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The Stand Adopted For Process Investigations Thermal Reclamation

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Abstract

The paper presents the analysis of construction solutions of some thermal reclamation equipment applied in used sand reclamation treatment as well as the experimental appliance constructed according to the author`s own idea. The experimental apparatus enables the sand grains to be regained when the machine works in either the horizontal or the vertical position. Different construction versions of the apparatus were prepared to provide a variety of working conditions for thermal reclamation treatment in order to obtain the reclaimed sand in the most efficient way. The possibility of choosing from among various set points of the appliance, such as the temperature of reclamation process, the time of thermal treatment cycle, the method of fluidization (cold or hot air) and other individual parameters characteristic of particular construction versions create the conditions for comparative research.

Keywords*:* Thermal reclamation, Used sand

1. Introduction

The search for economical thermal reclamation appliances is caused by unsatisfactory results of removing the binding material from the matrix grains which are obtained by the use of mechanical appliances which are quite cheap as far as installation and maintenance costs are concerned. The existing construction solutions of mechanical reclamation appliances which include basic operations of different degree of intensity, such as rubbing, obrasion or crushing are insufficient as far as the complete purification is concerned. The reclaimed sand which is obtained in the result of mechanical operation has, in comparison with quartz sand, the following characteristics:

1. considerable loss of ignition (insufficient purification of grains in the binder),
2. changed acid/ alkaline reaction,
3. changed granulation composition.

The factors mentioned above cause the worsening of strength characteristics of the mixture based on the reclaimed sand, which, in turn, has an impact on the quality of casting. Therefore a number of actions are undertaken in order to compensate for the property loss of the mixture made from the reclaimed sand in comparison to the one made from fresh components. The first improving action is intensive pneumatic classification with the aim of removing impurities from the reclaimed sand. It development of improves to some extent the quality of the matrix which is being reclaimed by eliminating the smallest fractions from its granulation composition but, on the other hand, it generates considerable amounts of dust as the side effect of the reclamation process which leads to further problems with its utilization. Another method of increasing the strength property of

the mixture prepared from the reclaimed sand after the mechanical reclamation is the use of binding materials in various proportions of binder in relation to hardener, i.e. by increasing the amount of binder. However, there are some disadvantages of the option, namely: the increase in costs, the necessity to monitor the quality of the obtained mixture and interfering in the cyclical technological process. Still another method of remaining the quality of the mixture is adding quartz sand to its composition, with the mass of the reclaimed sand accounting for its bigger part. However, as the research shows [1] only big amounts of quartz sand can guarantee the properties of the mixture similar to those of the mixture based on quartz sand. The bigger the amount of the reclaimed sand in the mixture is, the less possible it is to use the mixture for the filling purposes parallel with the model mixture made from quartz sand. The issues mentioned above which limit the efficient use of reclaimed sand after mechanical treatment create the starting point for a more thorough analysis of thermal reclamation treatment.

2. Trends in the development of thermal reclamation method

Three trends in the development of thermal reclamation method can be found in literature. The first one is concerned with production plants, which, driven by economical reasons, took some steps in order to create the system of reclamation, according to the currently used moulding and core sands technology, for their own purposes [2]. The second trend concerns the commercial offer of particular appliances which make use of different sources of energy in order to provide the most economical system of reclamation [3]. The third trend of the development of thermal reclamation appliances is the result of creating central reclamation stations [4], which, in turn, leads to constructing appliances enabling the reclamation of the used sands produced by the use of a variety of technologies.

Thermal reclamation equipments involve the use of various sources of energy. However, the operation of most of them is based on the process of burning natural gas. In such constructions the used sand is reclaimed in the fluidized bed, where it is be burnt by burners operating on the surface of the fluidized bed. Alternatively, the bed can be fluidized with the mixture of natural gas and air. In such option the burners` role is to initiate the process of burning natural gas and fumes.

One of the appliances which uses natural gas, described in specialist literature, is the installation produced by the Society Neu Sechage Industriel [2, 5]. Another appliance is "Thermreg 500" [6, 7] Products of Richards company, which specializes in the production of thermal reclamation equipment, are discussed in specialist literature [8, 9 10, 11, 12]. There are also offers of the company Fata-aluminium, e.g. products called Hot- Reg and Eco-Reg [13, 14, 15] and many other.

Another type of appliances are the ones which use, in a variety of ways, electrical current as to initiate the process of burning. The appliance produced by the Italian company IMF [16, 3, 12, 17], in which high temperature of approximately 2000 °C in fluidized bed can be achieved by the use of lamps of infrared, thanks to which the layer of binding material grains can be burnt for a short time. The advantage of this solution is the fact that there is no loss of energy because the grains of matrix are not overheated.

In another solution, which is produced by the company IMF [16], the process of burning the remains of organic resins left on the grains involves the use of an electrical resistor, placed in the reactor zone, which initiates the process of burning in the presence of oxygen. As soon as the reaction starts, it spreads towards the zone of the reactor, where oxygen needed for burning is supplied. The process of burning is controlled by actions of thermocouples. The processes of removing the reclaimed sand and introducing the new one are synchronized by the mechanism similar to a screw, invented by Archimedes, whose action never ends. The apparatus for electrical reclamation treatment called "Sun Sand" is described in one of the publications [18]. The reclamation process in fluidized bed lasts 3 hours. The sand is heated by the system which uses electrical current and thermostat control. The process, whose main advantage is the lack of ash and fumes, is applied in a French Brea [18].

There are problems concerning the equipment which uses natural gas as the source of energy, namely:

- short time of burning the layer of a binder on the grain surface and, as a consequence, protecting grains from overheating as well as focusing on efficient energy use,
- appropriate distribution of natural gas in bed, i.e. creating specific conditions for mixing gas with air so that the process of burning is optimal,
- making the process of burning more effective by supplying oxygen to the reclamation chamber,
- providing a steady, regular process of fluidization of the bed since it has impact on the quality of the reclaimed sand,
- providing appropriate temperature for different types of thermal reclamation: 400 °C for low-temperature reclamation, 600 °C for medium-temperature reclamation and 850 °C for high- temperature reclamation,
- the way in which burners are placed in reclamation chamber since it has impact on the efficiency of the burning process,
- providing appropriate steering and control system of the process.

3. Research station

A new own appliance was created in order to carry out the process of thermal reclamation in the most efficient way. The machine can work in either a horizontal position or a vertical one. The combustion chamber consists of a steel body, thermal insulation and the floor made of creep-resisting concrete. The body of the kiln is mounted on a bearing, thanks to which it is possible to change the position of the kiln from horizontal to vertical.

The chamber is equipped with burners which are supplied to it by articulated sockets. This construction solution makes it possible to adjust the burners in relation to the zone of action and the distance from the bed. The three burners can be placed on a wall of the body but it is also possible to place one of them on the opposite wall. This variability makes it possible to create different conditions for the machine`s operation.

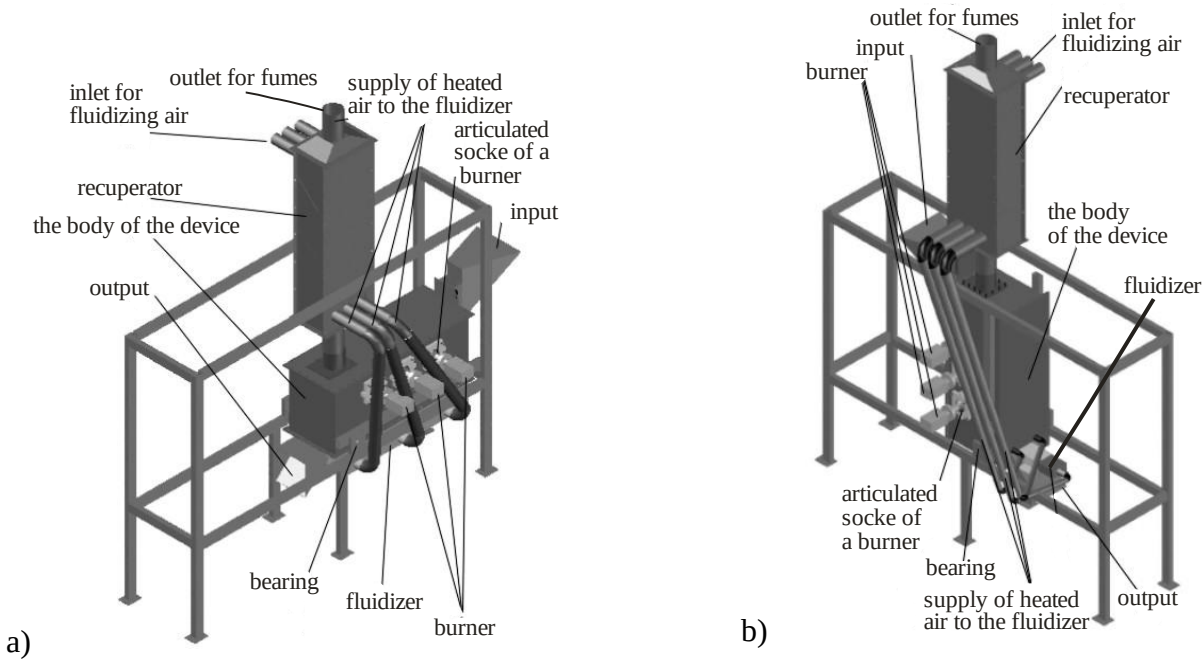

Fig. 1. Diagram of thermal reclamation device: a) horizontal option, b) vertical option

The fluidize floor of the chamber is divided into three sections which enable different ways of conducting the process of bed fluidization, i.e. either the whole floor is supplied with air or, subsequently, its particular sections. The method is used in order to prevent the bed from cooling, which might result in lengthening the working time.

A heat exchanger was installed at the outlet of the chamber. It`s function is to regain the heat in order to heat the air needed for fluidization. As it was stated before, fluidizing the bed of the reclaimed sand with cool air causes drop in the temperature of the chamber and lengthening of reclamation time.

A special construction made of creep-resistant steel, which enables the reclaimed sand to be circulated, is installed in the chamber for the vertical option. The option involves the work of three burners.

The circulation of the reclaimed sand can be carried out by the use of both cold and hot air provided by a recuperator.

The machine is fully automated. Thermocouples are installed in the body of the chamber in the area o burners` operation. They are connected to temperature controls which enables the reclamation process to operate in low, medium or high temperatures. A signal is sent from the controls to automated ignition burners. The burners` control systems start the ignition system according to the required temperature and control the starting point of the flame, which is particularly important because of safety reasons. During the whole process the automatic ignition device controls the functioning of solenoid valves which are installed in the equipment supplying air and natural gas for the burners. The appliance is also equipped with a module which makes it possible to carry out the operation of fluidization in different ways.

The thermal reclamation apparatus possesses also data recorders in which the main parameters of operation, such as temperature in the chamber, temperature of air for fluidization, pressure (air, natural gas), the amount of the media used in the process, i.e. energy, are recorded. This way of gathering the data enables the researcher to verify the operation options from the point of view of the quality and efficiency of the reclaimed sand obtained in each option.

4. Summary

The thermal reclamation appliance presented in the paper was constructed in order to find optimal conditions for thermal reclamation treatment of the used moulding and core sands. It was impossible to carry out research on a bigger scale [19, 20] using the former appliances. The burners introduced to the chamber of the present construction will enable the researcher to place them on different levels above the bed, which, in turn, will make it possible for the flame to be diversified as far as the direction is concerned. Different options of parameters, e.g. the temperature of burning, will create various conditions for obtaining quartz matrix from the used sand bound by organic binders.

There is extensive research in the field of thermal reclamation in the world. However, its progress and effects are not fully revealed because of commercial reasons. Comparative research on thermal reclamation carried out by the use of the present appliance and already existing appliances of commonly known principle of operation, i.e. in fluidal bed, will create possibilities of acquiring bigger experience and knowledge in the field of

thermal reclamation as well as evaluating the already- existing solutions.

Fig. 2. Thermal regenerator in the horizontal during operation

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