Proceedings of Engineering & Technology (PET)
pp.99-102

Mineralizers in cement manufacture: Fluorspar

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***Abstract*— In this study, the influence of fluorspar addition on the clinkering process is examined. The percentages of fluorspar added to the raw material vary from (0.25 % to 1% by steps of 0.25 %). It is added to the raw meal to prepare 9 g of a homogeneous mixture. Clinkers were synthesized in a kiln type Nabertherm. The temperatures of cooking varied between 1300 and 1450°C. The basis of assessment of raw materials was the estimation of free lime and C3S content. The burnability behavior of clinkers produced was investigated by Optical Microscopy (MO).**

The experimental results can show that the addition of small amounts of fluorspar (0.75 %) to cement raw material accelerates the formation of alite (C3S) phase and intensifies the process of the free lime combining during the clinkerisation. We can also conclude that we can perform a good burnabiliy of raw material at temperature of 1300°C instead of 1450°C.

***Keywords*— raw material; fluorspar; clinkers; alite; free lime; burnabiliy**

I.

II. Introduction

The global market economy has always forced industrials to be more competitive in monitoring their activities. This involves developing more efficient and economically viable means of production. The production of cement involves several steps which are particularly electrical energy consuming: raw materials grinding and heating and clinkers grinding.

The total electrical energy consumed by the cement manufacturing process is approximately 110 kWh/t. About 60% of this energy is consumed in heating clinker [1]. Therefore, the objective of cement producers is to make this phase of production more economical and this is the major goal of the present work. Several investigations studied the subject of clinker grinding. They were primarily articulated around the effects of the chemical [3, 3], structural [4] and morphological [5, 6] characteristics of the clinker. However, there are few studies, especially in Tunisia, which treat the effect of mineralizers on clinker's burnability and cement quality.

An approach to reducing energy consumption in this sector is to add various mineralizers to the clinker's raw material [7]. Thereby, mineralizers are materials that may activate the clinker formation process by: (i) accelerating the decomposition of calcium carbonate [8], (ii) accelerating the reactions in the solid state, (iii) increasing the amount of the solid phase, (iv) decreasing the temperature of formation of clinker, etc. Their effects are presented differently according to the nature of raw and the concentration of mineralizers [9-10].

Obtaining a raw mixture with a small percentage of mineralizers can minimize energy expenditure [11, 12, 13].

In this work, the influence of fluorspar was studied. We analyzed the relationship between the mineralizers percentages added, the cooking temperature and clinker phases' formation.

III. Materials, Equipment And Methodology

The industrial raw material used in this study comes from cement plant of Gabes, in the south of Tunisia. The refusal of 100µm is equal to 9.4% while the refusal of 200µm is 0.8%.

The composition of fluorspar was determined by chemical analyses and is given in *TABLE I*.

ISSN: 2356-5608

TABLE I. CHEMICAL COMPOSITION OF FLUORSPAR.

(%)	CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	Na_2O	K_2O	SO_3	F
F	42,18	5,79	7,59	0,49	1,48	1,08	<0,15	8,40	19,04

F : fluorspar

IV. METHOD OF FIRING

The percentages of fluorspar added to the raw material vary from (0.25 % to 1% by steps of 0.25 %). It is added to the raw meal to prepare 9 g of a homogeneous mixture. Then pellets were made from this mixture to give a regular burnability of the clinker. The clinker was burned in platinum crucibles in an electrically heated furnace. After burning, the clinker was cooled very quickly to prevent decomposition

V. RESULTS AND DISCUSSION

A. *Free Lime (f-CaO)*

The free lime content for different clinkers synthesized with addition of fluorspar is given in Fig. 1. We can deduce that the free lime content decreased with the addition of fluorspar. From an addition's percentage of 0.75%, we note almost the same free lime content. So the optimized content of fluorspar addition was 0,75%.

Free lime data showed that the mineralizing action of fluorspar was better at low temperature. Hence the cooking temperature can be reduced to 1300°C with an addition of 0.75% fluorspar.

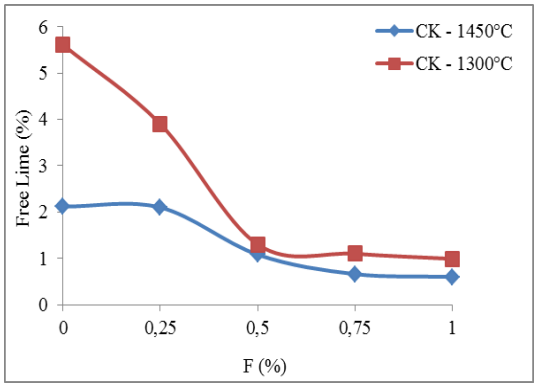

Fig. 1 Free lime content of mixtures fired at different temperature.

B. *Mineralogical Composition*

The mineralogical composition of these clinkers was determined from the Bogue formula [14].

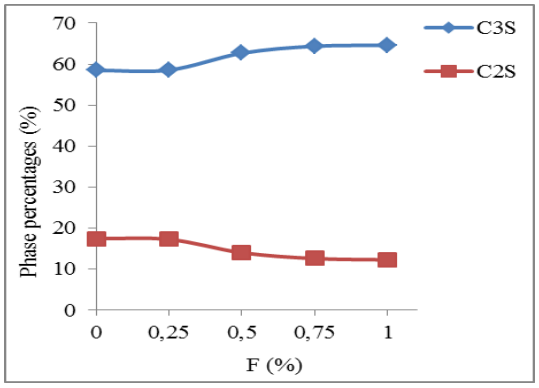

Fig. 2 Variation of levels of potential phases fired at 1450°C with addition of different percentages of Fluorspar.

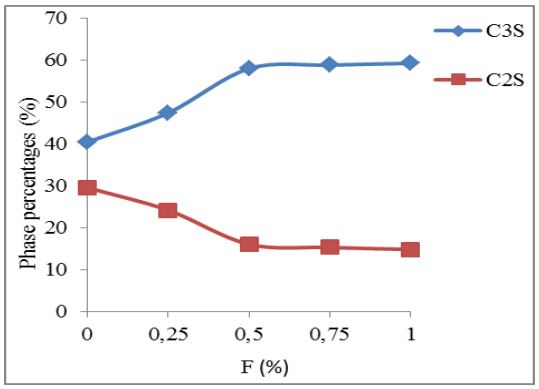

Fig. 3 Variation of levels of potential phases fired at 1300°C with addition of different percentages of Fluorspar.

According to Figs.2 and 3, we see that the addition of fluorspar has significantly changed the contents of C_3S and C_2S. Hence, we can conclude that the addition of fluorspar to the cement raw material, improve the percentage of the principal phase, **C_3S**.

CONCLUSION

The addition of 0.75% of this mineralizer in clinker raw mixture permits to decrease the free lime content in the clinker to 1.25% for burning temperature of 1300°C. These very satisfactory results are due to the mineralogical composition of the fluorspar composed of CaF_2, specifically of the ion F^-. This ion makes interaction with ions from the surface of solids phases and then deforms it. Therefore the use of mineralizers in cement industry can significantly improve the energy efficiency.

ACKNOWLEDGMENT

The authors thank the Gabes Cement Plant for the material and financial support. This research work and innovation is effected as part of a thesis MOBIDOC funded by the EU under the program PASRI.

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