

# GRINDING TECHNOLOGIES

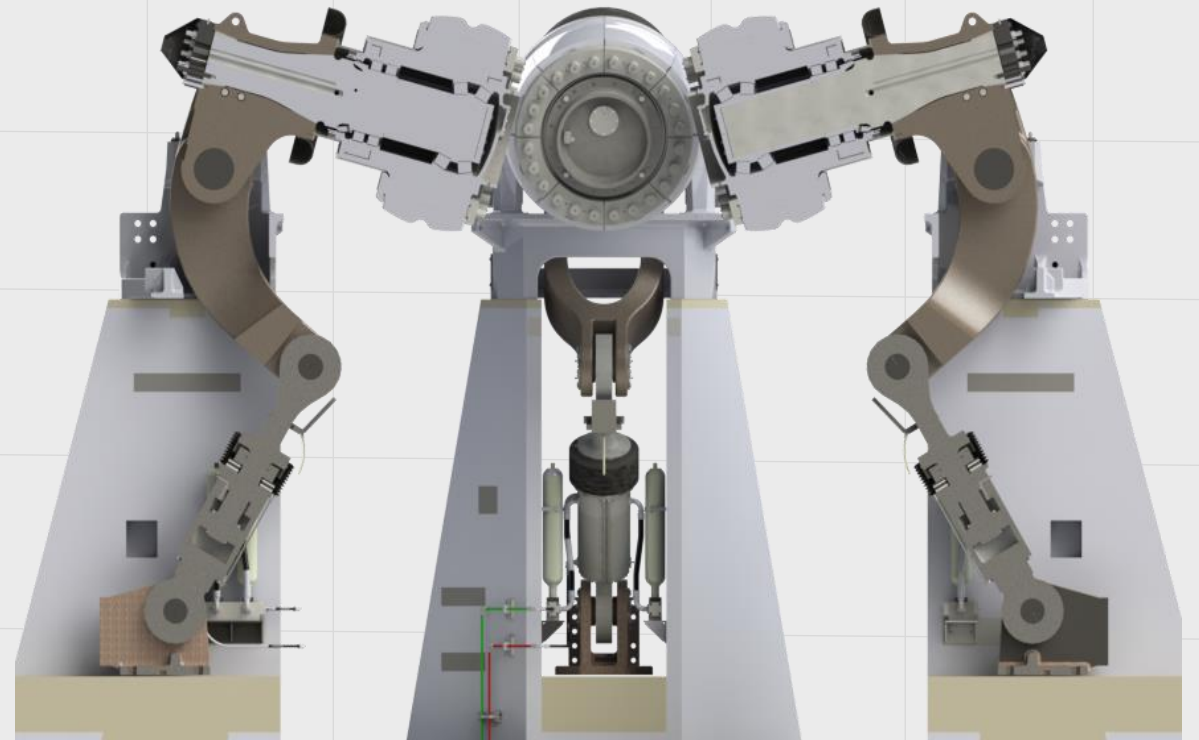
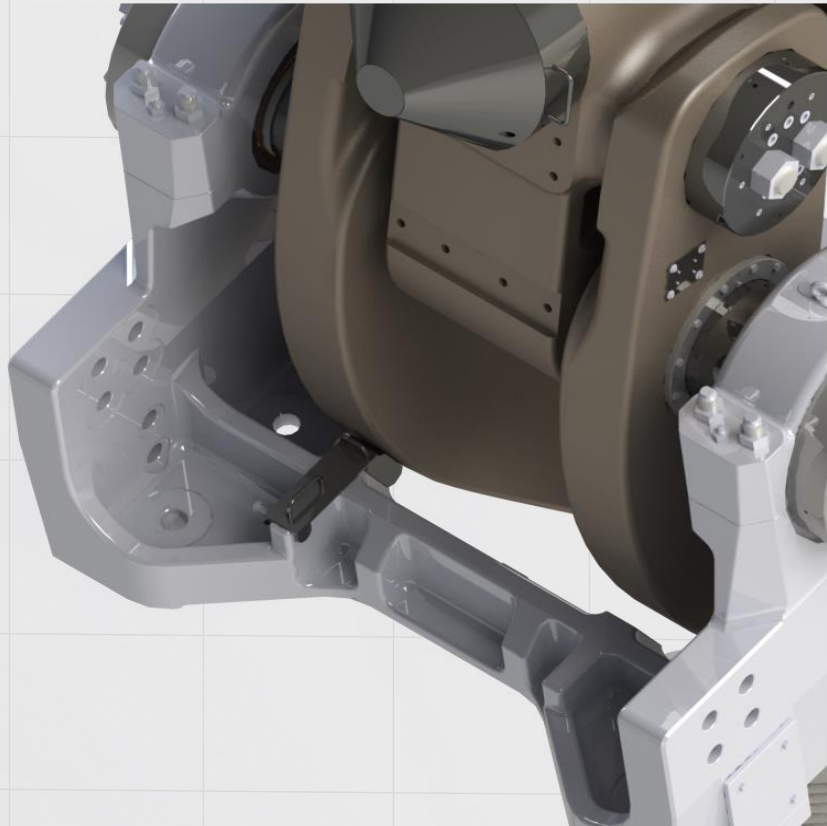
FLSMIDTH  
CEMENT





**SAFETY SHARE**

# HYDRAULIC SAFETY



# AGENDA

Introduction to FLSmidth Cement Grinding Technology

---

Overview of Key Technologies: OK™ mill.

---

Energy Efficiency and Power Consumption

---

FLSmidth Cement Services

---

Case Studies and Practical Applications

---

Q&A Session

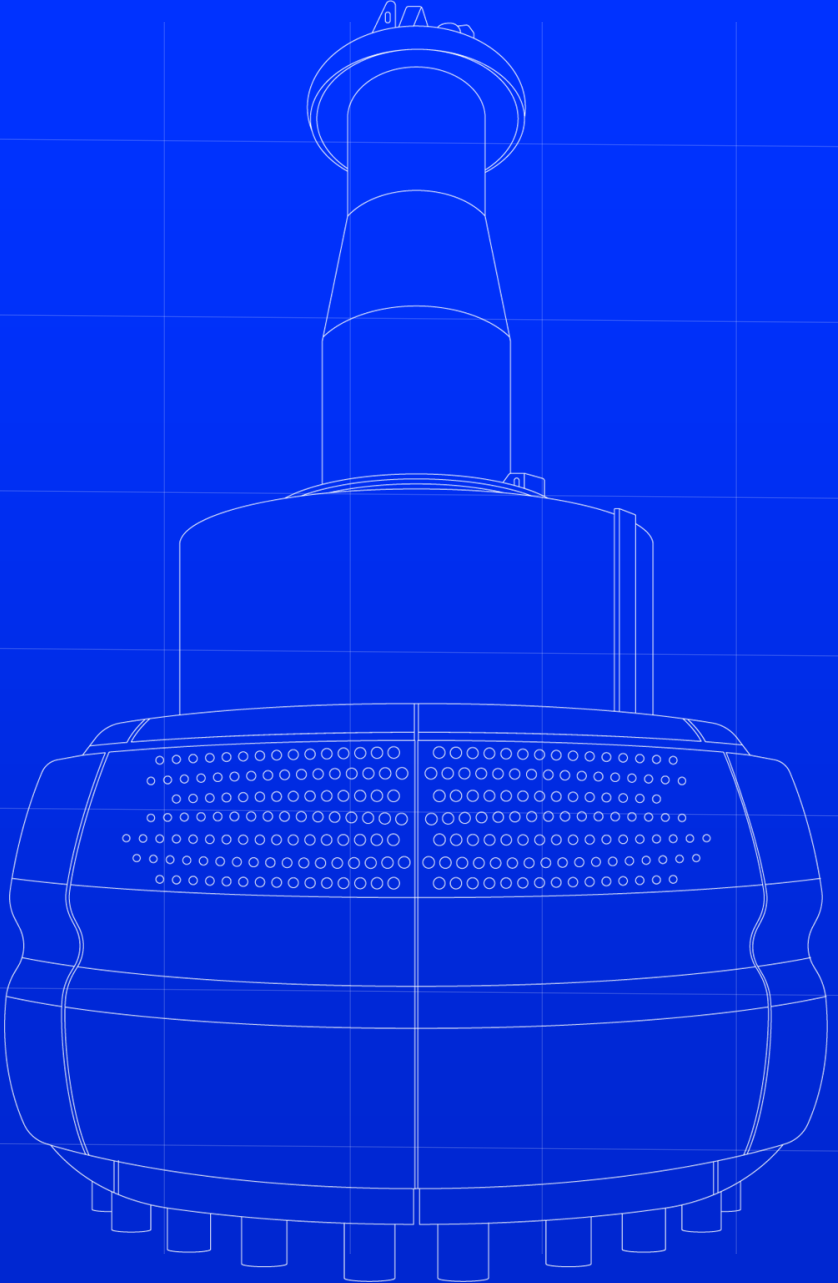
---



POLL QUESTION 1

**DO YOU HAVE AN FLSMIDTH  
MILL AT YOUR PLANT?**

# FLSMIDTH CEMENT GRINDING SOLUTIONS



# FLSMIDTH GRINDING PRODUCTS OVERVIEW

## RAW



HRP Raw



OK Raw Mill



ATOX  
Coal Mill

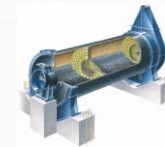
## CEMENT



OK Cement Mill



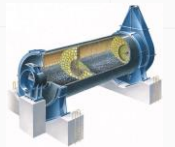
HRP



Ball Mill



HRP  
pre-grinding  
Ball mill grinding



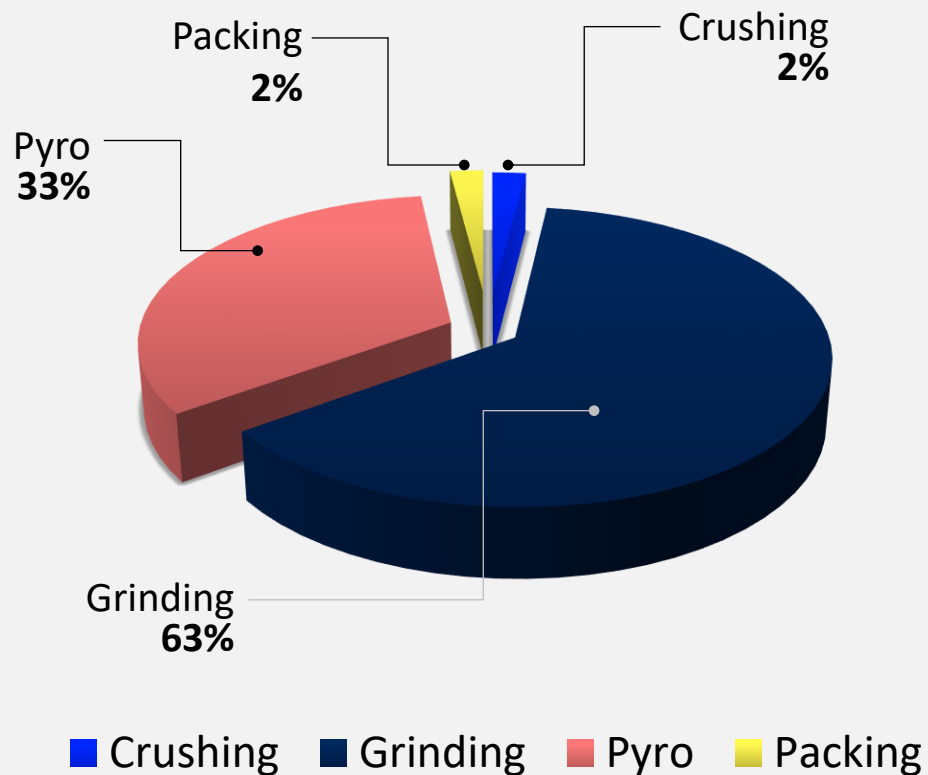
## STAND ALONE

## STAND ALONE

## COMBINED

# IMPORTANCE OF EFFICIENT GRINDING SOLUTIONS

TYPICAL POWER DISTRIBUTION  
IN CEMENT PLANT



Grinding section	Fineness	kWh/t of Clinker
Raw Meal	12-15% on 90 $\mu\text{m}$	10 - 25
Raw Coal	12-15% on 90 $\mu\text{m}$	2 - 4
Cement	3000-6000 $\text{cm}^2/\text{gm}$ 1-8% on 45 $\mu\text{m}$	25 - 60
Total		45 - 90



# OK™ Mill

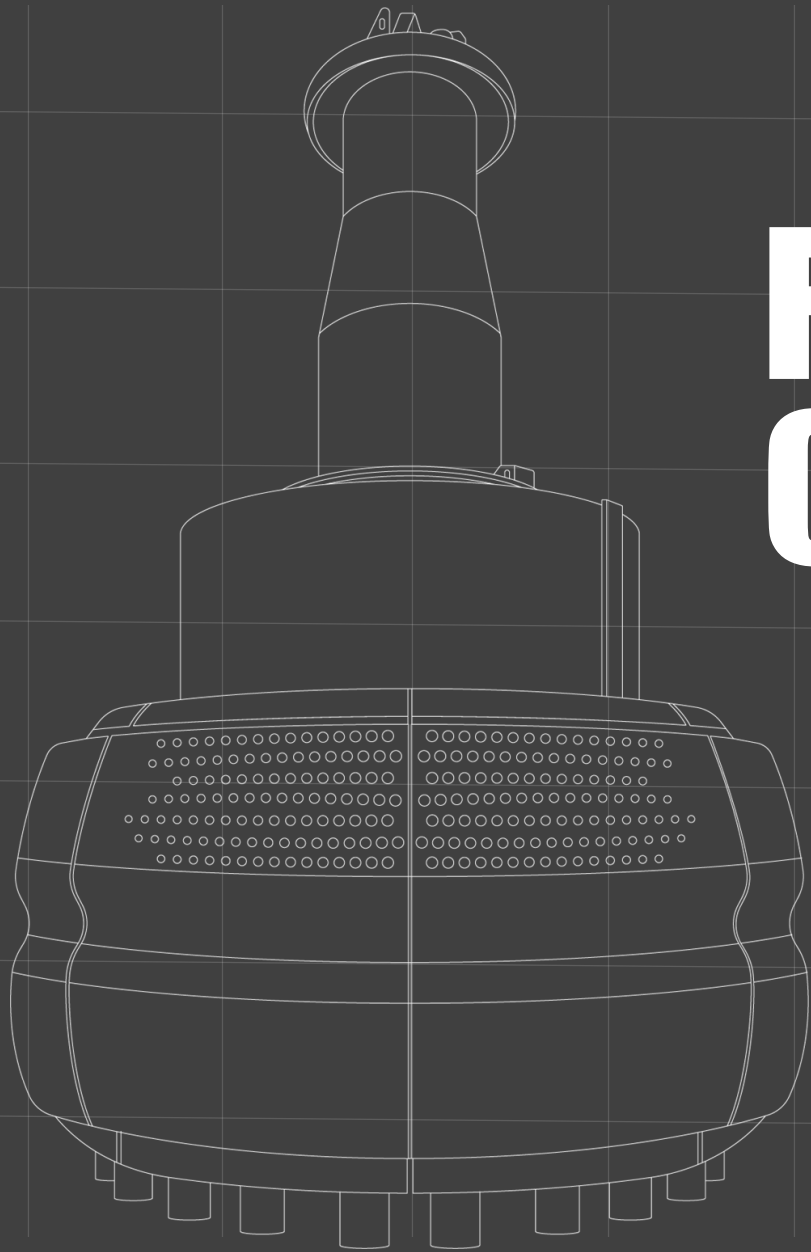




POLL QUESTION 2

**HAVE YOU EVER TRIED TO  
OPERATE YOUR VRM MILL ON  
REDUCED ROLLER NUMBERS?**

# FLEXIBLE OPERATION



OK™ MILL

# FLEXIBILITY



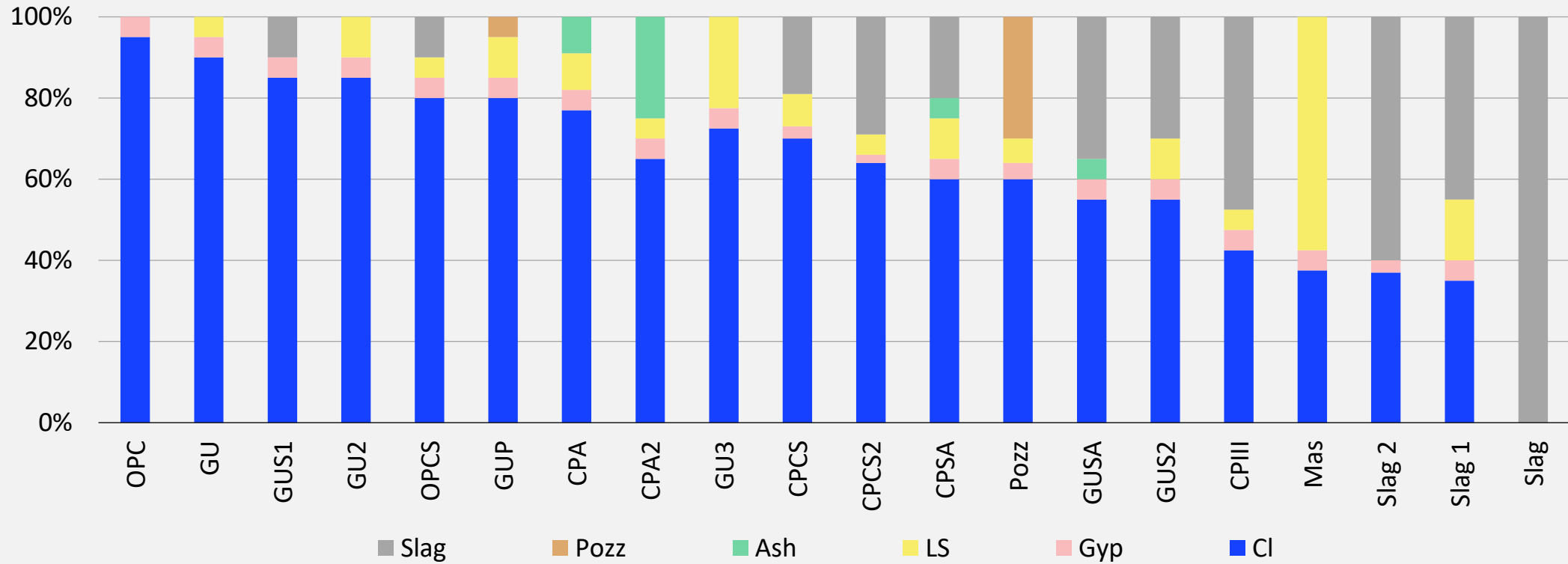
OK™ MILL

# FLEXIBILITY

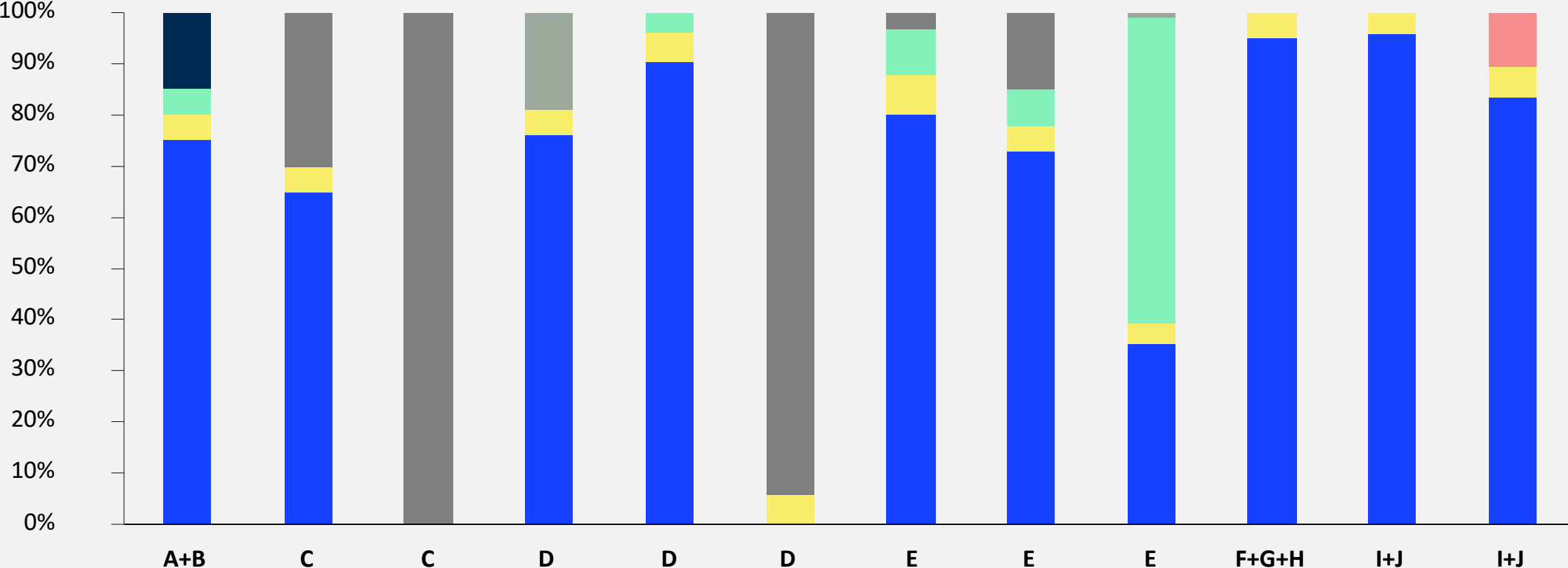
Condition	Production t/h	Blaine cm <sup>2</sup> /g	kWh/t Mill	kWh/t fan	kWh/t sep.	Total kWh/t
2 rollers	92	3600	15.2	13.6	0.7	29.4
4 rollers	144	3800	16.1	8.7	0.6	25.4
Guaranteed	140	-	17.2	-	0.6	-

OK™ MILL

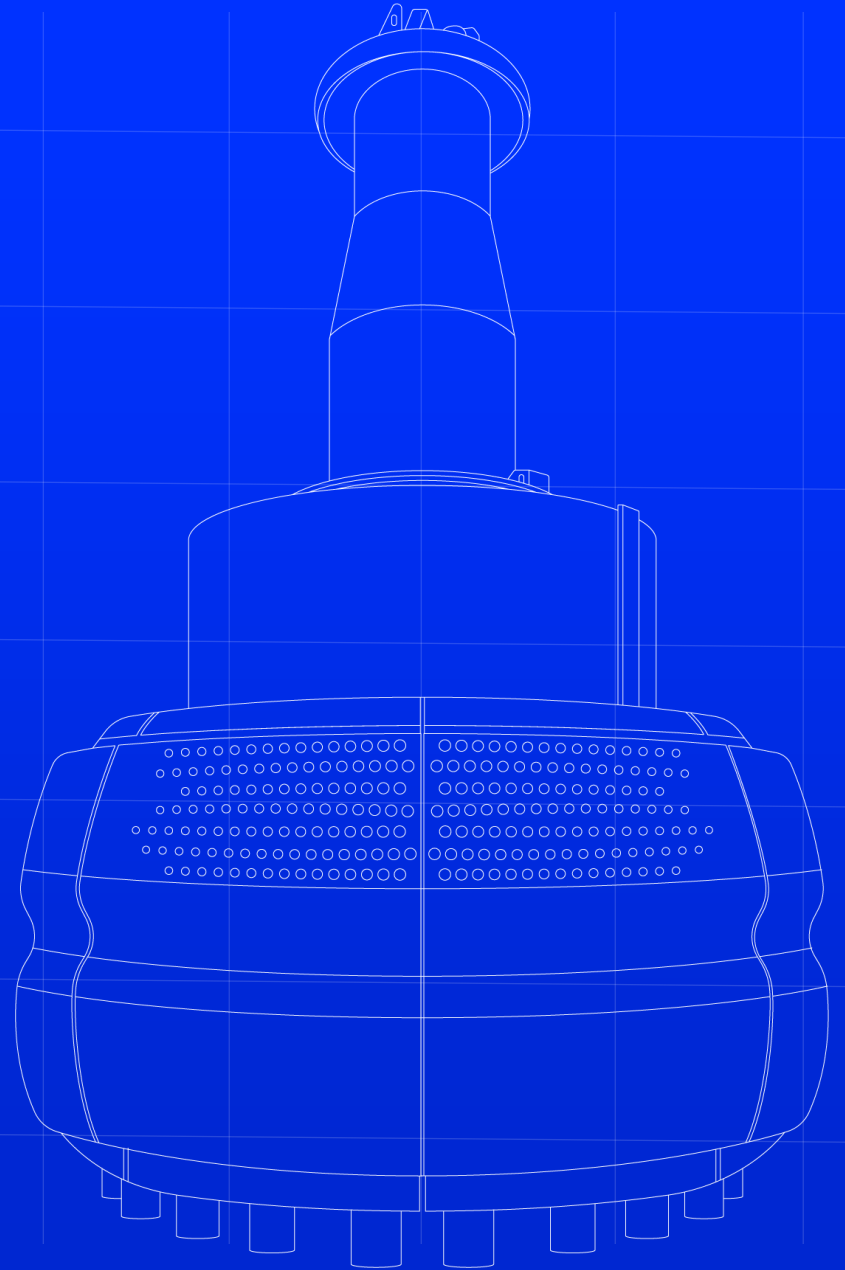
# PRODUCT FLEXIBILITY



# OK™ MILL PRODUCTS



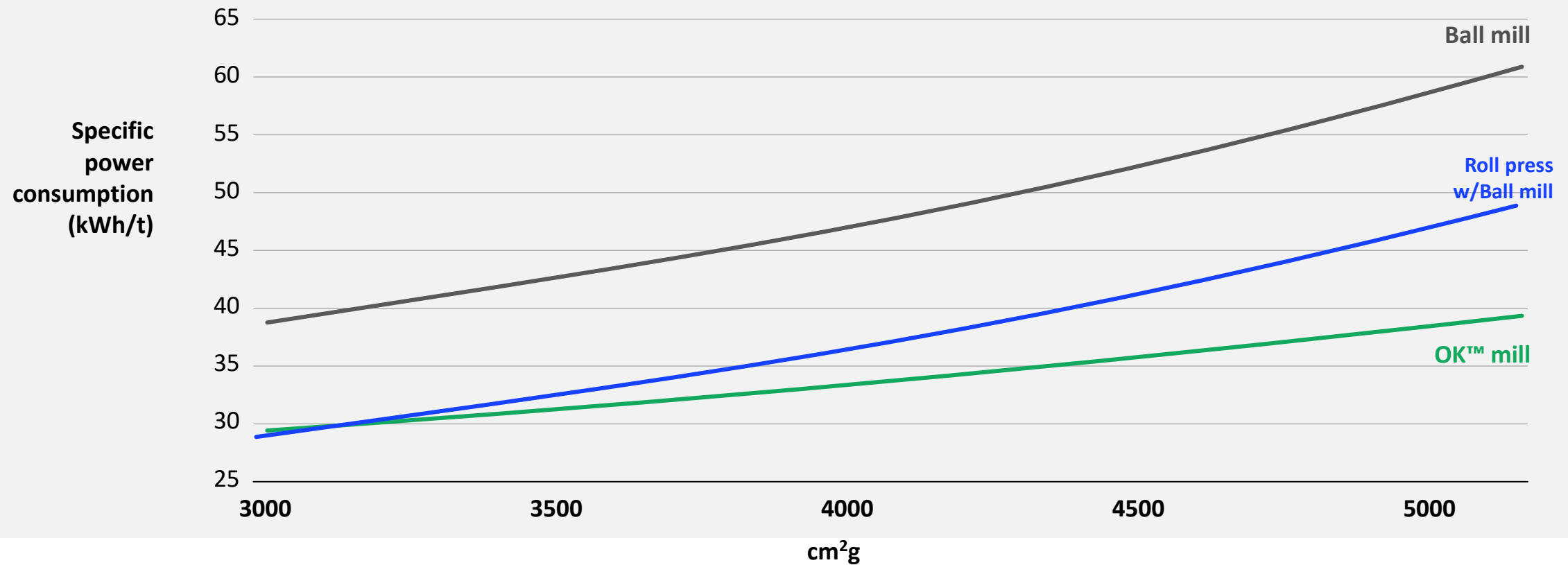
# ENERGY EFFICIENCY and POWER CONSUMPTION





## MILL COMPARISON FOR CEMENT GRINDING

# SPECIFIC POWER CONSUMPTION

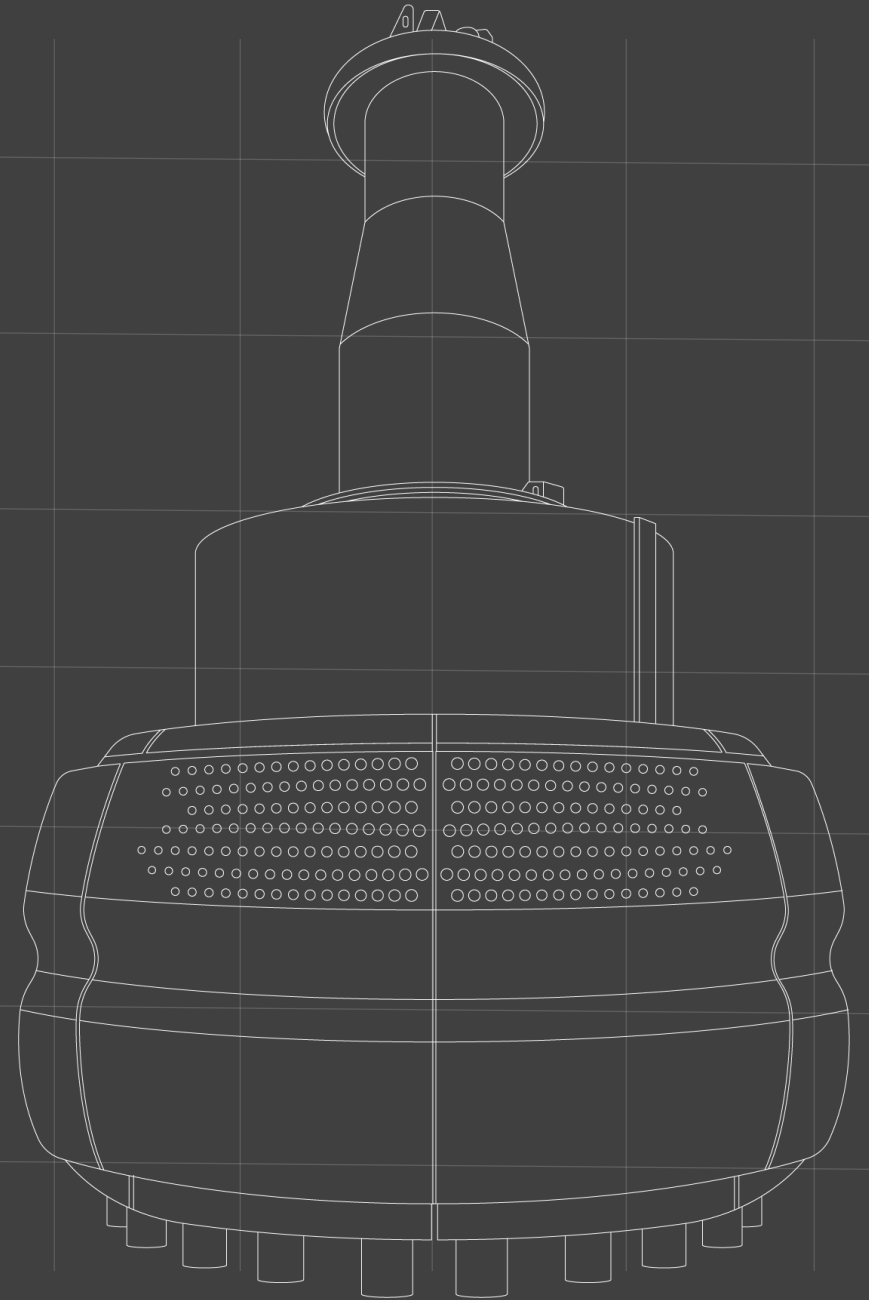


# OK™ MILL VS. BALL MILLS

## ENERGY CONSUMPTION

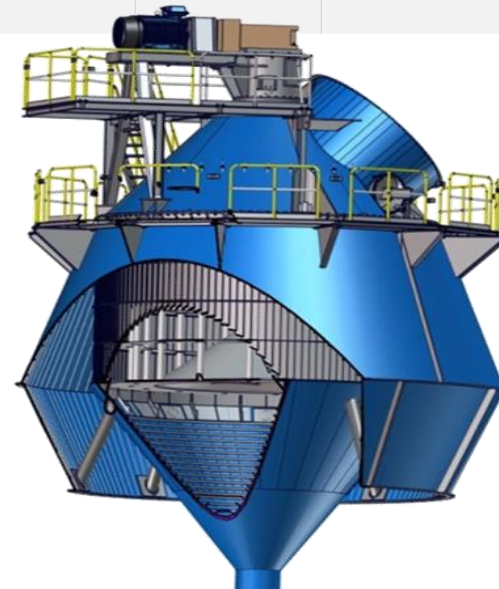
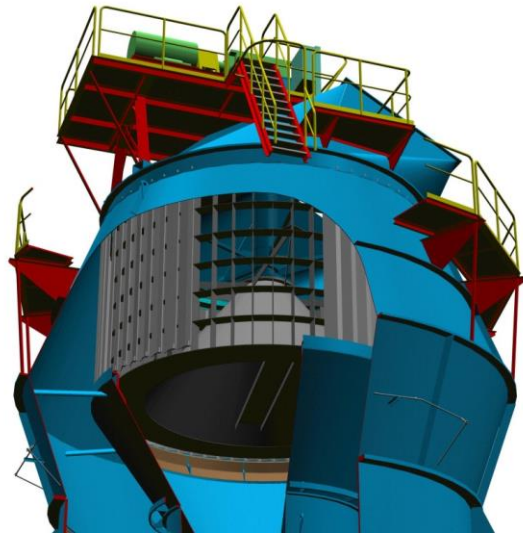
	OK™ mill	Ball mill	RP + Ball mill
Blaine cm <sup>2</sup> /g		3800	
Total kWh/t	29	40.8	37.4
% increase in kWh/t		~ 40%	~ 29%

# SEPARATOR AND POWER SAVING



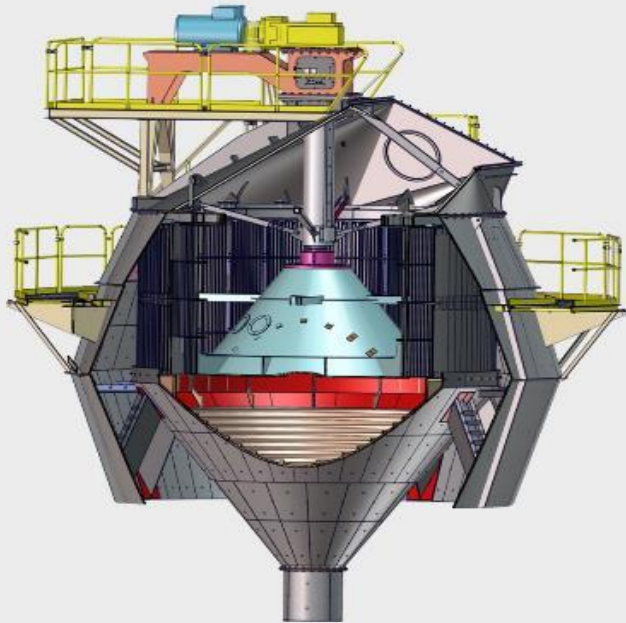
# ROKSH AND RARM SEPARATOR

RARM



ROKSH

# ROKSH SEPARATOR FOR OK CEMENT MILLS



- Physical dimensions optimized to enhance velocity profile
- lower air velocity
- Less wear
- Lower differential pressure
- Lower separator power

**THE ROKSH SEPARATOR** FOR CEMENT GRINDING IN VERTICAL ROLLER MILL

# **ROKSH® RARM® SEPARATOR UPGRADE**



Reduced Power Consumption  
1-1.5 kWh/ton



Increase in Cement production  
~5-10%



325 Mesh Increase from  
98% to > 99%



Increase in Operational  
Stability & availability

# EASE OF INSTALLATION FROM OLD SEPARATOR TO ROKSH

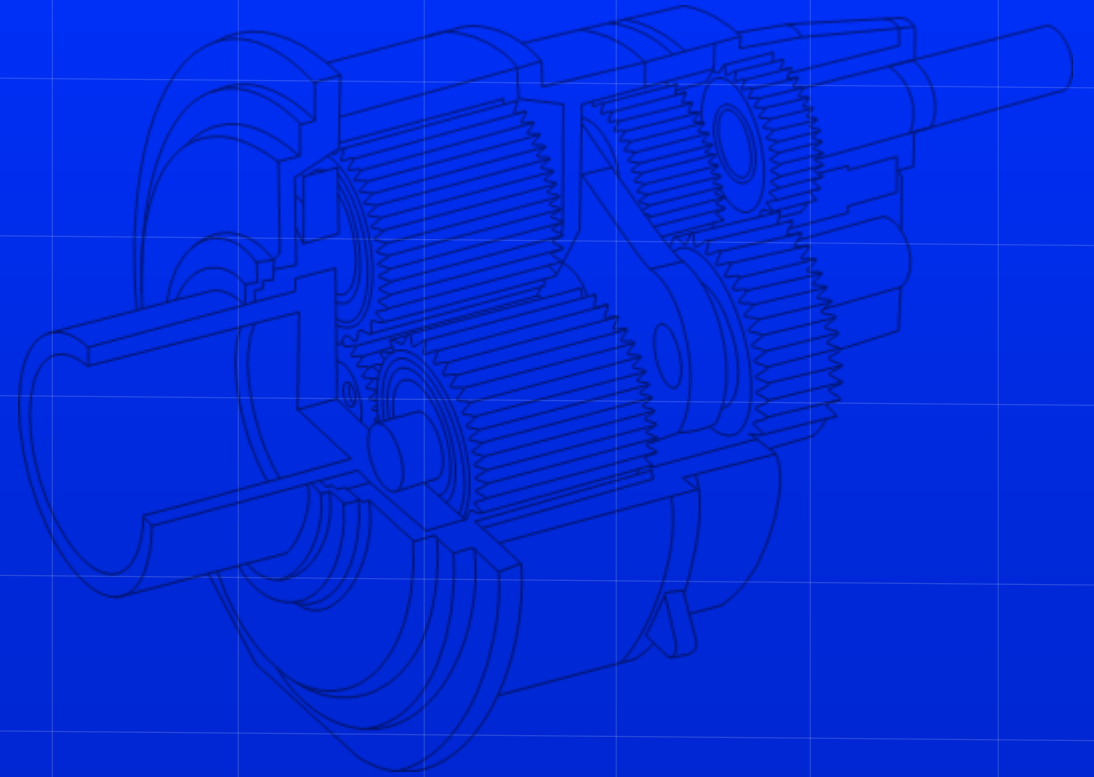


BEFORE



AFTER

# FLSmidth Cement Services





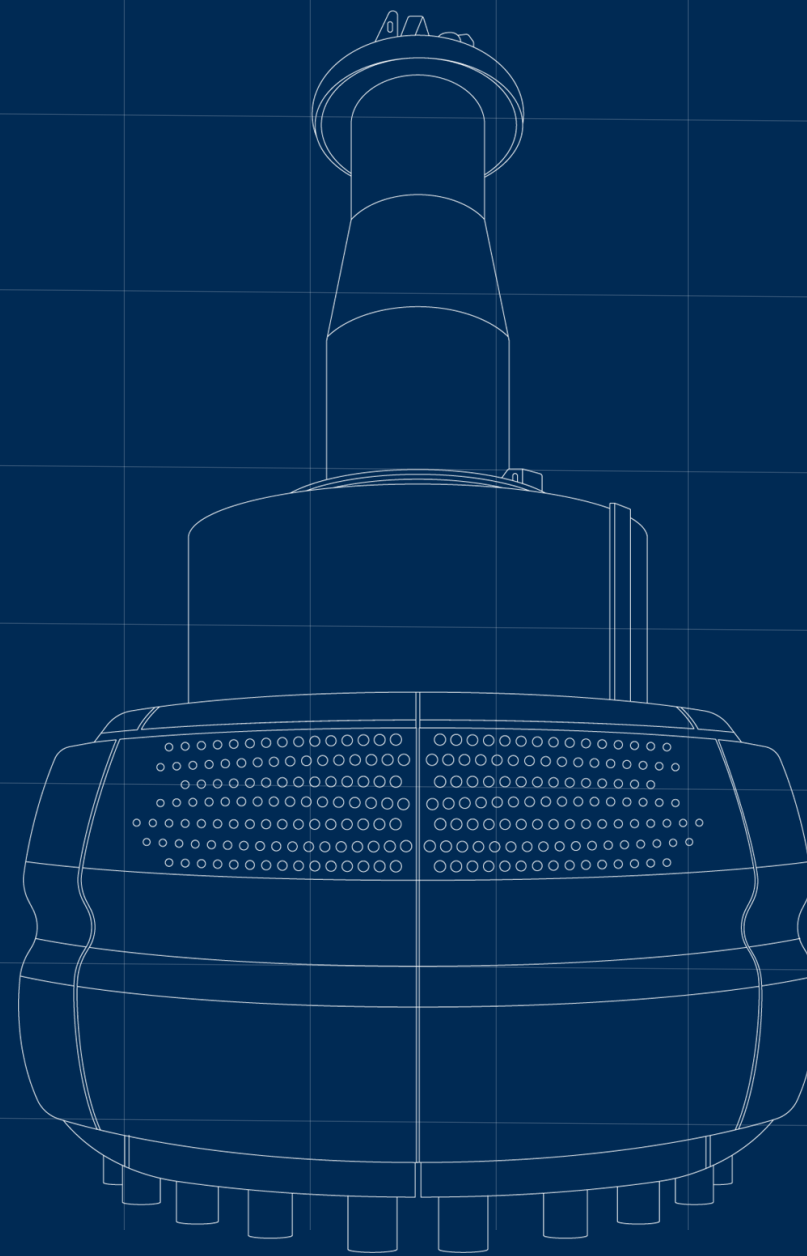
The background of the slide features several faint, light-gray technical drawings of industrial machinery. On the left, there is a large circular component with concentric rings and small square holes. In the center, a complex assembly of pipes and structural frames is visible. On the right, a vertical cylindrical component with various fittings and a flange is shown. The overall theme is industrial engineering and mechanical systems.

Poll Question 3

# What do you believe is more valuable to you??

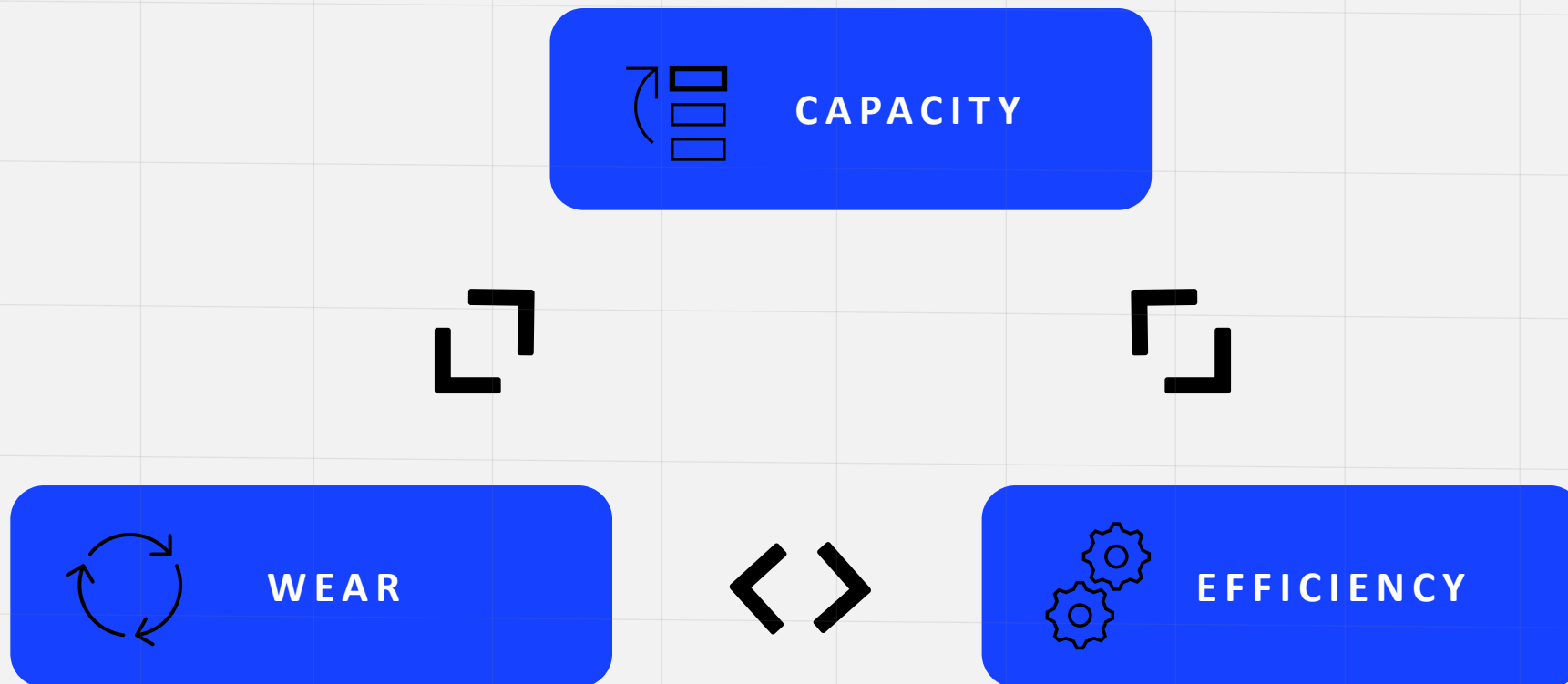
- **One time per year on-site mechanical service**
- **One time per year a comprehensive process audit**
- **Having an Online Conditioning monitoring service agreement**

# Grinding System AUDIT



WHEN & WHY

# CHOOSE ANY 2



# IMPROVE YOUR RESULTS WITH OUR AUDITS

PRODUCE  
MORE



PRODUCE  
CHEAPER



PRODUCE  
WITH LESS  
RESOURCES

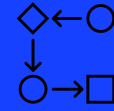


# VERTICAL ROLLER MILL AUDIT



## WHEN & WHY

- Mill Performance reduced
- Increasing capacity studies
- Baselines
- Upgrades



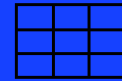
## PROCESS (MILL ON)

- Grinding Hydraulics
- Airflow
- False Air
- Pressure & Temperatures



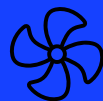
## INTERNAL INSPECTION (MILL OFF)

- Dam Ring
- Nozzle Ring
- Accumulators
- Water Injectors
- Wear Segments
- Wear on Mill-insides
- Crash Stop



## DATA COLLECTION & KPI'S

- Local Control Panel Settings
- Torque Factor
- Specific Grinding Pressure
- Calculation Tools
- Heat and Mass balance



## MILL FAN

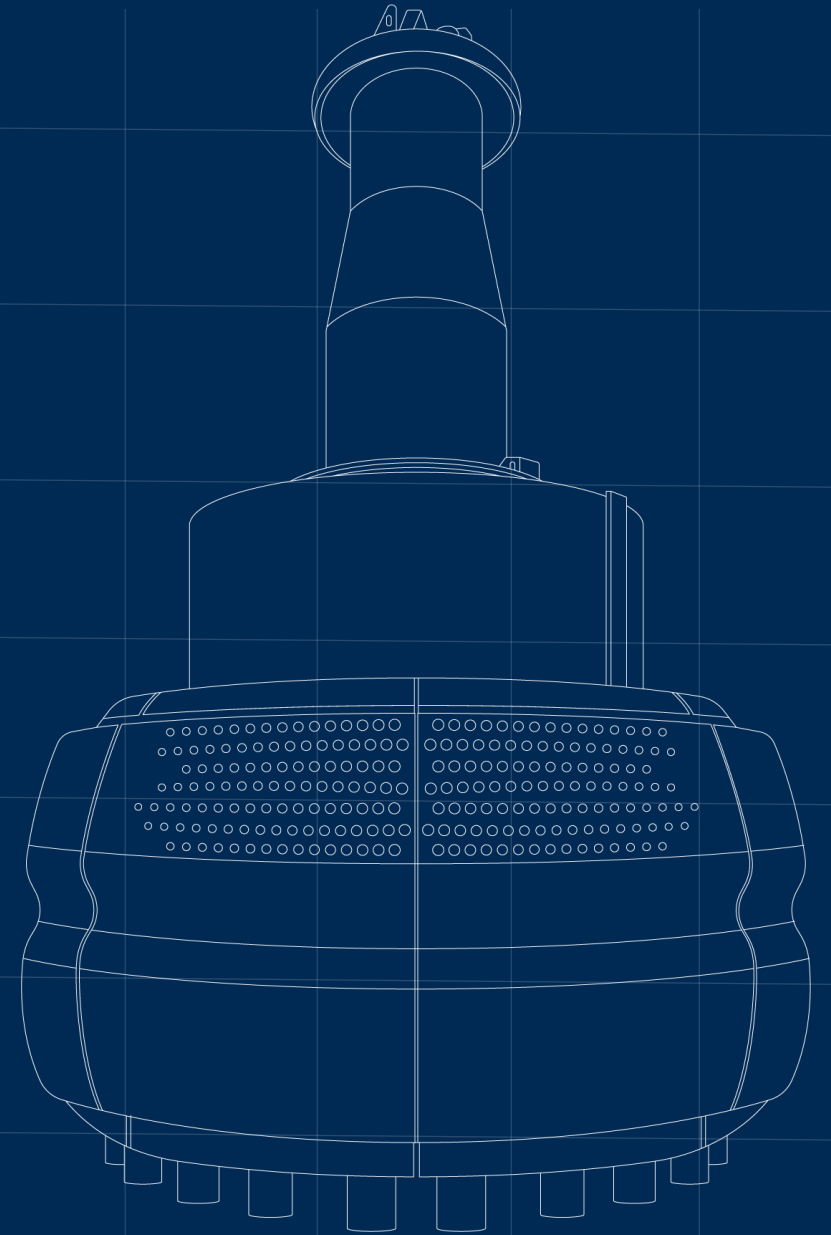
- Housing
- Rotor
- Inlet One Gap
- Efficiency



## REPORTING

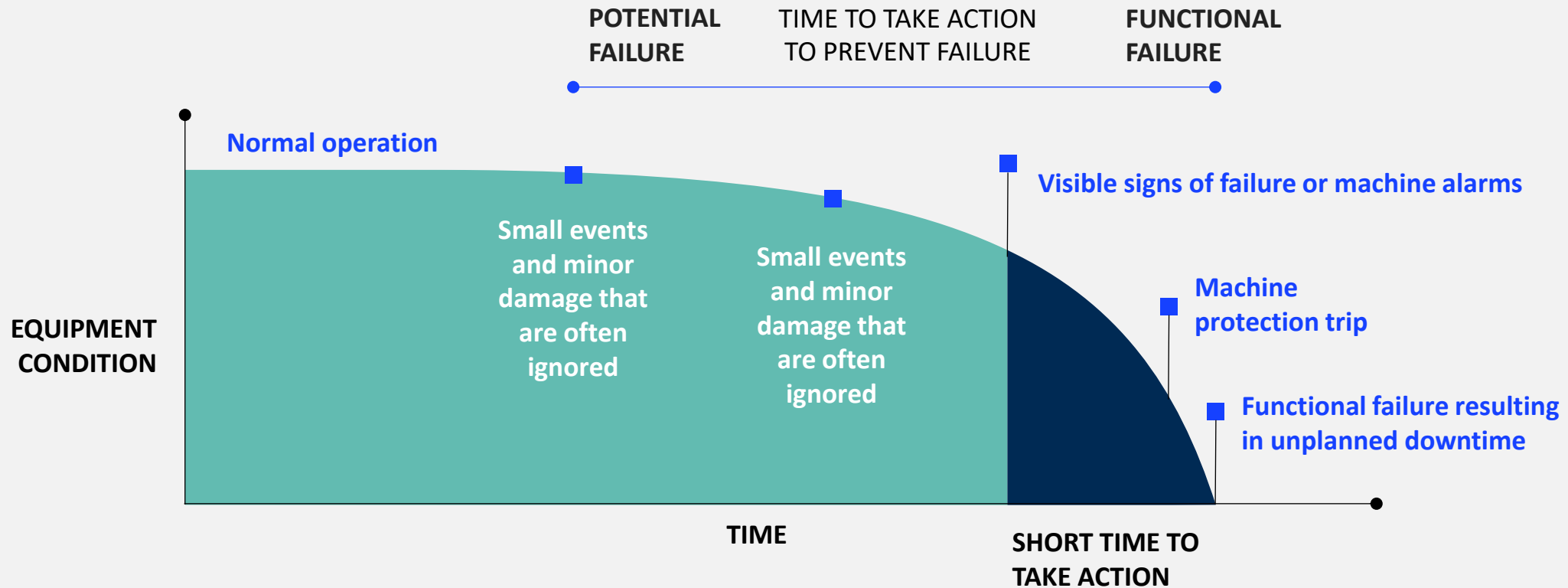
- Audit Report
- Datasheets
- Process proposal

# ONLINE CONDITION MONITORING SERVICES



ENABLING YOU TO ACT BEFORE IT'S TOO LATE

# DETECT POTENTIAL FAILURES TO AVOID ACTUAL FAILURES



# INSTRUMENTATION AND SENSORS

## FEED AND FEED CHUTE

### Feed

- Particle Size Distribution
- Moisture & Chemistry
- Material flow rate

## SEPARATOR

- Speed & Power
- Product PSD

## MILL

- Vibration
- Hydraulic Pressure

## ROLLERS

- Bearing temperature
- Shaft speed
- Accurate Roller position indication
- Stop Impact and Force

## OUTLET DUCT

- Product PSD
- Airflow
- Temperature & Pressure

## NOZZLE RING

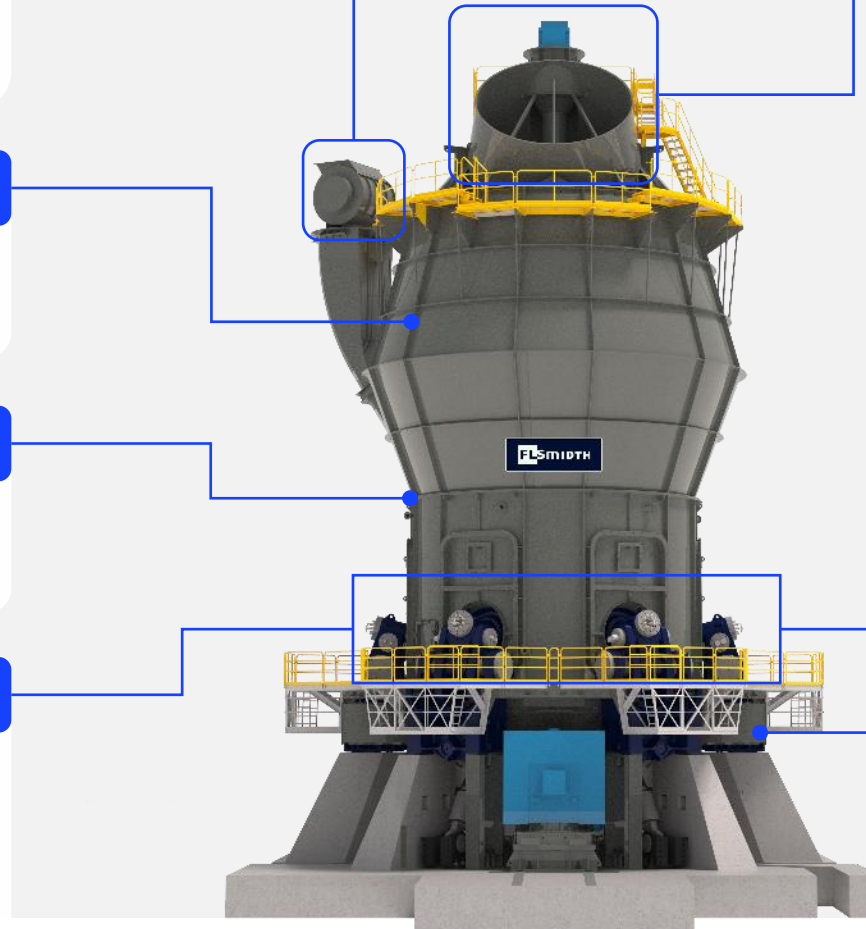
- Material reject rate
- Airflow & velocity

## INLET DUCT

- Airflow
- Temperature & Pressure

## TABLE LINERS & ROLLERS SEGMENT

- **WEAR** thickness measurement scanner





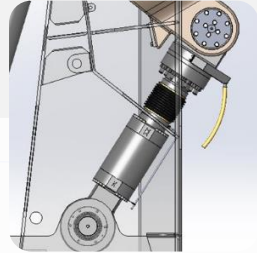
## ONLINE CONDITION MONITORING SERVICES

# FOCUSED ANALYTICS



### MILL AIR CIRCUIT & FAN

- Indicators of increase in circuit false air



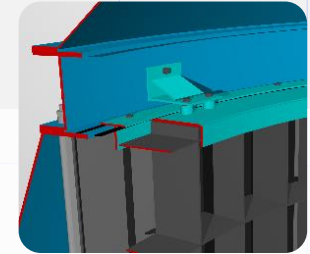
### GRINDING HYDRAULIC SYSTEM

- Frequency of pump activation
- Holding pressure settings
- Indicators of leaks and mis-operation



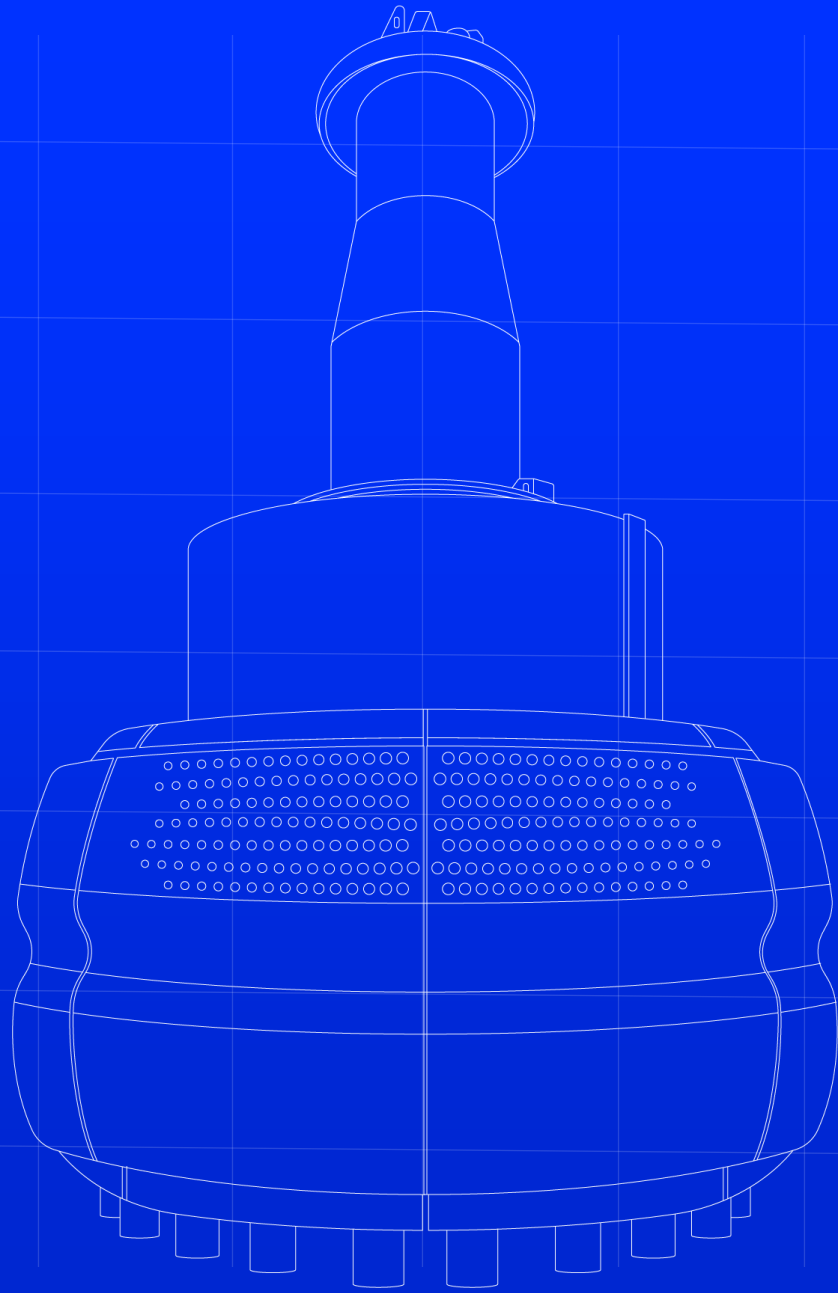
### MILL GEAR UNIT

- Input Torque in VRM gear.
- Table wobbling and tilting in VRM gear
- High resolution gear and bearing vibration.



### SEPARATOR RELIABILITY

- Monitoring of Separator behavior, to indicate replacement time.



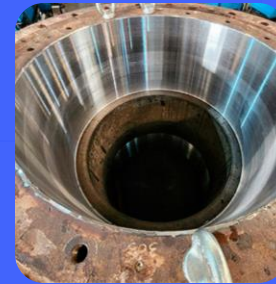
# ROLLER REBUILD SERVICE

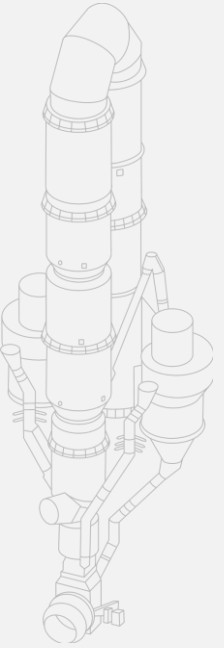
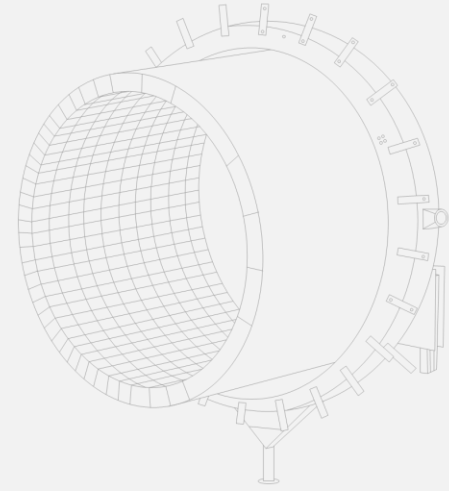
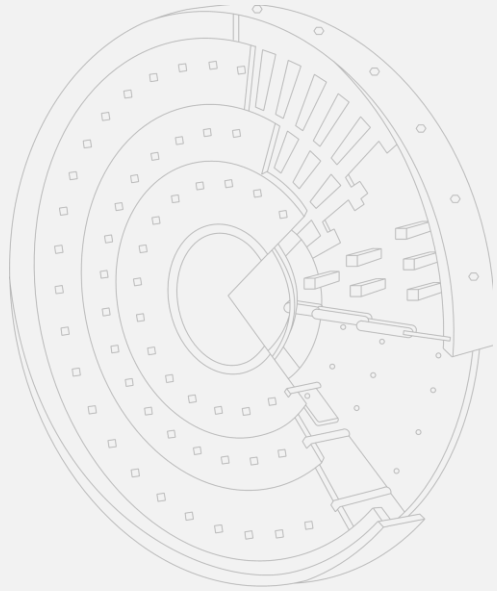
# RESTORE YOUR ROLLERS TO THE ORIGINAL DESIGN CONDITION



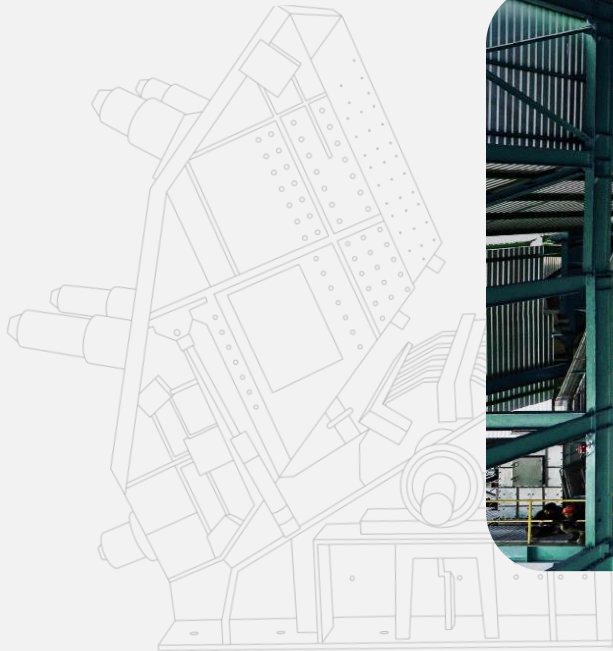
# HOW IT WORKS

- Roller rebuilds can return your rollers to design condition, for both ATOX® and OK™ Mills
- A comprehensive inspection is done to the roller Identifies what needed to bring it back to OEM conditions
- Our workshops carry out the necessary work to rebuild the roller

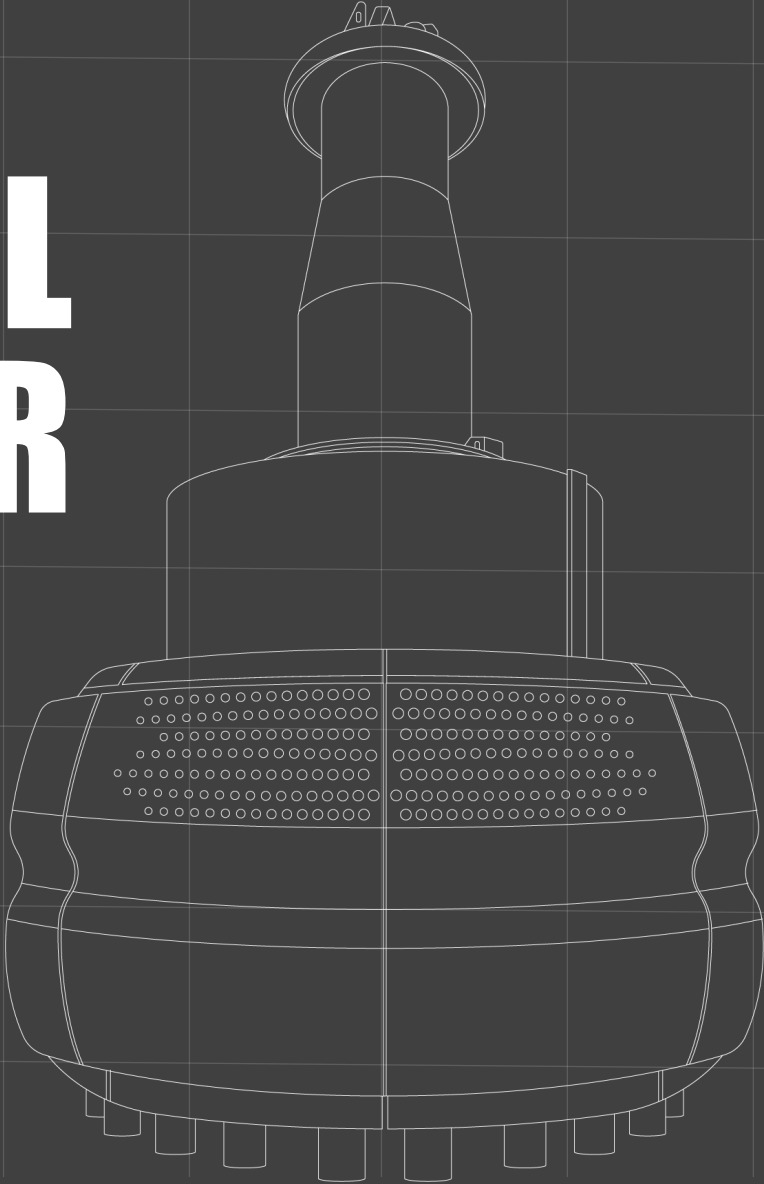




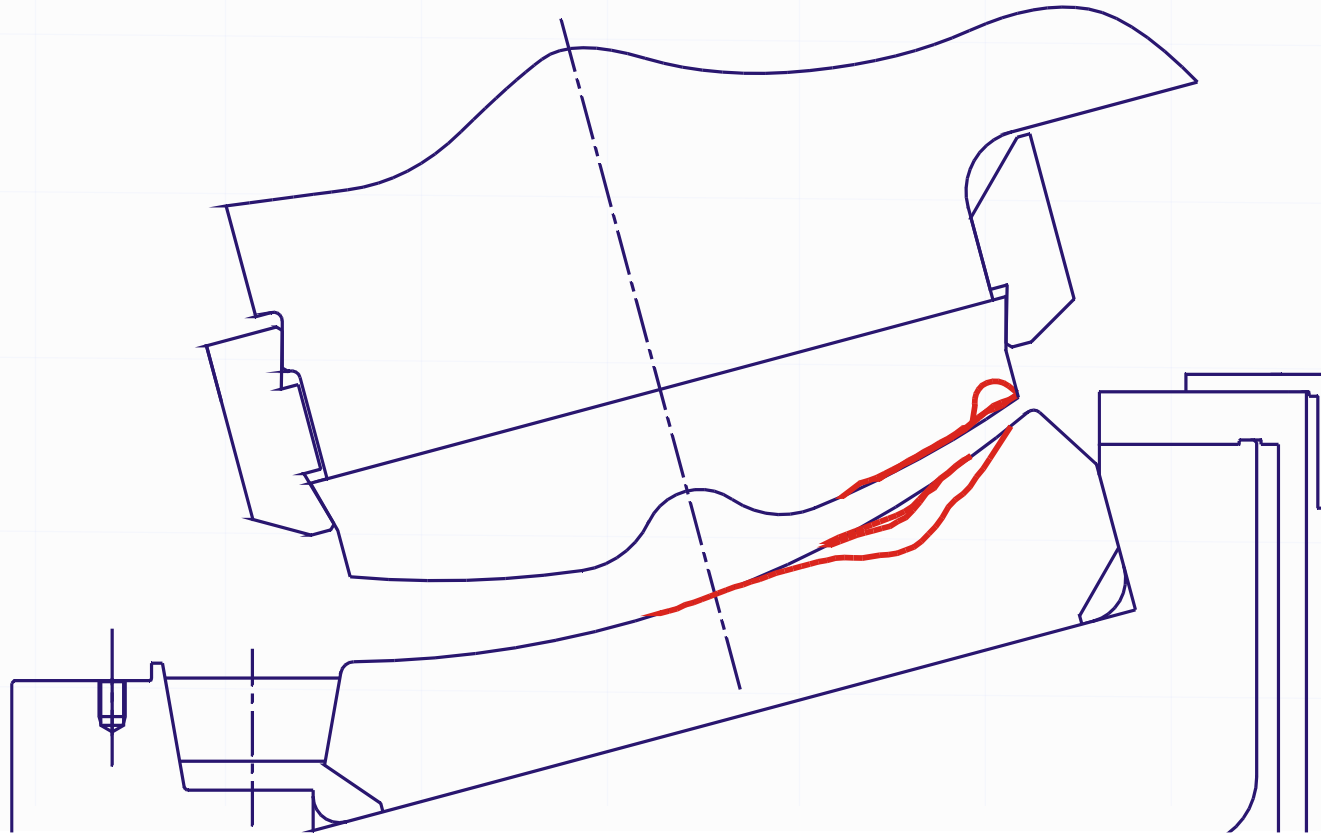
# REAL CASES



# MILL WEAR



# NORMAL WEAR PROFILE FOR OK MILLS



# NORMAL WEAR





# VERTICAL MILL WEAR



# WEAR/DAMAGE FROM UN-OPTIMIZED OPERATION



# WEAR/DAMAGE FROM UN-OPTIMIZED OPERATION

*« ..total wear rate decreased from 20.4 g/t to 11.8g/t (decreased about 58%) »*

## 1 Executive Summary

- This report shows the effect of changing Mill operating parameters (grinding pressure & layer thickness) which done by FLS specialist during his visit 13-15 October 2014 on the wear rate of both rollers & table wear segments.
- According to wear rate measurements it was observed that from 13-August-2014 to 30-September-2014 the mill produced 35,929 ton with total wear rate 20.4 g/t, and from 30-September-2014 to 11-November-2014 the mill produced 38,412 ton with total wear rate 11.8 g/t.
- After decreasing of grinding pressure & increasing of layer thickness the total wear rate decreased from 20.4 g/t to 11.8 g/t (decreased about 58%).
- After adjusting of mill parameters the phenomena of broken edges for both rollers & table wear segments was disappeared

# THE MAJOR CHALLENGE WITH SEPARATORS IN OPERATION IS WEAR! **OPERATION CHALLENGES OF SEPARATORS**



WEAR ON  
GUIDE VANES



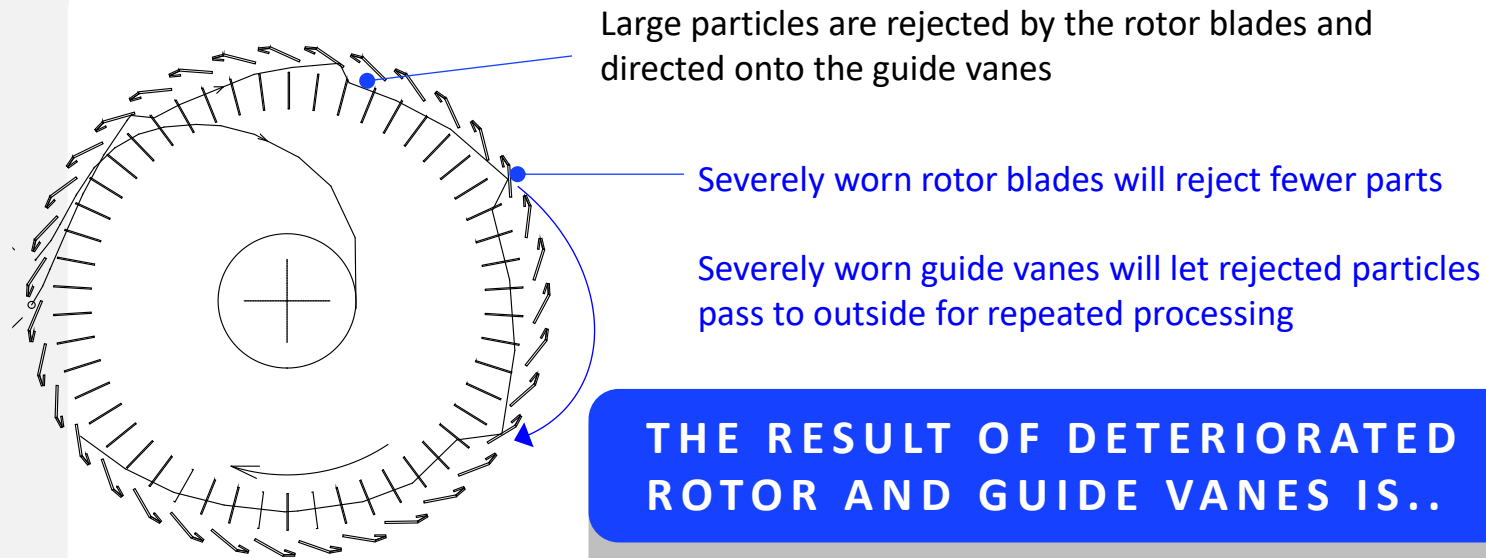
WEAR ON  
ROTOR



WEAR IN ROTOR SEAL

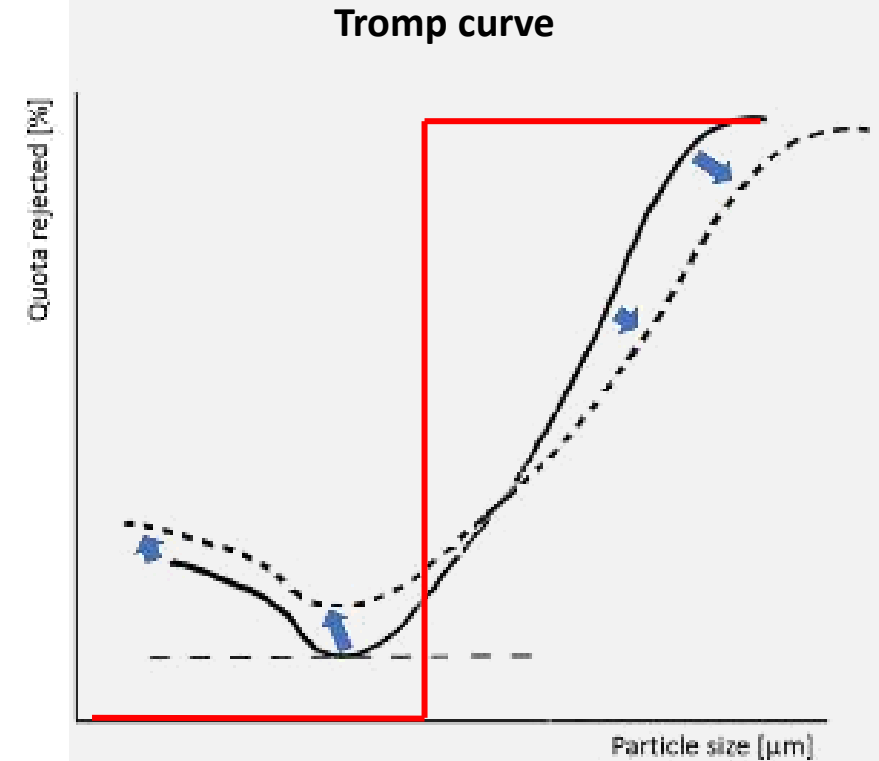


# OPERATION CHALLENGES OF SEPARATORS



## A less efficiently working separator

- Decreased sharpness of separation  
Flatter product curve
- More bypass of fine material to mill  
Instability and vibrations of mill





POLL QUESTION 4

**HAVE YOU EVER FACED  
LUMPS OR OTHER ISSUES  
IN YOUR CEMENT SILO?**

# ALREADY LUMPS AND BUILD-UPS IN SILO?

If these pictures are already a reality, there is nothing that can be done operationally to remove it.

By following the guidelines, further development of lumps and build-ups can of course be prevented.



# VRM OPERATION STRATEGIES



## MILL OUTLET TEMP. ~75DEG.C.

- Low dehydration level
  - Compromise the positive effect of high dehydration level
- Minimum operation of HGG
- Challenge to obtain a low outlet temperature with hot clinker (increasing water injection)

## STORAGE IN SILO @ LOW TEMPERATURE

Below 70deg.C., no further gypsum dehydration in silo

## MILL OUTLET TEMP. ~120DEG.C.

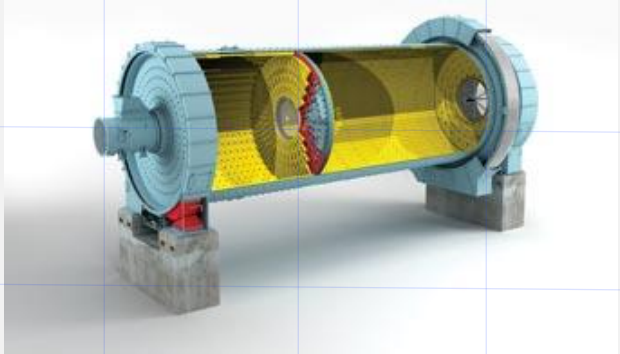
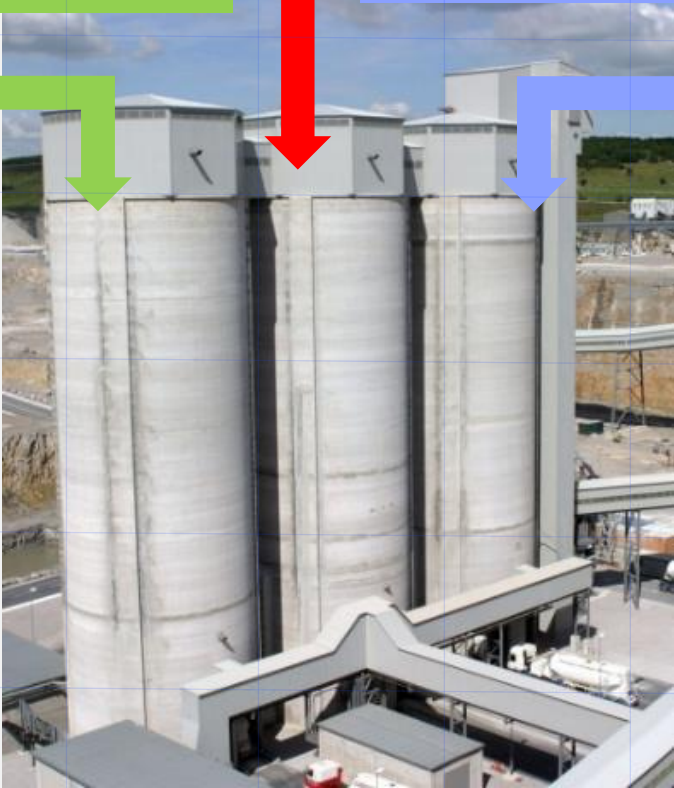
- High dehydration level
  - Positive influence on strength development
  - Positive effect on gypsum activity

## STORAGE IN SILO @ HIGH TEMPERATURE

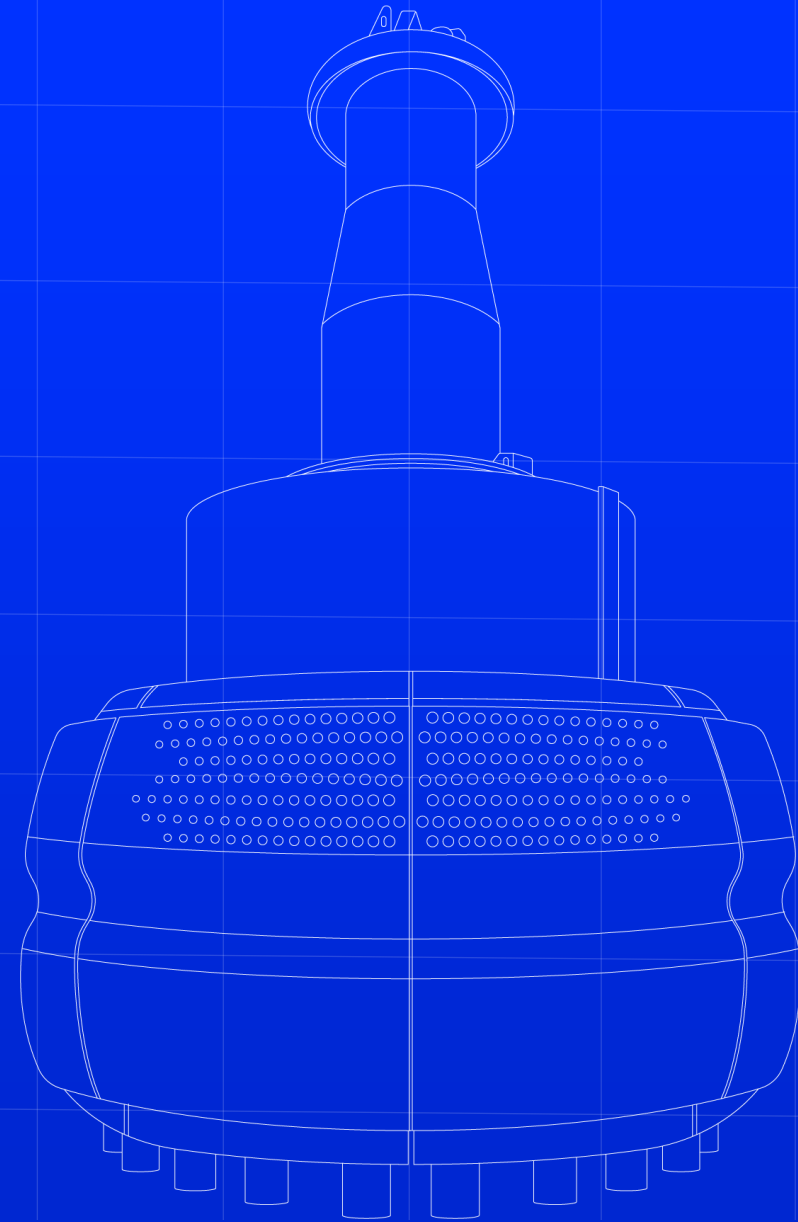
If gypsum is not dehydrated in the mill, it will continue to dehydrate in the silo (= potential for silo build-ups)



# SUMMARY



# HOW OCMS SAVED A VRM FROM FAILURE?



## CUSTOMER STORY

# HYDRAULIC SYSTEM

### OBSERVATION

Hydraulic leak suspected due to “irregular hydraulic pump cycle length”

### ROOT CAUSE ANALYSIS

Internal leakage from cylinder

### RECOMMENDATION

- Following up pump start-stop intervals.
- Air vent for hydraulic circuit.
- Spare seal kit to be available.

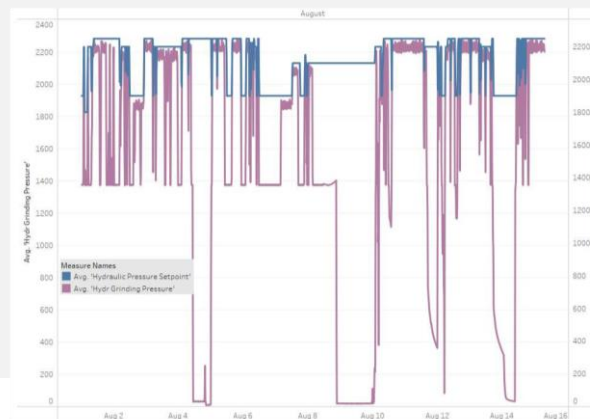
### SAVINGS OF \$45 K, AVOID NEW

- Pump
- Cylinder rod
- Seal kit

« Glad that the CMS team detected the failure in the hydraulic seal and replaced from cylinder#2 as it was damaged ,and CMS allowed the plant team to order the spares on-time without impact on Mill operation »

PLANT MANAGER

Cement customer in Poland



## CUSTOMER STORY

# SEPARATOR

### EVENT

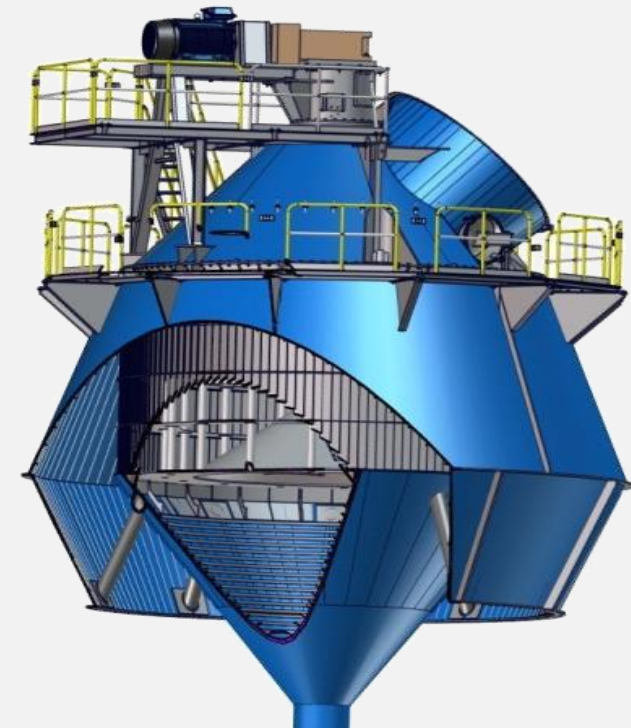
- Separator bottom & middle bearings high temperature – High Mill outlet temp
- Repeated High alarm of mill outlet gases temperature during mill operation tends to 125°C.

### RECOMMENDATION

- Check the automatic grease cycle/consumption function and the amount of grease in the tank.
- Control the mill outlet gases

### VALUE

- Up to 500K\$ to replace separator bearings and possible shaft repair.
- Time to prepare the needed spares in advance.



## CUSTOMER STORY

# OPTIMIZATION



### EVENT

- The mill runs with low-low grinding rollers bed layer thickness for most of the mill operation, which is directly correlated with insufficient water injection flow rate.

### RECOMMENDATION

- To increase the bed layer thickness, gradually increase the water spray flow rate up to 2 % of the mill fresh feed rate.
- To stabilize mill  $\Delta P$  and bed thickness layers adapt the following operating parameters:
  - Mill feed rate
  - Water flow
  - Grinding pressure
  - Mill fan draft
  - Separator speed

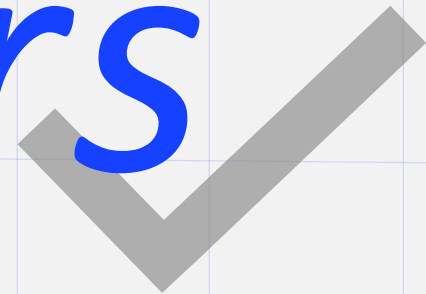
### VALUE

- Increase mill productivity by 50 tph.
- Avoid mill vibration.

**QUESTIONS?**

&

*Answers*



---

Ahmed Seaf

Ahmed.seaf@flsmidth.com

1110 American Parkway, Allentown, PA 18109 • USA •  
www.flsmidth-cement.com

---

FLSMIDTH-CEMENT.COM



# FLSMIDTH CEMENT