Method to optimize SO₃ in the cement

1. OPTIMUM SO₃ IN THE CEMENT

The SO₃ determined in the cement is the sum of SO₃ of the different constituents:

- Clinker
- Mineral components (Fly ash, Slag etc)
- Calcium sulfate added for finish grinding

The SO₃ from the different constituents does not react in the same manner. This reaction can considerably influence the cement properties in terms of the following:

- Setting Time (Initial & Final)
- Rheology of the cement paste
- Kinetics of hardening
- Dimensional variations
- Admixture Compatibility in the fresh concrete

In case of clinker the SO₃ is integrated in the crystal lattice. The contribution of sulfur by the raw meal or by the fuels influences the final SO₃ content in the clinker.

The SO₃ of clinker varies mainly as a function of the fuels used during the burning process. Attention has to be given to obtain sufficient SO₃ in form of alkali sulfates in order to avoid fast setting of the cement.

It is not possible to calculate in a quantitative manner the effect of all these phenomena without a purely experimental study applied to the cement. This is more indispensable since not all the cements have exactly the same composition, the same burning conditions, the same MIC, the same particle size distribution, etc.

There are certain mathematical models to determine the optimum SO₃ in the cement. None of them gives satisfactory results, as the effect of particle size distribution is not taken into account.

In the Plant lab Ball mill grinding carried out by making cements at different SO3 contents is not an ideal test primarily because the lab ground cement have different particle size distribution.

2. METHOD TO OPTIMIZE THE SO₃ IN THE CEMENT

The optimization exercise has to be realized on an industrial scale for all different cement types produced.

Once the cement mill is in a stable condition, deliberately increase the dosage of calcium sulfate in order to produce cement out of standard for a short period. The cement should be directed to a transition silo or directly "diluted" in the normal silo.

The Blaine might increase a little bit, but do not touch the grinding system!
At a certain moment, the cement analysis will show an elevated $\text{SO}_3$, for instance 5%.

This will be the $\text{SO}_3 \, t_0$

Then: Stop the weigh feeder for calcium sulfate (or divide the weigh feeder dosage by two or three to avoid a too strong effect) and take a sample every 5 minutes of 5 - 10 kg (quantity depends on amount of tests to be realized) and analyze the $\text{SO}_3$ content.

$\text{SO}_3 \, t_5 \, \text{SO}_3 \, t_{10} \, \text{SO}_3 \, t_{15} \, \text{SO}_3 \, t_{..... \, \ldots \ldots}$

You will observe that the $\text{SO}_3$ of the cement will decrease rapidly.

Usually the exercise is finished within one hour. Put the weigh feeder back on its original set point.

Test the cement samples with different $\text{SO}_3$ on the different properties (setting, strength, shrinkage) and establish the corresponding curves of values as a function of the $\text{SO}_3$ content (e.g. Comp. Strength = $f(\text{SO}_3)$).

Note: Testing cements with a high $\text{SO}_3$ content will help to understand the behavior of cement at the limit of the standard in general.

**Recommendation:**
The optimum $\text{SO}_3$ can help to optimize fineness, strength, workability and other cement properties.

Every time you change:
- the composition of clinker (or clinker source / factor)
- the composition of MIC (or percentage of addition)
- the fineness
- the type of calcium sulfate (Gypsum Type)

$\Rightarrow$ pl do $\text{SO}_3$ optimization!