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**ENERGY CONSERVATION  
IN CLINKER GRINDING  
THROUGH USE OF  
GRINDING AIDS**

# ENERGY CONSERVATION IN CLINKER GRINDING THROUGH USE OF GRINDING AIDS

## INTRODUCTION

Energy conservation in industrial sector has assumed great importance all over the world. This is true with cement industry as well. It is estimated that nearly 130 kWh power is consumed for producing each tonne of cement by dry process and a few kWh less for the wet process. Nearly 80 percent of it is consumed in crushing and grinding operations alone, but the energy that is gainfully utilized is very low. Even in comparatively big mills, out of every 100 kWh energy put in, only 0.6 to 0.8 kWh is used for theoretical comminution and the rest is wasted mainly in generation of heat. If by some means the energy consumption can be lowered by even 2 kWh/tonne of cement, it amounts to an annual saving of Rs 12 million at the present level of production of cement. The performance and efficiency of grinding operations depend on factors, such as (i) proper choice of mill, (ii) design of diaphragm, (iii) proportioning of ball mill charge, (iv) proportioning of chamber length and (v) proper venting of mill circuit. Besides the above, improved grinding efficiency can also be achieved through use of grinding aids.

## GRINDING AIDS

Grinding aids are chemical additives which when added in small quantities to the clinker in the grinding mill improve the efficiency of clinker grinding. Grinding aids are mostly organic surface active agents which get physically adsorbed on the freshly formed clinker surfaces in the grinding mill thereby neutralizing the free valencies which are responsible for adhesion. Thus, the grinding aids reduce incrustation on grinding balls and lining plates, secondary grain formation of the finest grains and the adhesion of the finer particles on the coarser ones. Therefore, the pulverisation action of the clinker to be ground and the separation of sufficiently fine grains from the materials is facilitated. These factors lead to improving the over all grinding efficiency of clinker grinding.

The most frequently used grinding aids in cement industry in advanced countries are ethanol amines, glycols, organo-silicones, sulphate lye etc. However, their use in cement industry in India primarily depends on the techno-economics.

### **R&D WORK BY CRI**

CRI has carried out a detailed evaluation of the performance of various indigenous grinding aids in improving clinker grinding efficiency by monitoring the Blaine fineness of clinker ground to different time periods both in presence and absence of different amounts of grinding aids. The grinding aids studies were mono, di, and triethanolamines, mono, and diethylene glycols, glycerol, sodium lauryl sulphate, cetyl trimethyl ammonium bromide, Superpol EO-60 (N) and BN (non-ionic surfactants), Swanic CM (non-ionic polyoxy ethylene ether type surfactant), coal, Celex (processed by product from paper industry) and sulphate lye (black liquor from paper industry). The study revealed that all the above grinding aids improved the clinker grinding efficiency particularly above 3000 cm<sup>2</sup>/g fineness (Blaine). The increase in fineness of clinker was as high as 30 percent compared to the blank and the ball coating and coating on liners was also minimized in presence of grinding aids. The laboratory studies followed by selected pilot plant trials indicated a possible saving of upto 10 kWh/tonne of clinker for grinding to a fineness of about 3500 cm<sup>2</sup>/g and the savings increasing with increasing fineness. Based on techno-economic considerations sulphate lye black liquor appeared to be a promising grinding aid for grinding clinkers in the range above 3300 cm<sup>2</sup>/g.

### **PLANT TRIALS**

Based on the laboratory findings, CRI has evaluated the performance of triethanolamine and sulphate lye as grinding aids in a regular commercial grinding mill in a 600 tpd cement plant. The grinding mill was a three compartment air-swept mill having a capacity of 35 tph at a fineness of about 3000 cm<sup>2</sup>/g.

Different concentrations of the aqueous solutions of the grinding aids were prepared and added to the clinker as it left the feed table by means of a specially designed arrangement. The arrangement

consisted of an over head tank filled with the grinding aid solution and kept at a height of about 4 meters above the clinker feed table, a perforated pipe and a hose pipe connecting the two. The perforated pipe was made of steel and had an internal diameter of 2.5 cm and was fixed over the feed table across the cross-section of the clinker in such a way that the liquid jets coming from the perforations fell on the clinker at a slight angle. The flow rate of the solution was controlled by two regulating valves, with one of them just before the delivery pipe and also by maintaining a constant level of the solution in the tank throughout the operation.

The benefits obtained during the plant trials are as under :

- i) Triethanolamine (0.03 to 0.06 percent by weight of clinker added in the form of 20 percent aqueous solution) increased the fineness of cement by 18.5 percent at 2810  $\text{cm}^2/\text{g}$  and 23 percent at 3325  $\text{cm}^2/\text{g}$ . Alternatively, the mill output was increased by nearly 40 percent at a constant fineness of 3325  $\text{cm}^2/\text{g}$ .
- ii) Sulphate lye (0.06 percent by weight of clinker added in the form of 8 percent aqueous solution) increased the fineness of cement by about 35 percent at 3325  $\text{cm}^2/\text{g}$ . Alternatively this can lead to an increase in mill output by 35 percent at 3325  $\text{cm}^2/\text{g}$ .
- iii) The possible saving in power consumption by employing sulphate lye as grinding aid works out to about 3, 11 and 19 kWh/tonne at 3000, 3500 and 4000  $\text{cm}^2/\text{g}$  fineness, respectively (see Table 1).

## EFFECT OF GRINDING AIDS ON THE PROPERTIES OF CEMENT

Investigations on the setting, hardening, strength development and air content of cements ground with and without grinding aids revealed that grinding aids used in such small concentrations have practically no effect on these physical characteristics of cements. Also the amount of the grinding aids employed (less than 0.1 percent) is such that the cements ground with grinding aids are very much well within the standard specifications.

**TABLE 1 : POSSIBLE SAVING IN POWER CONSUMPTION BY EMPLOYING SULPHATE LYE AS GRINDING AID**

Fineness cm <sup>2</sup> /g	Possible Saving in Power Consumption kWh/t
2900	1.36
3000	2.93
3100	4.48
3200	6.06
3300	7.65
3400	9.28
3500	10.88
3600	12.52
3700	14.17
3800	15.85
3900	17.51
4000	19.20

### RECOMMENDATIONS

Based on the techno-economic considerations sulphate lye black liquor from paper plants, which is rich in lignin sulphonates and is surface active and whose cost is less than a rupee per kilogram, appears to be a potential grinding aid for improving clinker grinding efficiency in Indian Cement Plants particularly when grinding cements to fineness of around 3300 cm<sup>2</sup>/g and above. The benefits obtained in terms of increasing output or increasing fineness are more or less at par with those derived from the well known triethanolamine and ethylene glycole, which are prohibitively costly in India.

As the mineralogical composition and the surface characteristics of clinker have an effect on the functioning of the grinding aids, it is essential to establish the optimum dosage and dilution of the grinding aid by a regular plant trial and employ the optimum dosages to derive maximum benefits.

## AVAILABILITY OF SULPHATE LYE

Sulphate lye is the black liquor obtained during the cooking of wood with steam and other inorganic chemicals in the paper industry. The black liquor generally consists of 10-15 percent of solids of which about 50 percent is organic and the rest inorganic matter. The organic portion is made up of 10-15 percent wood sugars, 40-50 percent lignin derivatives and about 20 percent tannin matter. The organic portion, particularly the lignin derivatives, is considered responsible for the grinding aid action of sulphate lye. Many paper plants recover the inorganic salts from the black liquor followed by burning off the organic portion to get the heat value. In the recycling process, some plants have agreed to supply part of the black liquor to the cement plants nearby on regular basis.

## ASSISTANCE BY CRI

CRI has brought out a Research Bulletin entitled "Grinding Aids for Energy Conservation in Clinker Grinding" RB-15-80 (priced Rs 25/-) which provides fuller details of the study. CRI extends any assistance to those cement plants who wish to employ grinding aids in their regular production.

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