EXERGY ANALYSIS OF THE CLINKER PRODUCTION APPLYING SCRAP TIRES AS FUEL

M.L.G. RENO, R.J. SILVA and M.N. BELATO

Dto. de Eng. Mecânica, Univ. Federal de Itajubá, Av BPS 1303, Itajubá, Minas Gerais, Brasil
malureno@yahoo.com.br, rogeriojs@unifei.edu.br, maribelato@yahoo.com.br

***Abstract*— *Abstract*— The finite nature of global fossil fuel resources, high prices and most importantly, their damaging effect on the environment underscore the need to develop alternatives for industrial systems include the cement production process. This industry is classified as energy intensive consumption, so the application of the alternative fuels in cement production can extend fossil fuel supplies and help resolve air pollution problems associated with the use of conventional fuels. This paper proposed to analyze the clinker production from energy and exergy view point, applying the alternative fuel scrap tires with aim of reducing the fossil fuel consumption. The results achieved energy efficiency of 75%, exergy efficiency of 37% with the main irreversibility source provider of rotary kiln**

***Keywords*— clinker, alternative fuel, exergy and energy analysis.**

I. INTRODUCTION

Cement production is one the major industries driving Brazil's national economy, and production trends within the industry have been dynamic throughout the past 30 years. Today, Brazil has become the largest cement producer among all Latin American countries, and it is ranked 7th in the world for cement production (SNIC, 2010).

One important aspect of the cement industry is that the cement production is an energy intensive process, consuming about 4 GJ per ton of cement product. Electricity and fuel energy have a portion of approximately 55% among all the costs (Ari, 2011).

The exergy losses concentrates in process of clinker production, which consumes a large amount of the fuel, corresponding 94.3% of the total exergy loss in the overall system when it is compared with the material preparation and clinker crushing process (Akiyama *et al.*, 2000).

Cement production also generates more carbon emissions than any other industrial process (IEA, 2007). As result the cement industry represents 5% of global total CO_2 emissions from fuel use and industrial activities (Huntzinger and Eatmon, 2009). According to the International Energy Agency's (IEA) and Greenhouse Gas R&D Programme (Hendriks *et al.*, 2000), cement production generates an average world carbon emission of 0.81 kg CO_2 per kg cement produced. Approximately 60% of CO_2 emission is generated from chemical reactions involved in the clinker production (Renó *et al.*, 2012).

However the cement industry recognizes its responsibility to manage the environmental impact associated with the manufacture of its products. Over the past 20 years specific energy consumption has been reduced by about 30%, equivalent to approximately 11 million tons of coal per year. One way for achieving this energy saving is the use of waste as alternative fuels and raw materials to reinforce its competiveness and at the same time contribute to solutions to some of society's waste problems. The use of alternative fuels today substitutes approximately 2.5 million tons of coal every year. Thus, in this context this paper focused on analyzing from energy view point the clinker production applying alternative fuel.

The use of wastes as alternative fuels in cement industry has numerous benefits such as (Trezza and Scian, 2000):

- Reduction of the use of nonrenewable fossil fuels as well as the environmental impact associated with fossil fuel production;
- Helpful in recovering energy from waste and to find a solution to the problem of waste management;
- The cement quality and its compatibility with the environment not decrease;
- The use of wastes as alternative fuel does not increase the costs; on the contrary, it brings profits.

Other aspect of alternative fuels in cement industry is the favorable conditions inside rotary kiln where occurs the clinker burning, as high temperature, alkaline environment, oxidizing atmosphere, good mixture of gases and products, and sufficient time for the disposal of hazardous wastes. The rotary kiln is also advantageous in relation (Mokrzycki and Uliasz-Bochénczyk, 2003):

- Does not require any additional source for waste treatment
- It is much cheaper to adapt a cement kiln to waste incineration than build a new incineration plant

However the use of waste-derived fuel presents certain limitations such as the volume of waste, which fed to the kiln, cannot change the kiln running and the clinker quality. There are also limitations related to environmental safety, since the wastes should be used in accordance with rules which ensure that incineration