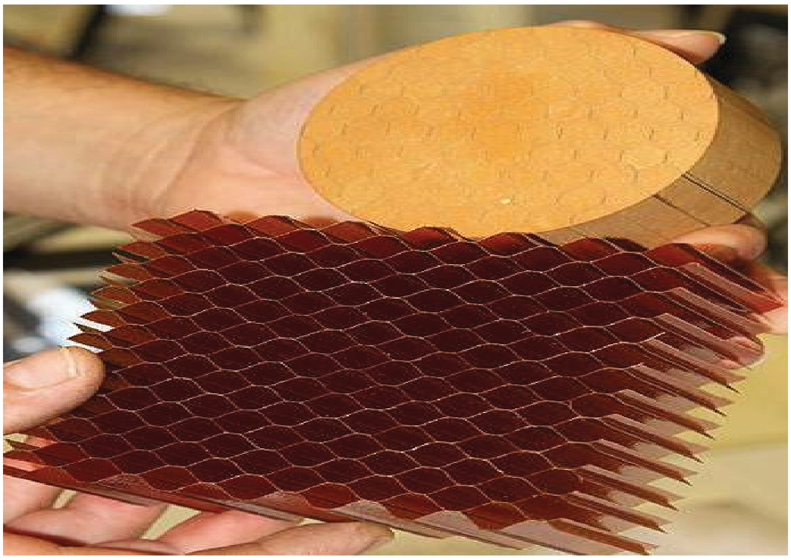

Figure 5 Honeycomb matrix. Source: [10]

Among the most widespread ablative material takes part, without a doubt, composite materials which consist of graphite or quartz fibers interconnected phenolic resins. Ablation mechanism of these materials is quite complex and challenging. These materials have a high melting point. The matrix may be of glass, asbestos, carbon or polymeric fiber braided different ways. In some cases, the honeycomb structure is used, which is filled with a special blend of organic and inorganic substances with the addition of glass fibers. [8] This special blend is into a cell honeycomb matrix filled gradually. **Figure 6** is empty honeycomb matrix and matrix filled by mixtures. Initially, the heat exchange happens by conduction. When the surface temperature reaches the pyrolysis temperature of resin, the resin will carbonize and the gases generated by the decomposition carry away heat to the ambient air. The charred part is very porous, its strength is increased by fibers, which form the composite system. Heat exchange is going leadership. When the surface temperature reaches the pyrolysis temperature of resin, the resin will carbonize and the gases generated by the decomposition carry away heat to the ambient air. [9] The charred portion is substantially porous, its strength is increased fiber, which is a composite system formed. On further heating face pyrolysis proceeds in depth. Gaseous products diffuse through a porous carbonized surface to the ambient air stream. In the boundary layer air stream then may also char combustion mantle surface. However, other materials which, upon sublimation does not carbonize but sublimation releasing gas directly from the solid phase. Their main disadvantage is that it must be used in a much thicker layer. [11, 12, 13] Each of the above materials has its field of application. Selecting a particular variant is based on the structure and duties to be the protector secure.

5. CONCLUSION

The main use of insulation materials is possible, and is applied with a controlled heating in continuous furnaces. That means, primarily in optimizing of the heat modes (reduction of heating time, reducing the incidence of surface and internal defects), for heat transfer in the system or to minimize the time of the temperature cycle to achieve desired properties and levels of residual thermal stress. Using a new, unusual materials or new, modern techniques, moves this issue despite the large financial costs towards the optimization. The aim is therefore to provide an outer wall of the measuring device for measuring temperatures in continuous furnaces. The main problem appears to be the availability of materials that withstand the thermal stress and the heating time, which is given in the order of several hours. As the most effective appears systems, which are already used in the construction of a thermal protection shuttles and rockets. Especially when heat dissipation rocket engines. The protection involves the use of liquid hydrogen. This ensures thermal protection while ignition temperature up to 3300 ° C at the desired 54 ° C. Today, this element is used in a number of cryogenic processes. For example, different sectors of medicine, pharmaceuticals and the like. The advantage of a complete safety of use, it reacts with other compounds only under high temperatures and pressures. For measurement of heating furnaces it is suitable in terms of safety of use.

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