技 術 交 流

RAW MILL PLANT와 KILN PLANT의 問題點

昨年10月 우리나라를 訪問하여 몇차례의 시멘트工業技術「세미나」를 가진바 있는 濠州聯邦科學工業硏究所 應用鑛物學部門 首席硏究官(Senior Research Officer, Division of Applied Mineralogy, Commonwelth Science and Industry Research Organization)인 「헤롤드 · 에드워드 · 비비안」(Mr. Harorld Edward Vivian)氏가 雙龍洋灰 工業株式會社로부터 시멘트工業 技術問題에 對한 書面質疑를 받고 다음과 같은 Comment를 보내왔다. 우리 시멘트工業界의 技術發展에 多少나마 도움이 될까 하여 여기에 揭載한다.

A RAW MILL PLANT

1. What is the optimum circulating load in bucket elevator for the double rotator mill? The fineness of the raw meal ground is as follow:

Specific surface is 4,900 cm^2/g

Fineness is 10% residue on 170 mesh

What is that for the air swept mill?

Circulating loads vary up to about 600 percent. There is no very definite optimum and a satisfactory circulating load is one which permits a steady operation with respect to quantity and quality of output. It can generally be observed that a smaller circulating load (about 200-300%) gives a more satisfactory operation than a larger load.

Fineness of raw meal can be rather fictitious especially if clay is one of the raw meal components. A 10%residue on a 170 mesh sieve when the surface area of the meal is 4900cm^2/g. suggests that the different components are ground to different finenesses. It would seem that the coarse fraction would be mainly limestone. In an air-swept mill this raw meal should undergo segregation and great care would be needed to keep the meal composition within reasonable limits and some blending silos should be available to permit raw meal composition adjustments.

2. What is the optimum fineness of raw meal for clinker burning?

a) Residue % on 170 mesh or blain value?

b) It's upper or lower limit?

The optimum raw meal fineness will very depending on the nature of the raw materials. For example dense, pure limestone and clay or should when mixed as separate ingredients will be more difficult to react than a cement rock type of raw meal in which all the components are intimately mixed.

Purely for raw material combination it is desirable that all particles should be -36 microns. This would mean that the Blaine surface area should be greater than approximately 4,000 cm^2/g. and that clinkering would become easier as fineness increases at the same time other problems, such as increased dust losses, could become increasingly serious as fineness increases. The optimum fineness must be found for each raw meal and should be reconciled with the production operation that is being used. For example the clinker output, free lime content, kiln speed, klin temperature etc. are all factors that influence raw meal preparation or involve company policy decisions that require raw meal to be ground to some required fineness. Large amounts of coarse residues held on a 170-mesh sieve can increase the free lime content of clinker, reduce clinker output and make burning a difficult and costly operation. Once again it is not possible to give a residue figure that would be applicable to all raw meals and plants. Coarse quartz particles are very slow to react completely and coarse limestone particles can also contribute significantly to free lime in clinker. It should also be noted that mere recording of a 4000 cm^2/g Blaine fineness does not always mean that the residues held on a 170 mesh sieve would be in the 5–10% range. They may occasionally be relatively great and the coarse particles would cause burning difficulties, lower output or unsound clinker.

3. What are the influences given to preheater by the fineness variation?
Pertaining to:
a) The circulating ratio in cyclone?
b) The calcinating degree of raw mix?
c) The trouble of cyclone clogging?

Variations in the fineness of raw meal entering a preheater will show up as a variable separation of the meal and an increased dust (fines) loss. This separation upsets the raw meal composition. If the dust is collected and returned to the system it is virtually impossible to blend it satisfactorily with the coarser meal. Ideally the cyclones should act only as a heat exchanger the meal should undergo only one pass through the cyclones and decarbonation should commence only in the lowest cyclone. If decarbonation commences in an earlier cyclone it is likely that incipient clinker formation will commence in the lowest cyclone and this may cause some clogging

The presence of large amounts of sulphur in fuel can also lead to the formation of massive salt (calcium or alkali) sulphate deposits at some stage in the preheater and these deposits can also cause clogging.

4. What are the ideal modulus of raw mix and their upper and lower limit? In the case of Ssang yong (Raw mix)

	Standard	Range
L.S.F.	91	±2
S.M.	2.5	±0.1
I.M.	1.8	±0.1
H.M.	2.08	±0.05

In the consideration of saving of procurement and handling cost, we are thinking of changing S.M. of raw mix from 2.4 to 2.3.

In this case, we wish to get comments on infuences to the kiln conditions and recommendations on optimum value of other modulus.

From your experience, what is the maximum allowable ranges of total carbonate in raw mix to keep kiln conditions normal?

Ssang yong's data:
Standard; 77.1% ±0.1

Actual; 77.1% ±0.3—0.5

An ideal raw mix is probably impossible to achieve and maintain because the raw materials available are variable. As a general rule a reduction in the silica modulus will make burning easier even though it may be accompanied by an increase in tri-calcium silicate. There are however a number of other factors that should be considered. Increased iron oxide contents can make the kiln operation more difficult due to coating formation especially if the flame is not well controlled. The clinker also tends to become somewhat finer and more difficult to cool in available coolers and more difficult to grind satisfactorily. On the other hand exclusion of quartz, especially coarse quartz particles, would improve clinkering. There is a possibility that some decrease in S.M. is actually occurring if coarse quartz particles are not reacting completely. Addition of iron oxide as an additional raw meal component may make the modulus appear currect but may not in actual fact produce the desired effects in clinkering. A clay containing a large iron oxide content and a low free quartz content would be the most suitable means of modifying the silica modulus. A reduction in silica modulus without any change in lime content would increase the C_3S content of the clinker and the increased C_4AF would assist the C_3S formation As indicated above, addition of iron oxide as a separate would not greatly assist clinkering even though the raw meal chemical compositions and moduli were satisfactory. The iron oxide in this instance is not suitably disseminated throughout the raw meal since it is present as relatively coarse particles that are extremely difflcult to grind finely. It may also increase the thickness or coating on bricks immediately before entering the burning zone.

Ssang Yong data suggest that the limestone total carbonate is rather lower than what I am used to here in Australia. Most Australian raw meals would contain at least 80% total carbonate and the resultant clinker C.S. would be approximately 60%. It is generally aimed to maintain raw meal carbonates to a level of 10.1 percent but they may vary up to 10.25%. Your control is quite reassonable and raw meals having the maximum variation (+0.5 percent carbonate) should be easily burnt. Variable composition raw meals will yield variable clinker which may contribute to excessive variation in cement properties. Factors other than chemical composition can affect clinkering and the particle size distributions of the raw meal components and burning conditions can be indicated as two important ones. Experimentally we have produced very high C_3S clinkers (containing 70% CaO) provided the raw meal components are finely round. Free lime contents increase the clinkering becomes slower and less uniform as the particle size of the raw components increases.

5. What is the relations between blending efficiency and blending time?

a) What is the recommended length of blending time and tonnage of one lot of raw mix for the following silo dimensions.

Silo dimension	Blower cap.
19.8×10	$87m^3/min \times 1.5kg/cm^2$

b. When we use filter stone or canvas for blending units, what is the resistance for each?

The most satisfactory method of determining the relationship between blending efficiency and blending time is the experimental procedure. For raw meal of a givn type, the time required for homogenization in a given silo would become the accepted length of blending time. In a large scale complex operation this type of characterization is often the most effective means of determining the working requirements. Subsequent tests made on samples taken for control purposes will add to the operational appreciation of the blending equipment.

Filter stone is usually used in blending silos and it has a satisfactory low resistance to air movement.

6. What is uniform discharging methods of raw mix from raw meal bin for kiln feeding?

In our plant, kiln feed weighing machine has large variation because of flashing formation in the bin.

Uniform discharge of finely ground solids from a bin is difficult to attain continuously and under all possible conditions. As a general rule dry, finely-ground materials arch and do not flow easily out of bins when very finely ground. When the materials are coarsely-ground, or are deficient in fine particles, they flow very readily and surge out of bins. Slit disharges are often more effective than circular disharges. Kiln feed weighing devices are generally capable of giving a uniform feed rate because they cannot act rapidly to correct variations. Perhaps one of the most suitable proccedures to ensure a more uniform feed rate involves extracting the meal into a counter-balanced through from which a constant quantity of meal is extracted by a small screw conveyor. On account of the problems that arise in feeding uniform quantities of granular and finely-powered materials the development of constant feedings devices that do not cause material segregation would be most desirable.

7. grinding mill

a) What are the wearing factors and material specifications of steel ball for raw mill and cement mill?

i) Wearing factor?

ii) Composition?

b) What is the estimation method to determine the quantity of steel balls to be added?

We now use the method based on electric power consumption, steel ball wearing factor and charging volume ratio.

c) What is the optimum charging volume ratio of steel balls for raw and cement mill.

The wearing rates of steel balls in mills varies very considerably depending on the mill and its operation as well as on material factors such as ball quality. Dry grinding mills will generally consume $\frac{1}{2}-\frac{3}{4}$ lb. of steel mill plates and balls per ton of clinker ground and generally less than $\frac{1}{2}$ lb./tons of raw material ground. Wet-grinding raw mills will consume 4–5 lb./ton, and sometimes as high as 7 lb./ton, of raw material ground. Larg diameter mills tend to consume a large quantity of grinding media because of ball breakage and loss of nibs and scrap and sometimes mill places may be broken and have to be replaced.

Forged steel balls are generally used in the 4–2 inch sizes. These balls are usually shaped from steel round or square billets, and surface chilled to give a hard working surface. They sometimes contain in-built flows and break up rapidly into hemispheres or guadrants during use. Cast Ni-hard slugs (truncated cones) have been used occasionally but are costly and must be very carefully heat-treated to ensure a good working life. Small balls $1\frac{1}{2}-\frac{5}{8}$ inch sizes and cylpebs are generally made by casting. Chilled white cast iron or chilled cast steel media have generally performed satisfactorily. The method based on electric power consumption at operating speed gives a good indication of the adequacy of mill loading. The ball wearing factor (determined experimentally or by experience) can be used for determining the ball make-up at pre-decided intervals of time. The charging volume ratio can only be determined accurately after a. mill has been scuttled, the media sorted and the mill re-loadad (without any feed). The recommended loadings vary very considerably from one mill to another. As a general rule however it can be said that loading should be kept as high as possible (i.e. the optimum charging volume is 35 per cent or even higher if the balls does not spit back through the feed inlet and provided the input feed does not spit back when the mill is operating). Most effective grinding under the circumstances occurs near the input end of the mill and consequently attention should always be given to maintaining the level of loading in the first compartment of a compound mill. If balls are wearing evenly make-up should consist only of the maximum size balls for each compartment of a mixture of maximum size and the next smaller size. It is fairly common for maximum sized balls for cement mills to be 4inch diameter and the maximum size for raw mills to be 31/2 inch or even 3inch diameter depending on the input stone size.

Liner plates are generally reverse stepped in the first compartment and smooth plates in the later compartments. All plates are carefully backed up to minimize the risk of rapid breakage. Periodical inspections should be made of the mill to observe the condition of the balls and liners and to examine diaphragms and gratings for breakages and blockages. Diaphragms should be fitted with the open end of the tapered slots towards the feed end of the mill.

B. KILN PLANT

1. What is the sulfur content in fuel causing the kiln coating formation?

Sulfur content in demostic fuel B.C. oil is about 3.5-4%.

2. What is the effective methods to remove kiln coating?

1. and 2. The high sulphur content of fuel oil seems to be fairly usual in most places. The sulfhur is first oxidized and combines with alkalis, calcium oxide or even dicalcium silicate and is deposited in the kiln or precipitator where temperature conditions are suitable. Removal of these materials and costly because the installed equipment was not designed to handle such fuel. The more typical kiln coatings can be minimized by modifying the kiln chains, the raw meal fineness and composition and the burning conditions and fuel properties.

3. What is the effect of additives to the fuel oil in promoting combustion efficiency?

Admixtures to fuel oil to improve combustion seem to be a costly way of achieving a gain in fuel economy. There is considerable scope for improving burners, atomizers and combustion procedures.

4. What is the optimum air velocity in the primary air duct?

On account of the variability of equipment, the optimum primary air velocity would have to be determined experimentally. The major aim is to have a good oil droplet-air mixture that ignites sufficiently far away form the burner to prevent over heating. An adequately high primary air velocity will give a short intense flame, a low velocity gives a long, lazy flame while excessively high air velocities give flame which burn too far up the kiln.

5. What is the calcination degree of raw meal at kiln inlet?

Raw meal should have been partially decarbonated at the kiln inlet. The degree of decarbonation will depend to some extent on the particle size and density of the limestone. Clinkering and liquid formation should not occur in the final cyclone.

6. Insulating cover is presently installed on the kiln I.D.F. suction gas duct (from preheater stage I to kiln I.D.F.).

If we remove the insulation cover to cool down the waste gas temp., so as to increase the induction capacity of the fan, what would be the expected trouble?

Removal of the insulating cover from the duct on the kiln I.D. fan from pre-heater stage I would probably not cause major changes. It could increase the secondary air quantity and consequently increase dust losses from the kiln and it could increase the amount of heat recovered in the cyclone pre-heater. The position of the sulphate deposits could also change.

7. What is the effective method and mechanism to prevent clinker cooler dead plate from coating formation?

We have installed water jacket on the clinker cooler dead plate for the preventing of coating formation, but we have many troubles due to it's wearing and water leakage.

Your recommendations for the type, meterials and other pertinent informations are desired.

It is generally accepted that coller design is not all satisfactory. All coolers are suffering from the problem of excessive quantities of clinker discharging onto the dead plate, often in an uneven stream, and building up in rather thick masses, sometimes called incongruously snowmen. These masses of hardened clinker upset the whole function of the coller grate. Heat and abrasion will also cut out the plate rather rapidly. Installation of a water jacket is not considered to be a suitable solution for this problem due to the reasons given namely rapid wear and leakage. The use of higher quality steels is also not considered to be satisfactory. The best solution for this problem appears to be in the use of heat-resisting and abrasion-resisting refractory bricks placed in such a way that the clinker must discharge in series of small steps. In this way severe abrasion can be reduced and the build-up on the refractory bricks is not excessive. Although no one seems able to advance a satisfactory solution, it would appear that cooler design for large diameter kilns will have to be drastically modified.