Grinding Aid Effectiveness in Cement Ball Mill

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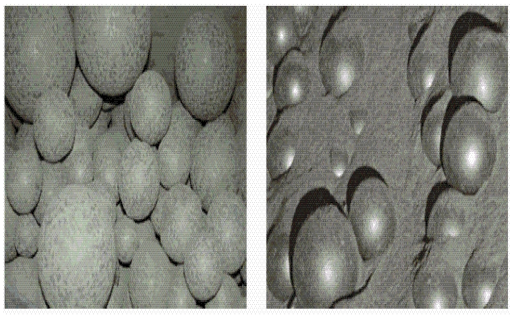
The introduction of the grinding aid (GA) has been started more than 50 year ago, to facilitate clinker grinding in cement mills improve mill output despite of the above features, the wear of mill interior parts well be increase.

Introduction

First it is important to know the types of cement mills used in cement plant to grind the clinker *(main Substance in cement production)* to produce ordinary Portland cement *(opc)*, mainly there are four types of mills**:** Horizontal Ball Mill in Closed Circuit, Vertical Roller Mill and other less using like Horo Mill, Vertical Ball Mill.

Mostly, Grinding Aid is being used in Ball Mill because there are many sizes of grinding balls *(Grinding Media)* ranging from 2 cm to 90 cm or 100 cm diameter, in addition to large surface area for different sizes of grinding Balls the grinded substance agglomerated above the Balls have many different reason among them: electrostatic charge, high cement temperature, aged clinker, rough surface balls and the moist in the mill.

Grinding Aid well contribute in decreasing the agglomerated substance *(coating)* above the balls, increasing the grinding efficiency of the mill and improve the flow characteristics of cement with preventing Pack-set in cement storages.
[13]



Before Using GA After Using GA

Grinding Aids (GA)

Grinding Aids are normally liquid products, traditionally formulated as water-based solutions of organic compounds with high charge density. [14]
Grinding Aids have in sold form also.

Grinding Aid types

There are many materials that can be used as grinding aid, such as
amines based:
TIPA *(TriIoPropanolAmine)*,
TEA *(TriEthanolAmine)*,
MEA *(MonoEthanolAmine)*,
Glycol based:
DEG *(DiEthyleneGlycol)*,
PG *(PropyleneGlycol)*,
Other:
(Glycerin),

Each type of that above listed grinding aids has its advantages and disadvantages.

Now, grinding aid manufacturers make a composite from known and unknown grinding aids with additives to improve the effectiveness. [5], [9]

Some cement manufacture using fatty acids based material like sunflower oil, oleic, stearic, myristic and lauric acids because it is renewable chemicals obtained mostly from natural sources. [11]

Grinding Aid uses and quantities

It use to increase the designed mill feeding with a reduction in specific power consumption *(KW h/t)* for produced cement. In addition to that, its improve cement Compressive strength and color. [12]

Grinding Aid metered in quantities from *0.006 %* to *0.3 %* of the clinker weight and mostly using quantities from 0.1 *%* to *0.3 %* depending on many different reasons such as mill feed rate, Compressive strength and setting time results after using Grinding Aids.

The optimum addition rate should be determined in cement mill tests to get appropriated economical results. [5], [6]

It is easy to adding Grinding Aids to the mill system from above the belt conveyor that feeds the mill with clinker after metering the suitable quantities of the grinding aid or using special system spray the Grinding Aid inside the mill from the mill first chamber.

Grinding Aid Cost

Each grinding aid making companies have his own price and the price of the grinding aid very important as it can affect production cost for one ton of the cement. Unfortunately, Grinding Aids prices are continuously increasing while energy prices decreasing in recent years. [10]

Effect of Grinding Aids in Compressive strength and setting time

Grinding Aid will increase Compressive strength of the cement differently according to the time a laboratory test is performed and generally around 5% increase but the actual mechanism of grinding aids in the cement is not clear and may be due to fine grinding of the clinker resulting in high Blaine of cement, also there are studies supposed that some Grinding Aids have a chemical effects on clinker phases like *(C3A, C4AF)* and somehow

the Grinding Aids can contribute to the increase in Compressive strength of the Cement.

Some types of grinding aid reduce early Compressive strengths within *28 days'* which is about normal. [2], [7], [6], [11]

Almost all Grinding Aids types can accelerate the hydration of the aluminate phases, for that reason a fine tuning is needed to adjust the gypsum additive in mills to control setting time, especially when producing High Blaine Cement. [4], [3]

Mill feeding increasing together with acceleration wear for Balls, diaphragm and the linings *(mill interior parts)*

It is well-known fact when using grinding aid in cement ball mills the feeding increase above the designed mill feeding capacity of the mill which means it can have *100 t/h* cement ball and using grinding aid feeding increase around *10 %* to *110 t/h* [8].

When using grinding aids, agglomerated coating can be removed from the balls and the liners lead to fast wear in mill interior parts with increasing in the specific power consumption *(KW h/t)* after longtime using of the grinding aid. In the table *(1)* below shows comparison between worn out state to normal state of the balls and liner plates: [7]

Table (1)

	Worn out state	Normal State	GAP
Grinding energy	39 KWh/t	32 KWh/t	- 18 %
Mill output	65 t/h	92 t/h	92 t/h

Boiling point of the Grinding Aid and cement mill temperature:

The heat is going to be increased when producing cement inside the mill, the reason is obviously because of the impact of balls with lining and clinker inside the mill and this increase in temperature evaporate some low boiling point Grinding Aids and reduces the effectiveness of Grinding Aid in general.

Table *(2)* below shows different types of the Grinding Aids along with their boiling point.

Table (2)

Grinding Aid	Boilng Point (Silesia)
Ethanol	< 100 c°
Propylene Glycol	100 c° - 200 c°
Diethylene Glycol	200 c° - 300 c°
Triethanolamine	> 300 c°
Polycarboxylate ethers	> 150 Decompsitions

Using less clinker with Clinker Grinding Aids (GA)

Producing a composite cement from clinker and pozzolan with added grinding aid can lead to 15.8 % and 10.5 % clinker reductions with energy savings of 4.5 % and 2.3 %, respectively and without any effects in compressive strength when adding appropriate quantity from grinding Aids. [11]

Conclusion

Using Grinding Aid in Horizontal Cement Ball mill lead to increasing in the mill designed feeding and reduction in specific power consumption for produced cement. Compressive strength

of the cement slightly increases and sometimes decreases depend on type of the Grinding Aid being used.

Removing the agglomeration above the balls and lining accelerate the wear in grinding Media and mill interior parts due to the direct impact between them and leading to increasing the power consumption and requires an emergency maintenance for both balls and mill interior parts to keep mill efficiency as high as possible.

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