The Proposal for optimization the kinetics of the process the caustification of magnesite

Andrej Olijár*[1], *Július Lišuch, Dušan Dorčák* and *Ján Spišák

The theme of this article is to establish a basis for a physical model of optimization the kinetics of the process caustification (firing). In developing the mathematical model were used available data on the subject. The experimental part was carried out in order to find the optimal state of firing caustic magnesite at a given temperature and its reactivity to fast speed rotary kiln (FSRK) and the integrated thermal unit (ITA). Both facilities are located in SMZ a.s Jelšava. In this article are only data related to spent magnesite for FSRK.

Keywords: *magnesite, caustification, kinetics of the process, heat treatment, the optimization of process.*

Introduction

Mining and processing of magnesite is currently one of the important sectors of the Slovak economy. Incommunicativeness of the production cycle, from mining to finished products is a modern industrial complex and has an important role in creating employment and social policy [1].

Magnesite is the most important mineral of magnesium. Magnesite is magnesium carbonate ($MgCO_3$), and it is in continuous isomorphic series with siderite ($FeCO_3$), also usually contains admixture of calcium carbonate ($CaCO_3$) and manganese carbonate ($MnCO_3$). Bulk density is 2.96 to 3.12 $g.cm^{-3}$, with an admixture of ferrous carbonate increases.

In nature it occurs in crystalline and cryptocrystalline (compact "amorphous) form. Crystalline magnesite grains have <10 mm, massive, banded or pinolitovú texture. Entire grain magnesite 0.004 to 0.01 mm, shell breakage, recalls china. Caustic magnesite clinker (MgO with low-CO_2) is produced from both types of magnesite.

Magnesite is mainly used to manufacture refractory bricks, ie bricks and shapes for lining furnaces and for making electric kiln It is also used to produce caustic magnesite (for purpose of building of production), chemical industry, cosmetics, pharmaceutical industry, the production of special cements, in the paper industry. The largest part (about 90 %) of world production is consumed in the production of refractory materials, the other branches of industry involved in the consumption of magnesite only the remaining 10 % [2].

Declining consumption of base refractory materials, caused by the changing technology of steel means that global manufacturers are transferred to the production of caustic burned magnesite. RORP and ITA are also devices that processes the fine material. In these types of furnaces is finding an optimal condition, not just a prerequisite, but facilitating their settings.

According to the firing temperature is distinguished caustic magnesite and dead burned one. Caustic magnesite is burned at a temperature maximum of 1200 °C, it has the ability to take on water and carbon dioxide. Dead burned magnesite is burned at a temperature of 1500-1700 °C.

To calculate the reserves of balance magnesite into account the possibilities of processing and therefore it is divided into three classes. Magnesite I. class, suitable for burning in rotary and shaft furnaces (containing min. 42.0 % MgO, max. CaO 2.5 % , max. 1.5 % SiO_2), magnesite II. class, suitable for burning in shaft furnaces, which charge for the rotary kiln requires a modification or blending with magnesium I. class (content min. 40 % MgO, max. 4.3 % CaO, max. 1.5 % SiO_2) and magnesite III. class, which does not meet the criteria set for I. or II. class and before firing requires the treatment [3].

Caustic magnesite is a special group of refractory products. It is a low temperature product of thermal decomposition of magnesite. Low firing temperature rise in an active, energy-biased system with a large internal surface area. Caustic magnesite has disordered structure ,is fine-grained, reactive and has a low content of crystalline phases. Reactivity depends on its specific surface area, which takes high values of 70 to 100 $m^2.g^{-1}$. Compared to crystalline phase of periclase, which the size of specific surface area is under a $m^2.g^{-1}$. The highest reactivity values are achieved at the lowest annealing temperature needed for decarbonisation that way, to calcine contained a small residue of undecomposed carbonate. The burning granulometry from 0.2 to 2.0 mm occur volume changes at temperatures between 650 °C - 850 °C [4].

To achieve the desired reactivity of charge it is used a combination of operations mechanical and/or thermal nature, that cause major changes in the properties of magnesite raw material source. The results

[1] *Ing. Andrej Olijár, Ing. Július Lišuch, Ing. Dušan Dorčák, PhD., doc. Ing. Ján Spišák, PhD,* Fakulta BERG TU v Košiciach, Vývojovo-realizačné pracovisko získavania a spracovania surovín, Nemcovej 32, 042 00 Košice, Slovensko, Tel.: +421 55 602 24 85, e-mail: andrej.olijar@tuke.sk, julius.lisuch@tuke.sk, dusan.dorcak@gmail.com, jan.spisak@tuke.sk
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of the study the impact of pretreatment conditions on the properties of charge under the following general conclusions:

a) Thermal decomposition reduces the charge weight of about 50 % and improves its grindability.
b) Grinding reduces the decomposition temperature of magnesite by100 to 200 K.
c) Pre-treatment has a greater effect on the properties of charge as the origin of magnesite [3].

Modelling of processes - the mathematical model

Modelling is an experimental information process in which the system under exploration (the original object, component) clearly ranks according to certain criteria different system, physical or abstract, so-called model. Models can generally be defined as a display of real-world objects and processes with the appropriate mathematical or physical means, which allows their systematic and efficient exploration. The results obtained by experimenting on the model can be transferred to the real object, respectively. the technological process. Models are also used to gather and prepare data for decision making and control of technological processes. A mathematical model is based on the similarity between the real and the abstract system. This similarity allows the exploration of real systems with abstract systems using mathematical relationships. A mathematical model is a formal statement of the problem in the physical and mathematical terms. It represents a set of mathematical relationships describing clearly studied phenomenon or process [5].

Discussion and analysis of measured values the process of caustification and determination of reactivity of magnesite

In Jelsava region exists over one hundred years old tradition of refractory materials production based on magnesite [6]. For that reason the actual analysis and analysis of acquiring and processing the results was used magnesite from SMZ Jelšava. It consisted of two types, which differ from the morphological characteristics (I.e, coloring, granularity composition and MgO, respectively. the quality of the firing). As in this case is not a comparative experiment, it is not necessary to describe both types of used magnesite samples. In order to obtain more accurate data, whether there was not error in the measurements, some experiments (especially in the firing process) were performed in duplicate.

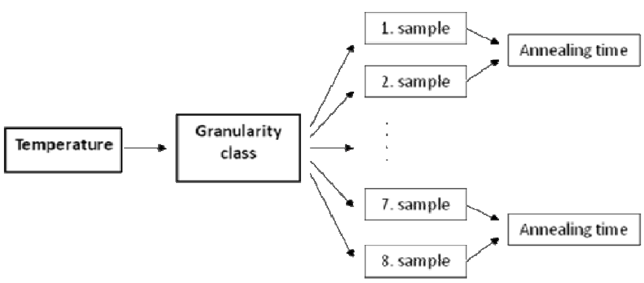
As a first step there was the need to make the homogenization of the samples to obtain accurate data for further use of these data.

The prepared sample was subjected to dry sieve analysis for network analyzer. To determine the required granularity classes screens were used the sieve with mesh size 0.25 mm, 0.50 mm, 1.00 mm and 1.60 mm. Table. 1 shows obtained individual weight gains for a given grain size class..

Tab. 1 Weight gains (WG), filing 400g

Granularity class [mm]	WG [g]	WG [%]	WG [g] - comparative	WG [%] - comparative
> 1,6	57,30	14,40	38,96	9,85
1,0 - 1,6	61,38	15,42	44,42	11,23
0,5 - 1,0	106,98	26,88	97,82	24,73
0,25 - 0,5	79,24	19,91	93,00	23,51
< 0,25	93,11	23,40	121,31	30,67
Σ	**398,01**	**100,00**	**395,50**	**100,00**

As a second and also the major step of the process was finding and determination, respectively. find an optimal state of the kinetics process of caustification and reactivity of magnesite under certain conditions. Initial setting of conditions (temperature, granularity class and annealing time) for the process of firing magnesite were determined on the basis of theoretical knowledge [7]. Later, due to the overall efficiency of the experiment was to change some of these conditions (Fig. 1).



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ditions.

Heat individual samples of magnesite in the process of firing was not at a gradual heating to desired temperature, but so. "Thermal shock" - exposure of the material of high temperature (800 °C - 1000 °C) in a very short time (few seconds). If is elected "thermal shock" is not possible to achieve prolonged firing (but it may not apply in determining the reactivity of magnesite, which is not possible to achieve the maximum value of firing).

The graph below (Fig. 2) shows the different firing processes, i.e loss depending on the annealing time for each grain size class and the entire range. Each class granularity has been achieved in the initial time firing up a different value (morphological characteristics of the mineral) with regard to the whole range. Ultimately,each granularity class and full range was to the achievement of maximum value, which shows that a sample of magnesia was pure nature.

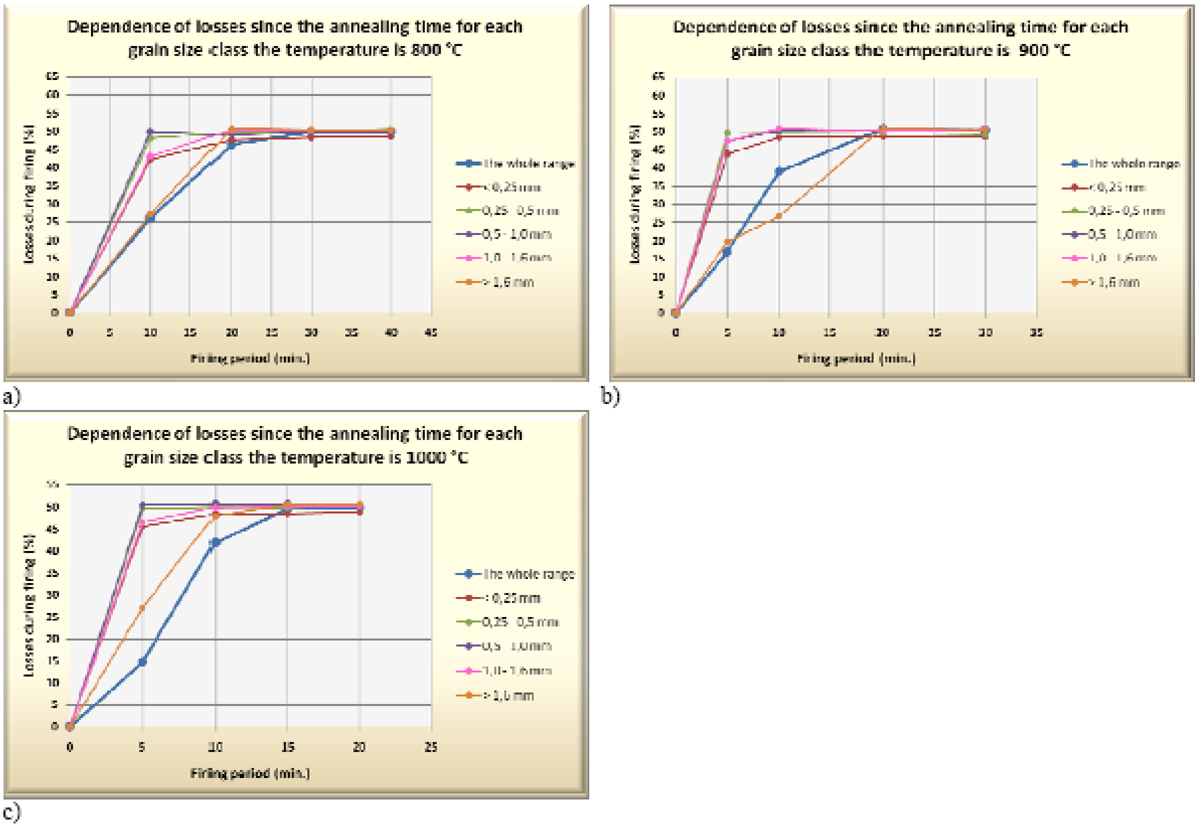

Fig. 2. Dependence of losses since the annealing time for each grain size class the temperature is a) 800°C, b) 900 °C and c) 1000 °C.

In this case, therefore, it is necessary to focus on the interdependence of temperature and firing time. Of course, taking into account the achievement of the maximum firing of granularity for the entire range of granularity class. Individual firing of granularity classes are necessary because they serve, respectively. may serve on a mathematical calculation to obtain accurate data. Fig. 3 shows all states and dependences obtained in experiments where you can find the optimum condition for the process of firing magnesite.

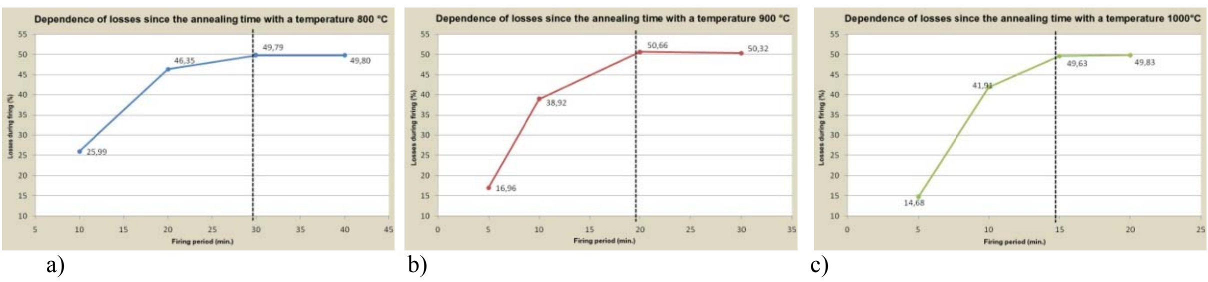

Fig. 3. Dependence of losses since the annealing time with a temperature a) 800 °C, b) 900 °C and c) 1000 °C.

The optimum in this case lies in finding the time and energy efficiency. They were shown at the time of firing for 30 minutes 800 °C, 20 minutes to 900 °C and 15 minutes to 1000 °C in the sustained adherence of the sample in the kiln, while there was an increase to the maximum amount of firing. The temperature here has played a role that in time has been reduced to achieve higher firing of magnesite samples. If we take into account the pre-heating the material, then the time was still lower to higher achievement firing and ultimately perhaps to the maximum. This would be to decrease needed firing time for the required temperature firing.

The process of determining the reactivity of each sample was determine whether the reactivity (quality) of caustic firing magnesite (grounded after firing process) from the firing time (25 minutes) (Fig. 4)). Reactivity was determined expression so. "Lemon numbers. It is a number whose unit is the time measured in minutes (or seconds) from entering the sample in 0.4 N citric acid solution until the pH reached 8.6. Ideal value "lemon number" is reached within 4-6 minutes (reactive magnesite).

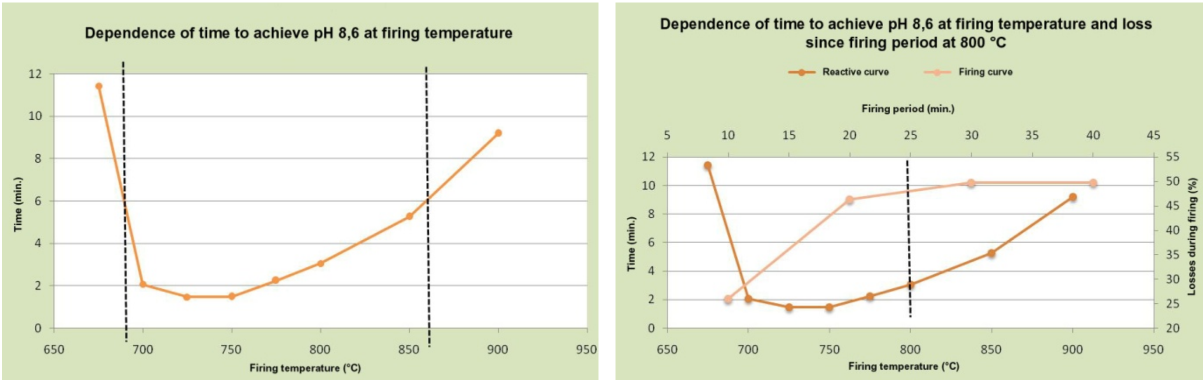

Fig. 4 a) dependence of time to achieve pH 8,6 during firing temperature in b) by comparison with loss since firing period at 800 °C

In this case, reactivity was obtained for temperatures from about 700 °C to 850 °C. The temperature of 900 °C reactivity was not reached the desired value and the temperature of 1000 °C was not performed. Ideal value obtained in this process at a temperature of 750 °C, resulting in a low value of caustic burnt magnesite and lower power consumption. However, when it comes to the entry requirement for maximizing the value of the firing of magnesite, the ideal value is deleted, there is a higher power consumption and quality of caustic burnt magnesite is reduced.

To be taken into account, the optimal state is not only found that higher energy and time efficiency, but also adding quality of caustic burnt magnesite, then, would be when the requirement arises to find depending on the one hand the time and the firing temperature of magnesite and other hand, the quality of the caustic burnt magnesite (Fig. 4b). Achieving the ideal state is not possible, it is necessary to sacrifice one of these three factors at the expense of the other two. However, there is a meet of all entry requirements.

Conclusion

On the basis of the following created and performed mathematical model that would allow application data to the physical model, where would be necessary to set parameters (eg temperature or reactivity). This would obtain the information necessary to optimize the process of setting the firing of magnesite. This information will have an impact on the economic and qualitative assessment of the firing process, the time factor plays an important role in the productivity of the process. The prerequisite is the need for understanding the nature of curvature firing and reactive curve. The necessity is to re-implement experiments for evidence of practical use.

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