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Calcium Sulphate-Bearing Materials Effects On Cement Characteristics in Vertical Mill and Storing

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ABSTRACT
This examination explores the effect of gypsum, anhydrite and mixes of them on concrete and their effect on the vertical plant activity and concrete putting away. Combinations of gypsum and anhydrite were set up in the proportions: 100:0, 62.5:37.5, 50:50, 25:75 and 0:100. The aftereffects of setting time, compressive strength, adequacy and dampness content demonstrated that both gypsum and hemihydrate had a similar execution in vertical concrete plant as concrete retarders with no observable change on physicomechanical properties of solidified glues and mixing both with various extents can be utilized as a regulator of concrete setting and dampness bring about progress in concrete plant activity and concrete putting away. All in all, gypsum can be supplanted by anhydrite mostly or totally in a vertical concrete factory with no impact on concrete properties. Also, gypsum and anhydrite mixing can handle dampness content in concrete, improve concrete putting away and try not to store issues.

Keywords: *Anhydrite,Cement,Gypsum Cement,Mill,Storing*

I. INTRODUCTION

Role of cement retarders is to prevent C_3A and water fast reaction, that's why natural gypsum is grinded and blended with clinker in cement mills with the different additives according to the cement type. Gypsum hemihydrate and anhydrite exists in nature same as gypsum and can replace gypsum partially or completely in cement production process, so other sources can be utilized without affecting cement quality [1]. When Clinker C_3A content increases, the used quantity of gypsum will increase accordingly but its upper limit will be the same as defined by cement standards, exceeding the permissible limit will lead to concrete expansion [2].

There are many theories explaining cement hydration steps and sulfate bearing materials role [3] [4], One of these theories demonstrates that calcium sulphate bearing materials give off sulfate anions after contacting water and ettringite is formed in the second step as a result of sulphate anions and C_3A reaction according to the equation: $C_3A + 3C\underline{S}H_2 + 26H \rightarrow C_3A.3C\underline{S}.H_{32}$. Then, the fast reaction is stopped as ettringite makes a shield around anhydrated cement grains as: $2C_3A+21H \rightarrow C_4AH_{13}+C_2AH_8 \rightarrow 2C_3AH_6 + 9H$. Another theory suggests that a layer with high concentration of alumina is formed on the surface with adsorbed Ca^{+2} after mixing C_3A with the liquid phase, thus decreasing points of active dissolution and the reduction rate. A further reduction of C_3A hydration occurs by adsorption of sulfate ions [5].

Evidences have been provided to validate these theories. [5] reported that first theory was based on previous works and showed that in hydration early stages, the morphology of ettringite formation is hard to provide a substantial barrier around cement particles. In addition, the possibility of a layer formation around cement particles as the origin of the slowing down of the hydration process was also questioned by studying the process of retardation of C_3A hydration in the presence of gypsum [6]. Two sets of controlled and uncontrolled C_3A hydration were investigated during early hydration, where C_3A was not controlled, the hydroaluminate or hydroxyl AFm phases precipitated from the suspension without stopping C_3A hydration. When C_3A hydration was controlled using a calcium sulphate source, the dissolution rate of C_3A was observed to be so high after all sulphate ions had been consumed. It was therefore concluded that neither ettringite nor AFm precipitation could be at the origin of the slowing down of C_3A hydration. Alternatively, this phenomenon was attributed to the specific adsorption of Ca^{+2} and/or SO_4^{-2} ions on the surface grains of C_3A, which block the dissolution sites of C_3A. This provided sufficient evidence to explain the high dissolution rate of C_3A observed after sulphate depletion within the system [7,8].

Factors that determine the release of Ca^{+2} and SO_4^{-2} include their concentration and their nature (physical and chemical) so more ions are provided when grinding gypsum with clinker [9], this is due to the improvement of the homogeneous particle size distribution of calcium sulphate within the clinker by grinding. For achieving the best control of setting time, sulfates react only with the hydrated portion of C_3A to give ettringite by controlling sulfates availability [10]. Previous researches have clarified that the amount of formed ettringite is affected by calcium sulphate reactivity (solubility and speed of dissolution), which depend on $CaSO_4$ form [11,12].

Other studies have clarified that gypsum and anhydrite have the same solubility while dissolution rate of anhydrite was slower than gypsum. The difference in dissolution rates between gypsum and anhydrite that gypsum dissolution rate is steady while anhydrite dissolution rate develops with the rise of solid/water ratio [13]. The equations $CaSO_4(S)$ show the balance between CaSO and Ca(OH) in a system that includes both. When Ca

$(OH)_2$ crystallizes, solid $CaSO_4$ and $Ca(OH)_2$ co-occur. Balance of the above equations accomplished. Ca^{+2} concentration increases with the increase of anhydrite solubility which decrease OH-, with the decrease of OH- concentration ettringite start to form at a space from the surface of solid phase and accelerate the hydration of calcium silicates However, in the absence of portlandite (CH), the concentration of OH- does not change with the increase in Ca^{2+} concentration [14].

It is clear that gypsum is not only used as a set regulator in cement, but also influences the development of cement paste's strength rate by either accelerating or decelerating the alite phase's hydration. It is therefore necessary to select the optimum content of gypsum as the quantity of gypsum that favors normal setting, maximizes the development of the strength rate and maintains the volume stability of the cement paste [15].

From a long time, cement industry has successfully applied vertical roller mill for grinding of solid fuels and raw materials. This technology has been applied recently for the comminution of portland cement, slag cements and blended cements [16]. The vertical mill differs from the ball mill that the vertical mill allows the comminution of the material bed to occur by exposing the material bed to a pressure that is high enough to cause the fracturing of particles using rollers. This requires the formation of a stable and consistent grinding bed between the rollers and the vertical grinding table while the ball mill allows the comminution to take place by impact and attrition. This happens in two compartments of different lengths. The first compartment for grinding coarse clinker. The second compartment is prepared to grind clinker coming from the previous compartment using smaller balls. These two compartments are separated by a diaphragm that passes only particles of a selected size to the second chamber [17,18]. Factors which can have a significant impact on the performance of cement due to the grinding process (e.g. the dehydration degree of the added gypsum) have been discussed in many researches [19]. Modern cement plants trend for the usage of vertical mill in cement grinding because of its many advantages of lower energy requirements, higher feed rates, simple layout (drying, grinding, material conveying and separation processes into just one unit), substantially reducing civil construction costs, lower noise level and improving the working environment comparing with ball mill [20].

To some extent, natural gypsum dehydration is advantageous for both cement hydration and storage, as it increases the solubility of calcium sulphate during cement hydration. This makes the gypsum more effective in controlling and retarding aluminate phase hydration, thereby enhancing the strength of cement [21]. Partial dehydration of gypsum is also desirable as its crystal water can cause cement particles to adhere during cement storage or form lumps. In addition, the formation of these lumps increases in the presence of potassium sulphate that reacts with gypsum and produces syngenite during storage of cement [21].

Nevertheless, researches remain limited on the impact of sulphate bearing materials on the properties of cement in industrial vertical mill and storage condition because of little experience of cement produced from a vertical mill as this technology has been used for the comminution of portland cement and other cement types recently. The majority of published work has investigated the effect of gypsum, anhydrite and blend of them on the properties of laboratory-produced cements. Meanwhile investigations remain lacking regarding the influence of sulphate bearing materials on cement properties in industrial vertical mill, such as setting time, compressive strength, soundness and moisture, changes in vertical mill operation parameters and conditions to increase gypsum dehydration and silos lump formation. Consequently, the aim of this research is to investigate the effect of gypsum, anhydrite and blend of them on the properties of cement. Setting time, compressive strength and soundness tests were carried out on cement samples. Moisture content was determined before and after the storage of cement samples. Moreover, microstructure of the phases of cement and lump samples were examined and characterized using X-ray diffraction (XRD) and scanning electron microscope (SEM). Study of the impact of rising vertical mill outlet temperature on its operation to increase gypsum dehydration was included.

II. EXPERIMENTAL

Source of the used gypsum and anhydrite was Zafarana area which is located 62 Km south of Sukhna, Red sea, (Egypt). Anhydrite occurs naturally as replacement of gypsum in a variety of sedimentary depositional environments. The mill operation was adjusted to achieve the correct feed composition, the demanded blaine level, and also the necessary outlet temperature of cement mill, temperature was measured by a thermocouple installed at mill outlet duct and to be controlled by fresh air dampers installed at mill inlet duct and/or by water spraying inside the mill. The vertical mill run with average feed 315 320 t/hr. and the average outlet temperature was 102 105 ○C.

Setting time adjustors including gypsum and anhydrite were used in the study. The chemical analysis of the used clinker, anhydrite, gypsum, and limestone were done using X-ray Fluorescence as shown in Table 1;

Clinker was grinded and blended with different percentages of gypsum, anhydrite, mixture of both and limestone as an additive in a vertical industrial roller mill at Beni-Suef cement plant to produce CEM-1 42.5 N type cement. The mill was operated with four rollers and used a hydro-pneumatic system to press its grinding rollers against the material bed on the rotating grinding table. Rollers profile had two grinding zones, an inner and an outer. The inner zone prepares the grinding bed by compressing the feed material as it moves under the rollers into the high-pressure grinding zone. The center groove allowed air to escape from the material. Grinding pressure was concentrated under the outer zone of the roller, allowing for most efficient operation. Cement with gypsum and limestone, referred as CGL, were prepared as shown in Table 2. The surface area obtained was in the range 2751 2885 cm^2/g.

Cement with anhydrite and limestone, referred as CAL, were prepared as shown in Table 3. The surface area obtained was in the range 2751 2950 cm^2/g.

Cement with gypsum, anhydrite and limestone, referred as CGAL, were prepared as shown in Table 4. The mixture of Gypsum/Anhydrite were done in the following ratios 100:0, 62.5:37.5, 50:50, 25:75 and 0:100. The obtained blaine was in the range 2852 3107 cm^2/g.

Addition percentage was controlled by cement mill weigh feeders. X-ray fluorescence was used for determining the chemical composition of the produced cement. The physical properties of the produced cement were determined using EN norms. The moisture of samples was tested after storing for one day to study the differences in moisture content before and after storing. Characterization of the phases of cement and lump samples was done using X-ray diffraction (XRD). The peaks of the cement sample were determined in comparison to International Centre for Diffraction Data (ICDD) file numbers 04- 013-6749, 00-028-0235, and 01-084-9871. The microstructure of the phases of cement and lump samples were examined and graphed by scanning electron microscope.

In addition, the effect of increasing the outlet mill temperature on vertical mill operation was studied. Stabilizing vertical mill operation depend on setting of material feed rate, gas flow rate and mill outlet temperature, It is essential to adjust the gas flow rate/temperature as slowly as possible to stabilize the grinding condition inside the mill, product temperature and gypsum dehydration. Prior to the mill start, sufficient warming up operation is carried out to pass the hot air to the mill by using hot gas generator, after that hot gas generator is stopped and source of hot gases is the used clinker temperature itself but in our trial hot gas generator was kept in operation to rise the outlet temperature to 120 °C to increase gypsum dehydration inside the mill. So, the outlet temperature was increased to 120 °C for six hours to increase gypsum dehydration inside the mill. Then, the volume of hot gases, cement mill feed rates and power consumption were recorded.

III. RESULTS AND DISCUSSION

With increasing the percentage of SO_3 in the anhydrite, the value of 2 d compressive strength increases slightly. The main reason of this case is that anhydrite is harder than gypsum and this forms better environment for the grinding of clinker. The finer particle it has, the faster hydration reaction occurs and accelerate the precipitation of further C-S-H responsible for improving the strength of the cement system [13,22]. Also, it was observed that increasing SO_3 led to increasing 2 d compressive strength gradually until value of SO_3 2.54 which is considered the best to achieve maximum early compressive strength then compressive strength remain stable with higher values of SO_3. On the other side, increasing SO_3 decreases early compressive strength of CGL gradually until reaching to the lowest value at 2.54 then starts to increase gradually but value is still lower than that of CGL. This means that using anhydrite is enhancing the early strength (Fig. 1).For late CGL strength, it was observed that increasing SO_3 decreases 28 d compressive strength gradually and the drop in compressive strength is about 2.5 Mpa, but for 28 d for CAL it recorded values lower than that of CGL. And the value of SO_3 2.54 % can considered the optimum value for late compressive strength also (Fig. 1). Generally, CGL had higher compressive strength in 28 d results and it can be concluded that anhydrite samples had more water demand than gypsum samples [13]. Cement setting is the result of C-S-H precipitation, which strengthens the newly formed microstructure and allows the cement paste to withstand some stresses [23,24], It was noticed that at higher values of SO_3, both values of initial and final setting are the same for CGL and CAL and the difference was observed at the lower of SO_3 and the difference was obvious in final setting time, cements with anhydrite had the lower values of setting times as it set faster than those with gypsum till value of SO_3 2.71, and both present an optimum but at different % SO_3 content (Fig. 2). In systems with anhydrite, the formation of C-S-H tended to be preferred as the reaction rates of anhydrite cement systems were faster than those with natural gypsum and experienced shorter initial setting time, possibly due to the fact that the consumption rate of calcium sulphate was higher in anhydrite cement systems than those with natural gypsum, aftersulphate depletion.

Table 1

Chemical analysis of Clinker, Anhydrite, Gypsum and limestone.

	Component	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	K_2O	Free-H_2O	Comb-H_2O	CaO	Na_2O
Clinker	%	21.16	5.45	3.77	1.17	0.84	0.24				0.48
Anhydrite	%	2.83	0.66	0.39	1.76	39.66	0.12	0.51	3.10	33.15	
Gypsum	%	2.83	0.75	0.42	1.87	39.14	0.13	0.29	17.15	32.32	
Limestone	%	4.06	1.46	1.01	0.55	1.17	0.12			51.05	0.08
	Component	Cl	C_3S	C_2S	C_3A	C_4AF	FCAO	LOI			
Clinker	%	0.02	53.63	20.22	8.52	11.48	1.90	0.23			

Table 2

The percentages of Clinker, Limestone, Gypsum, SO_3 and specific surface of the produced cement with gypsum.

Abbreviation	Clinker (%)	Limestone (%)	Gypsum (%)	SO_3 (%)	Blaine (g/cm^2)
CGL1	92	3.7	4.3	2.40	2751
CGL2	92	3.8	4.5	2.51	2852
CGL3	90	4.9	4.9	2.54	2885
CGL4	92	2.0	5.5	2.71	2785
CGL5	92	2.2	5.7	2.85	2785

Table 3

The percentages of Clinker, Limestone, Anhydrite, SO_3 and specific surface of produced cement with Anhydrite.

Abbreviation	Clinker (%)	Limestone (%)	Anhydrite (%)	SO_3 (%)	Blaine (g/cm^2)
CAL1	91	5.7	3.9	2.40	2885
CAL2	92	3.4	4.1	2.50	2819
CAL3	93	2.5	4.8	2.54	2950
CAL4	92	2.4	5.2	2.71	2682
CAL5	92	2.5	5.4	2.85	2751

Table 4

Admixing ratios for cement mixtures, SO_3 (%) and specific surface of produced cement with gypsum and anhydrite.

Abbreviation	Clinker (%)	Gypsum (%)	Anhydrite (%)	Mixture, G + A (%)	Lime- stone (%)	SO_3 (%)	Blaine (g/cm^2)
CGAL1	92	4.8	0.0	4.8	3.1	2.79	2982
CGAL2	92	3.0	1.8	4.8	3.2	2.50	2918
CGAL3	92	2.3	2.3	4.6	3.4	2.47	2852
CGAL4	92	1.2	3.6	4.8	3.2	2.46	3107
CGAL5	92	0	4.8	4.8	3.3	2.56	2950

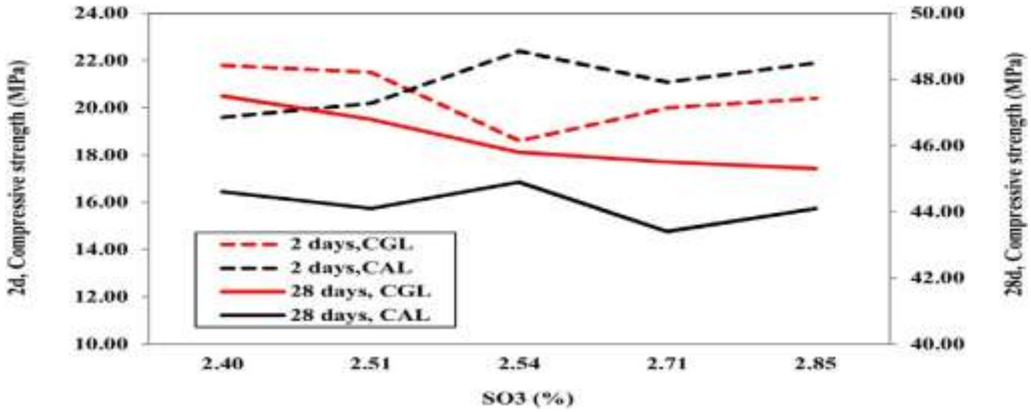
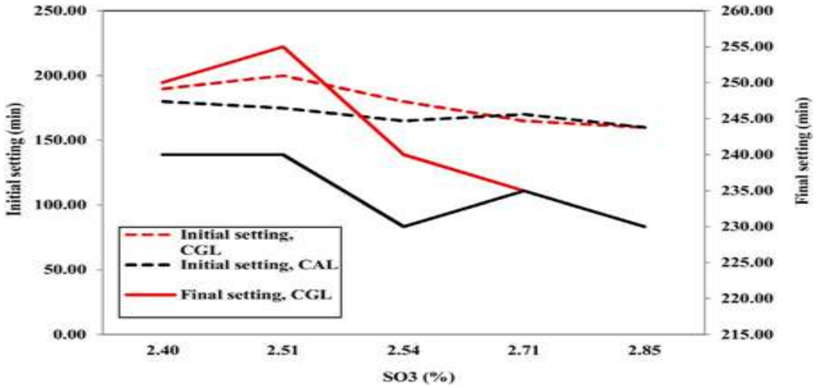


Fig. 1. Compressive strengths of CGL and CAL cements



vs.

Fig. 2. Setting time of CGL and CAL cements vs. SO3 (%).SO$_3$ (%).

almost identical degrees of hydration [25]. The short final setting times in anhydrite systems may be due to the rate and amount of ettringite formation during hydration. In fact, the precipitation of these hydrate products allows the formation of a network structure capable of enclosing a large quantity of free water required for the progression of hydration reactions [26,27].

When gypsum and anhydrite were mixed together at different percentages, cement results didn't show any effect on cement compressive strength (Fig. 3) while initial and final setting time decreased gradually with increasing anhydrite percentage as decreasing the amount of gypsum in the anhydrite-gypsum mixtures resulted in less available soluble SO$_3$ for the ettringite formation and consequently lowered the setting time [22] (Fig. 4). Initial and final setting time decreased by 5 min with 1 % increment in anhydrite content.

Table 5 shows the soundness (volume stability) results for all cement samples studied. It was concluded that all cement samples have an expansion factor within the acceptable limits, no changes in case of replacing gypsum with anhydrite also. Cement expansion, regardless of other factors, is closely related to the magnesia content [28]. If the magnesia content

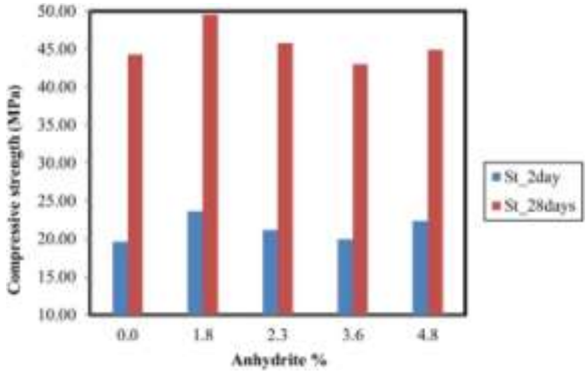


Fig. 3. Anhydrite % in CGAL cement vs. compressive strength results.

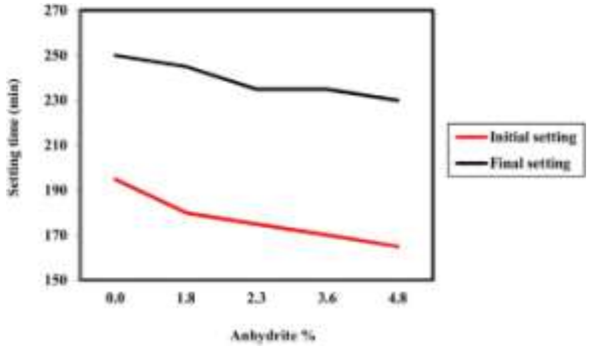


Fig. 4. Anhydrite % in CGAL cement vs. setting time results.

Table 5
Soundness results of CGL, CAL and CGAL cement samples.

Cement samples	CGL1	CGL2	CGL3	CGL4	CGL5
Soundness (mm)	1.00	1.00	1.00	0.00	1.00
Cement samples	CAL1	CAL2	CAL3	CAL4	CAL5
Soundness (mm)	1.00	0.00	1.00	1.00	1.00
Cement samples	CGAL1	CGAL2	CGAL3	CGAL4	CGAL5
Soundness (mm)	1.00	1.00	1.00	0.00	1.00

exceeds 2 %, it appears in clinker as periclase (free MgO). Periclase interacts with water to form $Mg(OH)_2$ and this is the slowest reaction of components in hardening reaction. $Mg(OH)_2$ occupies a larger volume than the free periclase (MgO) it replaces in the cement, and this naturally compromises the binding of the cement. This can lead to expansion cracks being created in reinforced concrete, known as magnesia expansion [29,30].

Moisture content of cement samples before and after storage were compared, the comparison showed that gypsum were more dehydrated in the silo as moisture of cement samples after storage was much lower (Fig. 5). Gypsum crystal water may cause cement particles to adhere or move to colder parts of the silos (cone and the walls) and causes build up coating [31], these coating appeared when the level of the cement changes with extraction of cement from the silo (Fig. 6: A–C). These phenomena is mainly based on the following factors; cement temperature, alkali content, aluminate reactivity and gypsum content [32,33],

Gypsum dehydration in the silo due to the high storage temperature, which cause problems in silos and negatively impacted on cement quality [34,35]. This problem was solved by adding a 50:50 % or 25:75 % mixture of gypsum and anhydrite, thereby reducing the total quantity of gypsum water (Fig. 7).

The X-ray diffraction is used for the identification of phase composition of cement and cement hydration products which consist mainly of hydrated silicates of calcium so called C–S–H phase accompanied with CH (portlandite) and hydration products of calcium aluminate (ettringite) [36]. The X-ray diffraction trace of Portland cement showed dominant peaks, compared to the International Centre for Diffraction Data (ICDD) file numbers 04-013-6749, 00-028-0235, and 01-084-9871. These peaks indicated that the cement was composed of tricalcium silicate (C_3S), dicalcium silicate (C_2S), tricalcium aluminate (C_3A) which are generally known to be the main phases of Portland cement. X-ray diffraction trace of lump sample

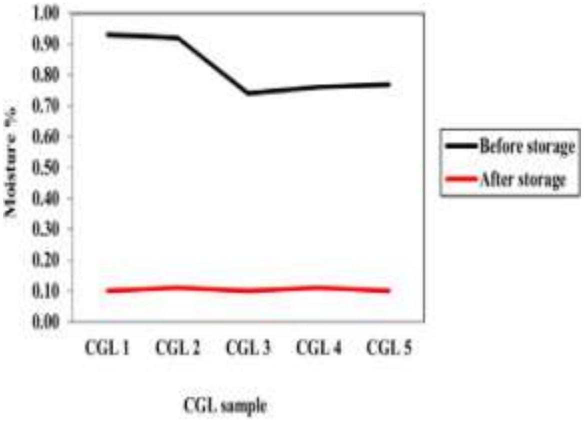


Fig. 5. CGL samples numbers vs. moisture % before and after storage.

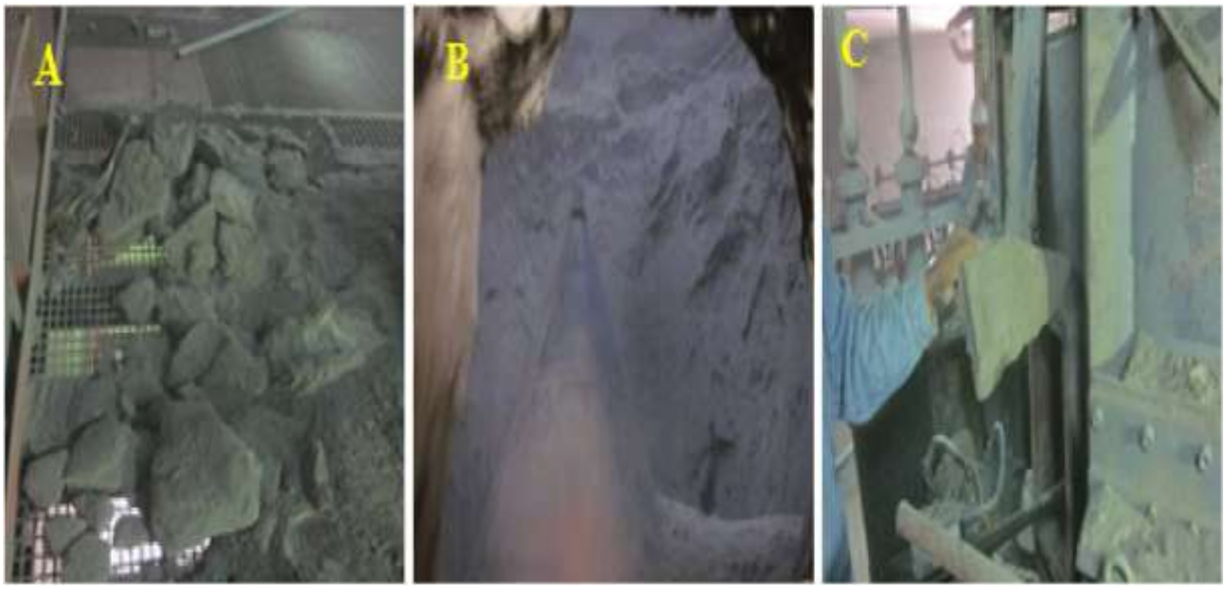


Fig. 6. lump formation inside cement silos.

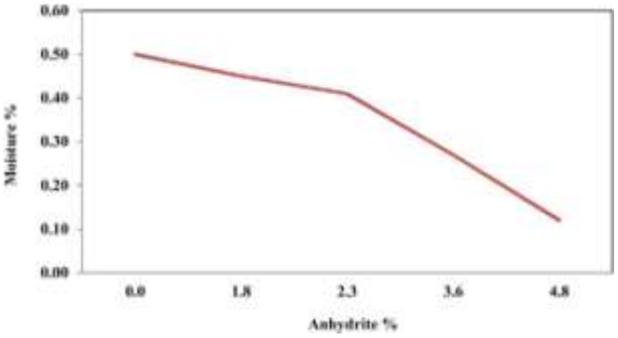


Fig. 7. Anhydrite % in CGAL cement vs. moisture.

showed clear reduction in peaks intensity comparing with the cement sample, appearance of calcium silicate hydrate (C–S–H) and CH (Portlandite) peaks which indicated the occurrence of prehydration process (Fig. 8) [37,38].

Microstructure and phase changes of cement hydration products can also be observed using scanning electron microscopy (SEM). Micrographs of the cement and lump samples were taken by a scanning electron microscope (SEM) where Portland cement particles appeared angular in shape with a particle size of about 1–100 mm while lump sample showed plates of CH (portlandite) and gypsum crystals with a particle size of approximately 300 nm (Fig. 9). These crystals were generated as a result of the prehydration of cement inside silo [39,40]. Hydrolysis of tricalcium (C_3S) and dicalcium (C_2S) silicates caused the formation of CH (portlandite) after the reaction between cement and water.

The morphology of the resulting portlandite crystals is controlled by available free space for crystallization, the type of additives and admixtuers [41]. Studying the impact of hydration on the morphology of C-S-H, it was found that C-S-H presented a particular morphology at each point of hydration. In addition, C-S-H can have more than one shape in the early stage of hydration [42]. Cement Grinding Office (2016) reported that small percent of the total energy supplied to the mill systems is used efficiently, while the rest is converted to heat; the energy produced heats up the ground cement in the mill and can cause the ambient temperature of the mill to rise depending on the initial temperature of the clinker and the mill characteristics [21,43]. Because the vertical roller mill has significantly higher grinding efficiency than the ball mill, the heat input from the grinding process is much lower. This is clear in almost 50 % less installed power, but is further taken into account with a smaller percentage of the energy absorbed by the material. A good vertical mill takes just 50 percent of the installed motor power as heat, compared to ball mills where 75 percent of the installed power can be absorbed. The end result is that the cement product is not going to be heated as much as in a ball mill. This means that a lower level of gypsum dehydration could occur in vertical mill [44–46].

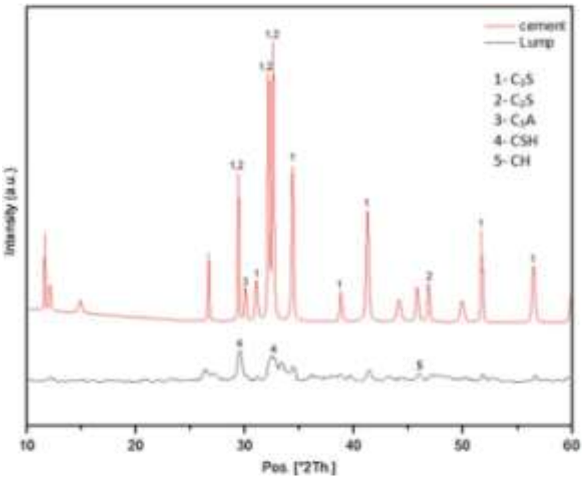


Fig. 8. X-ray diffraction analysis of cement and lump samples.

Fig. 9. (A, B) SEM micrograph of cement sample (A) and lump sample (B).

Table 6
Difference in cement mill operation parameters with different outlet temperatures.

Test duration	Cement mill outlet temp (o C)	Cement mill feed rate (T/ hr.)	Diesel consumption (L)	Hot gas generator (on/ off)	Cement mill power consumption (kw/h)
6 h	105	344	0	off	21.14
6 h	120	315	1900	on	22.17

Cement producers pay special attention to the prevailing temperatures within the mill. In order to minimize issues related to setting (false or flash setting) and stiffening, these temperatures are limited to a certain point by cooling the mill with water or fresh air [20]. At temperatures between 90—120 °C, the water of crystallization of the added gypsum will be partially lost [22]. reported that the upper limit of the temperature shouldn’t exceed 120 °C to avoid excessive or full gypsum dehydration, usually controlled by spraying water into the mill's interior. In these conditions, by losing half of its crystallisation water, the natural gypsum partially dehydrates into hemihydrate [47].

Modern cement plants aim to use less energy during grinding, and shorten the retention time of the ground cement in the mill, without losing the necessary cement fineness, due to economic and environmental reasons. However, this does not always allow for adequate dehydration of gypsum. As a solution, therefore, either more heat is supplied to the mill system to increase gypsum dehydration or using a mixture of gypsum and anhydrite [21].

In our trial with the vertical mill, when the outlet temperature was increased to 120 °C, the volume of hot gases increased, cement mill feed rates decreased by about 9 % and power consumption increased by about 5 % (Table 6).

Thus, using a mixture of gypsum and anhydrite was better than increasing the outlet temperature, to treat the hydration problems, asincreasing the outlet temperature was associated with loss of cement production and high consumption of powerHowever,incaseof no availables ourceforanhydrite and cementis manufactured atarelatively hightemperature and stillhas a lot of gypsum that is not dehydrated during the grinding process, a cooling unit should be used. Before going into the silo, the cement needs to be cooled to a lower temperature in order to decrease the risk of gypsum dehydration. It is commonly considered that the cement should be cooled below 80 °C after the mill. In such case, before transporting cement to storage silos, acoolerisusedonthe finished cement to meet customer requirements and minimize the formation of lumps, whichwould cause problems with handling, storage and packing. Cement cooling technologies, their evolution and testing results regarding their efficiency, maintenance, emissions, and contamination have been discussed in many researches [48,49].

IV. CONCLUSIONS

The field results show that gypsum can be replaced by anhydrite based on the strength, setting time and soundness results. Using the proper ratio of gypsum and anhydrite allows for better controlling of moisture and setting time as anhydrite appears to accelerate the hydration reactions and reduces the setting time, Initial and final setting time decreased by 5 min with 1 % increment in anhydrite content. A possible justification is that the addition of anhydrite in the mixture reduces the available soluble SO_3, which retard C_3A hydration. Cement storage improved as a result of using mixture of gypsum and anhydrite with following percentages 50:50 % and 25:75 % since the total quantity of gypsum water was reduced. Study of the impact of rising vertical mill outlet temperature on its operation to increase gypsum dehydration was included; increasing the outlet temperature was associated with loss of cement production and high power consumption. Thus, using a mixture of gypsum and anhydrite was better than increasing the outlet temperature. This fact makes mining stocks where gypsum and anhydrite coexist can be optimized in cement plant and avoid silos coating and build ups which cause problems in cement extraction from silos, waste time in silos cleaning, disturb workflow, increase production loss and lead to frequent end consumer complaints.

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