60.3.10.6 Short term uniformity (raw meal; kiln feed and clinker)

Description

Short term uniformity indicators show the variation of the chemical composition of raw meal, kiln feed and clinker during the clinker manufacturing process, emphasizing the short term (daily) fluctuations.

The indicators are calculated from the daily standard deviation of the moduli (LS, SR and AR) as the average of the daily standard deviation of LS, SR or AR over one month.

Purpose

Good short term uniformity is key for a for trouble free kiln operation and contributes to reduced operational costs (such as reduced heat consumption, optimal equipment performance, increased refractory lifetime).

Targets for excellence (monthly values) are:

Material	LS	SR	AR
Clinker, kiln feed	< 1.2	< 0.04	0.04
Raw meal	< 3.6[1]	n.a	n.a

Calculation

$$Daily\ standard\ deviation: \quad s = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2}$$

Where
N: number of daily samples (N ≥ 4, typically 6 to 24)[2]
x_i : LS, SR or AR of individual sample
$\bar{x}$: Daily average of LS, SR or AR

$$Monthly\ uniformity\ indicator: \quad \frac{1}{N}\sum_{i=1}^{N} s_i$$

Where
N: Days of month with daily standard deviation available
s_i : Daily standard deviation of LS, SR or AR

Comments:

- The indicators can be calculated for raw meal, kiln feed an clinker
- The daily standard deviation is calculated from the individual analyses (XRF results), taken at the frequency defined in the plant's quality control plan.

[1] Guide value, for plants with pre-blending system
[2] With less than 4 daily samples this indicator cannot be calculated

- A minimum of four daily analysis is required to calculate this indicator
- Sample type: Spot samples or composite samples over less than 2 hours

Unit of measure:

Dimensionless number

Examples:

Monthly short term uniformity clinker

	Daily standard deviation				
Date	s(LS)	s(SR)	s(AR)	# of daily samples	
01.01.15	1.31	0.06	0.03	15	
02.01.15	1.33	0.05	0.03	13	
03.01.15	0.92	0.05	0.04	18	
04.01.15	1.26	0.03	0.04	20	
05.01.15	1.87	0.03	0.03	10	
09.01.15	0.21	0.02	0.01	2	(excluded from the
10.01.15	1.09	0.03	0.04	14	monthly average)
11.01.15	2.09	0.04	0.04	15	
12.01.15	1.10	0.05	0.04	14	
13.01.15	1.42	0.05	0.04	16	
14.01.15	1.77	0.04	0.04	14	
15.01.15	1.26	0.03	0.03	14	
16.01.15	1.39	0.06	0.06	15	
17.01.15	2.14	0.04	0.05	14	
18.01.15	1.36	0.08	0.12	18	
19.01.15	2.77	0.08	0.06	19	
20.01.15	2.21	0.08	0.06	21	
21.01.15	1.62	0.05	0.05	20	
22.01.15	1.75	0.06	0.04	17	
23.01.15	1.85	0.10	0.05	19	
24.01.15	1.87	0.13	0.03	21	
25.01.15	1.29	0.05	0.04	13	
26.01.15	1.95	0.07	0.07	14	
27.01.15	1.87	0.09	0.05	17	
28.01.15	1.07	0.07	0.07	16	
29.01.15	1.10	0.04	0.05	15	
30.01.15	2.26	0.05	0.06	18	
31.01.15	1.48	0.04	0.05	15	
Short term uniformity	1.56	0.06	0.05	27	