

# *Investigation Of The Efficiency Of Using Gaseous Fuel In The Production Of Lime In Rotary Kilns*

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**Abstract** – The article presents the result of a study to improve the process of roasting lime in drum furnaces. Showing ways to reduce gas consumption. A thermal test has been carried out, the theoretical equations of the heat and material balance in the furnace have been compiled.

**Keywords** – Metallurgy, Chemistry, Mechanical Engineering, Construction Industry.

## I. INTRODUCTION

The construction industry in the Republic of Uzbekistan is developing rapidly. In the construction industry, natural gas is currently used primarily as a fuel.

Due to the growing share of non-renewable fossil fuels in the global fuel and energy complex, their extremely economical and efficient use is one of the most pressing problems in the first place. Today, industrial enterprises account for more than 62% of the total gas consumption in the world. Industrial enterprises that consume the largest amount of gas include: energy complexes that produce thermal energy: ferrous and non-ferrous metallurgy, chemistry, mechanical engineering, construction industry and others.[1-3]

This is why the economical use of gaseous fuels in all industries is extremely important. One of the urgent tasks of today is the creation of new energy-saving technologies at industrial enterprises, first of all, the creation of new energy-saving technologies, the use of the most economical equipment and devices, the optimal economic distribution of fuel resources.

Analysis of the global energy supply shows that fossil fuels will account for the world's major primary energy sources over the next several decades, and the use of nuclear energy is expected to increase.

Gas fuel is widely used in industrial and manufacturing enterprises, and this figure is growing, especially in all industries. Large-scale use of gas fuel in the country is used at industrial enterprises of the construction industry in the production of building materials, cement, lime, expanded clay, ceramics, sanitary ware and others. All of the above types of industrial enterprises require technological actions using various types of furnaces, drying equipment, units, and the formation of high temperatures. The formation of such a temperature is achieved by burning an extremely large amount of gaseous fuel.

In the construction industry, industrial rotary kilns with a cylindrical structure and tunnel-ring kilns are often used for the production of building materials in industrial plants.

## II. MAIN PART

Such furnaces use a large amount of fuel and energy resource - gas fuel. Countries around the world have done a lot of scientific work and invented new furnaces to solve the problem of achieving economical use of natural gas fuels in industrial furnaces. We know that in practice, in the production of lime, rotary drum kilns with high technological productivity are used. Such furnaces have a number of advantages, namely: a large production capacity, as well as a number of disadvantages: the need for a large amount of fuel, low cost of useful work, low product quality, and so on. Therefore, the elimination of the listed disadvantages in rotary-type drum furnaces used in practice is one of the most pressing issues in their installation and implementation of technologies for the correct choice of gas burners.[2,5]

Currently, to reach the modern level of various technological processes in the global construction industry, it is necessary to solve the following key issues:

1. An in-depth analysis of the industrial furnaces used in practice in the construction industry, the study of the analysis of the world's energy supply.
2. To study the efficiency of using the distribution of the amount of heat released during fuel combustion when using rotary drum kilns, which are a type of industrial furnaces in the construction industry.
3. Carrying out work on the exact calculation of the actual required fuel consumption by drawing up the equations of heat engineering and material equality, taking into account technological processes for rotary drum furnaces used at industrial enterprises in the construction industry.
4. Development of ideal thermal contact images for new heating systems between rotary drum kilns and dryers.

Based on the listed tasks, the problem of overcoming the disadvantages of using rotary drum kilns in the production of lime was considered on the example of the SUE "NAVOIY EXPORT BIZNES".

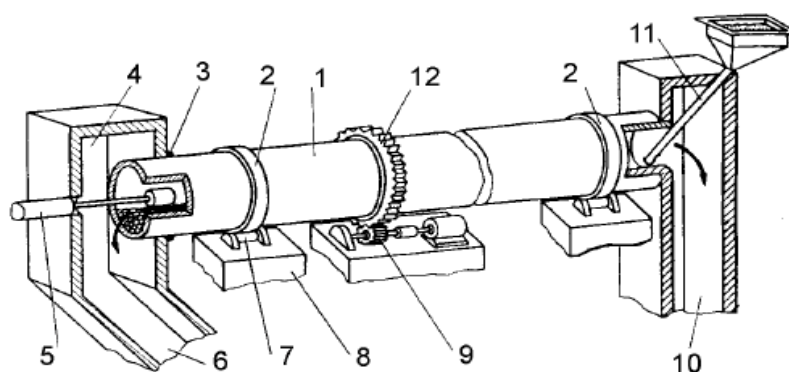
Rotary drum kilns have a number of advantages, such as full compliance with the dimensions of limestone to regulatory requirements, high strength, the possibility of unhindered firing inside the kiln, as well as some disadvantages, these include:

- the complexity of the composition of the mixture during cooking
- adhesion of materials to each other

The professors and teachers of the department conduct scientific research to eliminate such shortcomings in rotary drum furnaces, installation and assembly of the furnace, efficient and economical use of gaseous fuel.

Lime making and baking processes are mainly carried out using a single drum rotary kiln. The structure of the cylindrical furnace is made of steel metal, the inside of which is lined with refractory bricks.

The rotary movement of the furnace is carried out by means of an electric motor through the tanks. The furnace consists of a casting and filling device.



picture 1. Dimensional view of a drum lime kiln.

*1 drum, 2 belts, 3 seals, 4 combustion chambers, 5 fuel burners, 6 exhaust ducts, 7 support rollers, 8 foundations, 9 drum regulators, 10 chimneys, 11-product loading device, 12-gear mechanism.*

When developing a technology for the production of lime in laboratory conditions, samples are taken for testing from raw materials.

The time of lime sintering in rotary drum kilns is 10-12 hours, of which the first 4-5 hours are heated to  $900^{\circ}\text{C}$ , and within 2-3 hours the temperature is increased to  $1100 \div 1300^{\circ}\text{C}$ , while the temperature is baked for 10 -12 hours after, while the optimal state of the lime baking process is carried out at a temperature of  $1100 \div 1200^{\circ}\text{C}$  and is cooled.

Under the influence of high temperatures, the process of dehydration and amorphization is observed, in which a certain amount of liquid is separated from the limestone material.

To prevent the pellets from sticking to each other and to the inside of the oven, ensure the maximum swelling temperature.

The production of lime, which has a high quality index in kilns, depends on the cooking and cooling processes carried out in it, the granular interior of the kiln and the gas conditions.

In addition, the heat treatment of granular raw materials depends on the state of the gases in the furnace, that is:

- to the composition of the flue gas;
- to the value of the amount of excess air;
- to the composition of the gas released from organic compounds in the soil;
- separation of chemically bound water from various minerals introduced into the furnace, the moisture content of granular raw materials released during binding.

The amount of combustion products and excess air supplied to the rotary kiln under pressure moves towards the central axis during kiln operation.

The steam and gaseous products that come out of the raw materials during the heating and cooking process pass through the pellets and mix with the flue gases.

The pellets baked in rotary kilns move in the opposite direction to the flue gases. Depending on the temperature change, rotary kilns can be conditionally divided into the following intermediate sections:

1. Dehumidification in the intermediate construction zone or in the range in which the gas temperature is  $720 \div 930^{\circ}\text{C}$ , and the temperature of the material is  $40 \div 240^{\circ}\text{C}$ . The length of the construction interval is  $25 \div 36\%$  of the total length of the furnace, depending on the time required for determination of porosity, moisture and swelling of granular raw materials.

2. The heating range and area of the chemical reaction process is  $930 \div 1100^{\circ}\text{C}$ , and the temperature of the material is  $240 \div 880^{\circ}\text{C}$ . During the heating of the material, heat transfer is transferred from the flue gases to the heated material. The length of this zone can also be shorter, usually the length of the heating zone is 20-32 percent of the total length of the oven. When the temperature of the granule rises, gas, vaporous products and water vapor are released from it.

3. Lime baking process section. In this process, the temperature of the gas in the furnace is  $1100\text{-}1250^{\circ}\text{C}$ , and the temperature of the material is  $880\text{-}1160^{\circ}\text{C}$ , and in this case, gas evolution due to swelling of the burnt lime continues, the heating rate is  $50^{\circ}\text{C} / \text{min}$ . The intermediate zone of the cooking process is 15-20% of the total length of the oven.

4. The process of pre-cooling the quicklime corresponds to the process of introducing secondary air into the kiln. Oxidation of various compounds on the surface of the granules in this intermediate zone is brown. When the prepared granules cool down, the temperature drops to  $1000 \div 1050^{\circ}\text{C}$ . The intermediate zone of the cooling process does not exceed 5% of the total length of the furnace. At the same time, the speed of the lime cooling process is very important. The research will be carried out in a rotary drum lime kiln installed at the SUE "NAVOIY EXPORT BUSINESS".

The technical characteristics of the furnace are as follows:

- Furnace length 40m.

- The inner diameter of the kiln is 2.3 m.
- Lime productivity - 3330 kg / h.
- The incline of the firebox is 4%.
- The number of bases is 2.

The number of revolutions of the oven body per minute -  $0.6 \div 2.5 \frac{\text{acircle}}{\text{min ute}}$

The power of the electric motor in the main production is 10 kW.

According to the law of conservation of energy, the supply of heat in any heating device must be equal to its consumption. The equation of thermal conductivity in a rotary drum kiln is as follows:

$$\sum Q^{\text{transfer}} = \sum Q^{\text{dissipation}}$$

#### Heat transfer.

$$\sum Q^{\text{transfer}} = \sum Q_1^{\text{comb}} + Q_2^{\text{phys}} + Q_3^{\text{rm}} + Q_4^{\text{comb}} + Q_5^{\text{sa}} + Q_6^{\text{s}}; \text{ kJ}$$

Here  $Q_1^{\text{comb}}$  – the amount of combustible heat of the fuel, kJ.

$Q_2^{\text{phys}}$  – amount of physical heat of fuel, kJ

$Q_3^{\text{rm}}$  – the amount of heat brought in by the raw material. kJ

$Q_4^{\text{comb}}$  – the amount of physical heat of the air involved in the combustion process, kJ

$Q_5^{\text{sa}}$  – the amount of physical heat of the air due to the suction of air in the head of the furnace, kJ.

$Q_6^{\text{s}}$  – the amount of physical heat of the air supplied to the furnace, kJ.

#### Heat dissipation

$$\sum Q^{\text{dissipation}} = Q_1^{\text{mois}} + Q_2^{\text{chem}} + Q_3^{\text{k}} + Q_4^{\text{h,lost}} + Q_5^{\text{fg}} + Q_6^{\text{comb . fuel}};$$

$Q_1^{\text{mois}}$  – heat consumption for moisture release, kJ.

$Q_2^{\text{chem}}$  – the amount of heat consumed in the course of a chemical reaction, kJ.

$Q_3^{\text{k}}$  – heat loss of lime leaving the kiln. kJ.

$Q_4^{\text{h,lost}}$  – the amount of heat lost to the environment, kJ.

$Q_5^{\text{fg}}$  – the amount of heat lost with flue gases, kJ.

$Q_6^{comb, fuel}$  — heat loss in case of incomplete combustion of fuel, kJ

As a result of research carried out at the SUE "NAVOI EXPORT BUSINESS" with a capacity of 3330 kg / h of lime per hour, the average gas consumption for the production of 1 kg of lime is 0.3 m<sup>3</sup> / kg or 1 ton of lime accounted for 300 m<sup>3</sup> of gaseous fuel, and in the form of standard fuel - 375.2 kg of standard fuel. This indicator led to the efficient use of gaseous fuels in the production of this enterprise, and appropriate recommendations were given.

### III. CONCLUSION

The rotary drum kiln used for lime production has been heat tested. The operation of gas burners and other equipment installed in a rotary drum kiln was found to be satisfactory.

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