Energetic and Exergetic Evaluation of 4 Systems for a Rotary Kiln Improvement

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The energy balance of a rotary kiln used for calcination of 4400 kg/h of dolomite in a magnesium production company identified the kiln shell (26.35% of the input energy) and exhaust gases (18.95%) as the major sources of heat losses. To increase the efficiency of the kiln, the following systems are analyzed by the use of energy and exergy analysis: (i) system for preheating of the combustion air by heat exchange with the exhaust gas; (ii) system for space and DHW heating in the company by water heating with the exhaust gas sensible heat; (iii) system that consists of a recuperator that use sheat loss from the kiln shell to preheat the combustion air (designatedas iii-a) and the system given in (ii); and (iv) system that consists of (iii-a) and an cogeneration system that uses organic Rankine cycles upplied with heat by heat exchange with the exhaust gas. The system (ii) is the optimal solution by economic criteria because the company uses relatively expensive heavy fuel oil for space heating, where as exergetically, the most efficientis the the system (iv), which enables the kiln to have the exergetic efficiency of 36.02%.

Keywords: electrical cabinets, heat transfer, natural convection, forced convection, wall construction.

1. INTRODUCTION

This paper considers four systems for heat recovery. In each of the cases of the waste heat is used for the products of combustion rotary kiln. The waste heat is meant the losses contained in the natural heat of the combustion products and those who surrender to the surroundings through the mantle rotary kiln. Were considered forth the following systems for the utilization of waste heat rotary kiln:

- System for heating the combustion air, the heat contained in the flue gases (i).
- System for heating water (the water in the winter used to heat the hall, and in the summer for domestic hot water) heat contained in the flue gases (ii).
- The system for heating the water by heat contained in the exhaust gas in combination with a heat exchanger which uses the waste heat from the rotary kiln sheath (iii).
- System for the use of heat in the flue gases to produce electricity by Rankin - Klauzijus circular process with an organic working fluid in combination with a heat exchanger that uses waste heat from the mantle rotary kiln (iv).

RC process is historically the longest used to produce electricity. Today is to increase the degree of usefulness RC process when using a lower temperature heat source is often used instead of water vapour, organic working fluids in the ORC. Until the election of this process there is also the basis of the recommendations that can be found in the relevant literature. To approximately 1 MW of heat contained in the products from the rotary kiln on the basis of the diagram given in Figure 1 is the most optimal for the production of electrical energy using ORC.

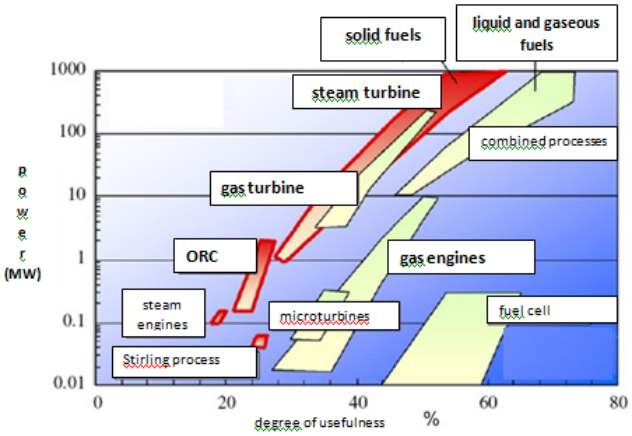

Figure 1: Degrees of usefulness and power ranges that use different systems for the production of electrical energy. ORC - Organic Rankine Cycle. (diagram originates from (Karl, 2004), and retrieved from (Karellas, et al, 2008))

2. POSSIBILITY USE OF WASTE HEAT FROM THE ROTARY KILN

Based on the previously approved system for the use of waste heat rotary kiln below to be shown the material and heat balances of each system.

2.1. System for heating the combustion air, the heat contained in the flue gases

The heat contained in the exhaust gas is used to heat air that is then used to fuel combustion in rotary kiln. Products of combustion at the entrance to the heat exchanger have a temperature of 343°C. In the heat exchanger products are cooled to a temperature of 150°C, wherein the combustion air is heated from 20°C to 312°C.

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