STUDIA UNIVERSITATIS BABES-BOLYAI, CHEMIA, LIII, 3, 2008

ECOLOGICAL SYSTEM FOR WASTE FORMING SANDS IN FOUNDRIES RECYCLING

VIOREL DAN[a], OVIDIU NEMEŞ[a], VASILE-FILIP SOPORAN[a]

ABSTRACT. This work presents results regarding the thermal regeneration of waste forming sands. The following aspects were considered: process thermal and hydro-dynamical conditions, constructive elements specifically for calcinations in fluidized bed, recommended parameters for the technological process of thermal regeneration, constructive solutions for the fluidized bed calcinations module and specifically parameters for the calcinations module.

Keywords: *waste forming sands, thermal regeneration, fluidized bed*

INTRODUCTION

Foundry sands wastes utilization represent a priority direction at global [1, 2] and national level [3] from at least two points of view: firstly because there are great quantities of waste sands to be deposited and secondly to protect the natural reserves of sand.

Regeneration of sands forming mixtures [4] involves removing the damaged components, the sand obtained after regeneration having comparable properties with those of new sand, while its cost is lower than that of the new one (reaching often up to about 25 % of the price of the new sand).

In this paper we present a thermal regeneration process of the forming sand wastes.

RESULTS AND DISCUSSION

In the process of the forming sand mixtures manufacture with chemical binders, bonding of the sand granules takes place in two ways: the first is the physical way and is related to the binders distribution on the sand grain during mixing process when a number of “bridges” between the sand grain during the compression were formed, and the second refers to the physical and chemical processes during which the system and cohesive forces appearance are strengthened. In this case, the refractory granular material participates in the chemical interaction with the binders and presents importance, especially for the existence, in the sand, of some active chemical ingredients.

[a] *Universitatea Tehnică din Cluj-Napoca, Faculatea de Ştiinţa şi Ingineria Materialelor, B-dul. Muncii, nr. 103-105, RO-400641 Cluj-Napoca, România, ovidiu.nemes@sim.utcluj.ro*

In case of organic binders, after the knock-out of mould, a heterogeneous product forms, as a result of the temperature gradient presence in the mould: around solidified alloy, resin is completely burnt (CO and CO_2); in the next region of the mould, a multitude of products, more or less volatile were generated, and also a damaged layer of resin that is stuck on the sand grain; the external mould parts are subject to lower temperatures and the building materials are almost undamaged.

The thermal regeneration consists in bringing the sand to a sufficiently high temperature for a certain period of time in order to ensure that the chemical binders (synthetic resin) from the surface of the sand grain were burnt. It is important that the heat unit and the air temperature to be adequate, otherwise the synthetic resin could be transformed in volatile organic carbonates which might lead to an increase of the air emissions over the allowable limit.

The heat transfer, that takes place between the fluidized bed and the solid particles, is made according to the following relation:

$$Q = A \cdot \alpha \cdot \Delta T = A \cdot \alpha \cdot (T_f - T_p), \quad [W] \tag{1}$$

where,

A is the surface area participating in the thermal exchange, m^2
α is the heat transfer coefficient between the two parts, $W/m^2 \cdot K$
T_f is the fluid temperature, K
T_p is the particles temperature, K.

Due to the large heat exchange area (the entry temperatures of the gas under the grid layer are 950 ÷ 1000 ℃) the flu idized layer of granular material with a thickness of 0.40 ÷ 0.45 m is maintained at a temperature high enough to remove the binder film from the sand granules surface.

To maintain the sand layer fluidized, it is necessary to fulfill the following condition:

$$\Delta p = H \cdot (1 - \varepsilon) \cdot (y_p - y_f), \quad [N/m^2] \tag{2}$$

where,

Δp is the hydraulic resistance of the fluidized layer (v = 0.4 ÷ 1.0 m/s)
H is the fluidized layer height, m
γ_p is the volumetric weight of solid particles, N/m^3
γ_f is the volumetric weight of the fluid in N/m^3
ε is the rarefaction index.

In the proposed technology, the heat treatment module must meet, under the regeneration process of the waste mixture, the following functions: bring the mixture at a sufficient high temperature, in order to ensure that the

binders burning process starts (pre-heat stage); burn the chemical binders from the sand granules (burning stage); recover the heat from the combustion process and from the regenerated sand cooling; cool the waste sand to an acceptable temperature for the technological preparation process of the forming mixture; collect toxic gases resulted from the heat treatment, in order to filtrate them.

Figure 1 schematically presents the thermal treatment module under the environmental regeneration of waste sand mixtures.

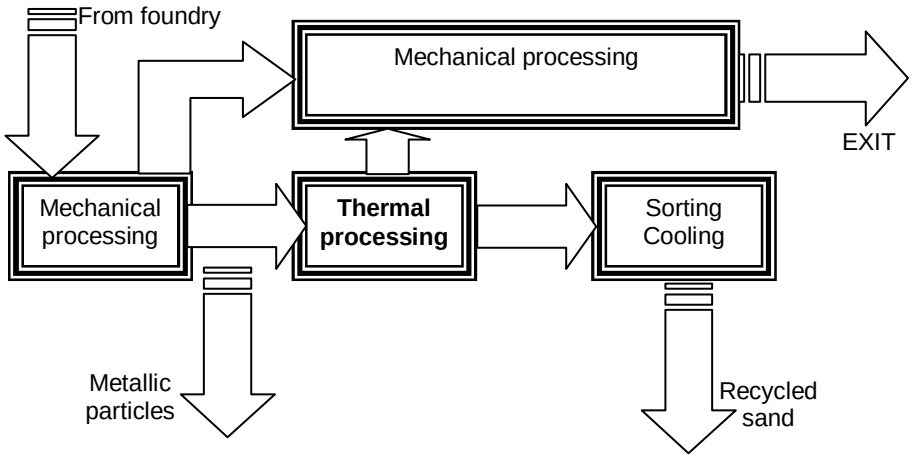

Figure 1. The thermal processing module in the ecological system.

CONCLUSIONS

The regenerative thermal process can be applied successfully in the case of wastes with organic binders, which are destroyed by burning.

To achieve a good efficiency of the process is mandatory to recover the heat from the combustion gases and from the cooling system of the recycled sand.

For the thermal regeneration process in fluidized bed, the used forming mixture must be subjected, before the regeneration process, to a separation operation of the metallic impurities, grinding and individualization of the granules.

After the regeneration process, the resulted gases must undergo a purification process before their discharge into the atmosphere.

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