Technical Development Program   
SPREAD 2016

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Morocco

Kiln Optimization  
Case Study  
Pre-Reading

Version 2016  
  
LafargeHolcim Ltd.  
Cement Industrial Performance

Introduction

You are the Process Performance Engineer in the clinker production department of the 'Dandelion' cement plant.

The 'Dandelion' plant is located 450 m above sea level. The plant, commissioned in 1974, includes one ball mill for raw meal preparation, one dry suspension preheater kiln (Polysius DOPOL, original design capacity 1’500 t/d) with grate cooler and two ball mills for cement grinding.

Several **upgrades** have been made in the past years:

* High momentum kiln burner
* Pfister kiln feed dosing system
* Dip tubes in all cyclone stages
* Fixed cooler inlet (KIDS)
* Precalciner with tertiary air duct designed for 2'500 t/d production
* Installation of retractable kiln inlet probe
* New dynamic separator for the coal mill

However, after the installation of the new precalciner early this year (Jan/Feb), the new design capacity (2'500 t/d) kiln could not be reached. Further the kiln system availability is too low (mainly due to ID-fan failures, refractory failure at the kiln outlet and kiln drive failures).

The highest achieved clinker production is reported at **2'350 t/d**. The next annual kiln shutdown is scheduled in January next year.

Raw material and raw meal preparation

The raw material from the quarry is quite **uniform** in chemistry. The raw mill has a capacity of 230 t/h and can be operated mainly at low electricity tariff only (nighttime and weekends). A new Pfister kiln feed dosing system has been installed and no problems with kiln feed variations exist.

Fuels and AFR

**Imported coal** is used in the main burner as well as in the precalciner. The cost of coal is high and is expected to increase further. The use of AFR is in an initial phase, recently first AFR trials have been carried out.

Fuels and AFR

The coal mill is **not a bottleneck**. A recent coal mill audit concluded that the capacity is sufficient even if 100% petcoke substitution would be achieved in the future.

Quality

Clinker **free lime is within target**. Reduced early strength, which occasionally seemed to be a problem in the past, has improved considerably since the installation of the fixed inlet (KIDS).

Market

Due to the considerable growth of the GDP (Gross Domestic Product) in the country the market conditions for cement are **very promising** and every ton of additionally produced clinker could be sold.

Plant Equipment Data

* Rotary kiln (commissioned in 1974)   
  Original design capacity **1'500 t/d** (DOPOL without precalciner)  
  Shell dimension dia **4.7 m x 72 m, 3 piers,** inclination **3 % (or 1.72°)**  
  Refractory lining thickness: **20 cm**
* Kiln drive (girth and pinion)  
  **350 kW**, **2.2 rpm max**
* Preheater
  + **DOPOL** type **four stages**   
    No. of cyclones from top to bottom: 2, 2, 1, 2
  + All cyclone stages are equipped with **dip tubes.**Dip tube dimensions (stage 4 = top stage, stage 1 = bottom stage):
    - **Stage 4 (top):** dia = 2.2 m, length = 2.5 m
    - **Stage 3:** dia = 2.5 m, length = 1.5 m
    - **Stage 2:** dia = 3.3 m, length = 1.5 m
    - **Stage 1 (bottom):** dia = 1.9 m, length = 1.0 m
  + Narrowest **kiln inlet** section area **7.45 m2** (inside refractory,   
    measured at narrowest position limited by the inclined inlet chute)
* Precalciner
  + Inline calciner (vessel type)
  + Calciner volume: **440 m3** (inside refractory)
  + Tertiary air duct diameter: **1.7 m** (inside refractory)  
    Take-off from kiln hood
  + One meal feeding point to calciner
  + Burners: simple tube (without primary air and swirlers)
* Kiln hood net cross section **4.6 x 3.7 m** (inside refractory,   
  measured at cooler roof level)
* Clinker grate cooler
  + Fixed inlet with one high pressure variable speed   
    **fan #1**: 30'000 Nm3/h, max. 100 mbar
  + 2 grate sections each with a mechanical grate drive
  + Three cooling air fans with dampers for aeration of moving grates:
    - **Fan #2** for first grate, first compartment:   
      30'000 Nm3/h, max. 80 mbar
    - **Fan #3** for first grate, second compartment:   
      40'000 Nm3/h, max. 60 mbar
    - **Fan #4** for second grate, two compartments, air distribution by flaps:   
      90'000 Nm3/h, max. 20 mbar
  + Grate dimensions:
    - Fixed inlet: **3.1 x 2.6 m** (active area inside horseshoe: **7.44 m2**)
    - First grate: **3.1 x 9.3 m**
    - Second grate**: 3.1 x 11.8 m**
    - Total active cooling area: **72.85 m2**
* High momentum burner for coal (**9 N/MW**)
* Damper controlled kiln ID fan:
  + Speed: **990 rpm**
  + Design flow: **105 m3/s**
  + Design pressure: **60 mbar**
  + Motor power installed: **800 kW**
* Position of analyzers for kiln control
  + At kiln inlet
  + At preheater exit

Production Period Year 1

During the major shutdown in January / February a precalciner and tertiary air duct for a design capacity of 2'500 t/d was installed. After this upgrade the kiln BDP was increased to the project design capacity (2'500 t/d).

However up to now (June) this production rate could not be reached. Further several problems have arisen in the preheater and with the ID fan. Due to these problems and kiln failures (see also kiln downtime Pareto below) the budget clinker production volume (775'000 t/a) will by far not be reached and the market demand cannot be met. At the increased production rate, more frequent failures of the kiln drive occurred when operating above 1.8 rpm hence the upper speed limit of the kiln had to be set to 1.8 rpm.

The kiln ID fan with drive (still the original installation) provokes a lot of operation problems (high vibrations, motor temperature, bearing replacements) and is operated at the limit.

Further the kiln feed to clinker factor from last year (1.70) is still used. However, since the start up with the precalciner, a growing deviation from reported and measured clinker stock volume could be observed.

The main fuel for the kiln is imported coal, alternative fuels are still in trial phase. Recently the plant started also with first petcoke burning tests.

Some important kiln KPI in this year up to now:



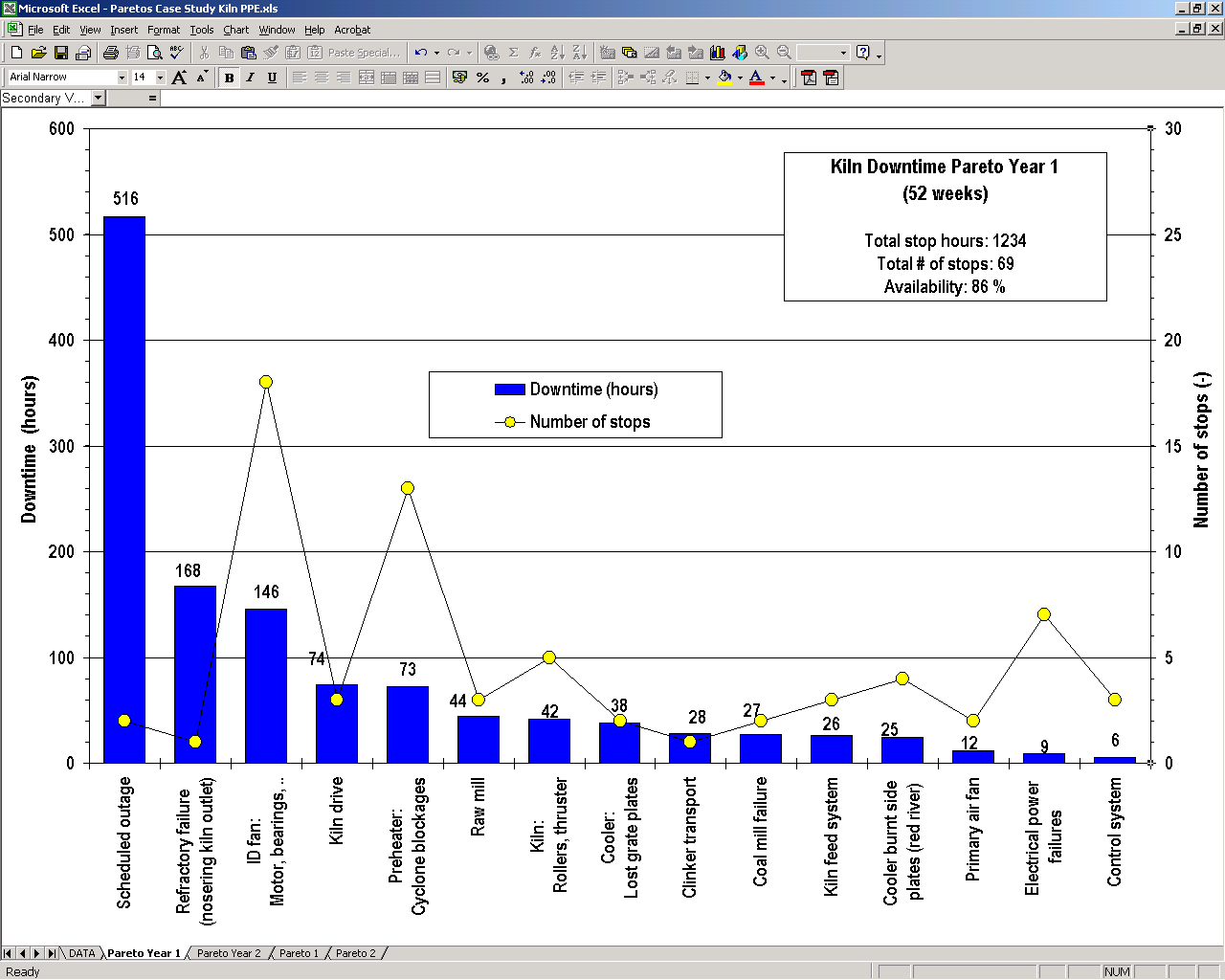
Just recently a heat balance at full production was performed (see diagram below). The production determined with a clinker drop test was 2'350 t/d. The dust loss of the preheater was determined by a filter dust weigh out during raw mill stop (97.9 t of dust during 3 hours). During the heat balance the kiln was operated with coal as the only fuel (no alternative fuels).

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**Lab Analysis Data during Heat Balance**



**Kiln Downtime Pareto Diagram for Year 1  
(Last 52 Weeks)**

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