

Fives Pillard, leading engineers & suppliers of combustion solutions



fivespillard



Energy



Minerals



Analyzers & Instruments



After Sales Services

- Novaflam® burner
- Return of experience
- Design criteria

Novaflam® burner

The NOVAFLAM® burner



From the ROTAFLAM®... to the NOVAFLAM® burner...



→ Main features :

→ (single air supply)

→ burner tips engineered according to process data

NEW PATENTS

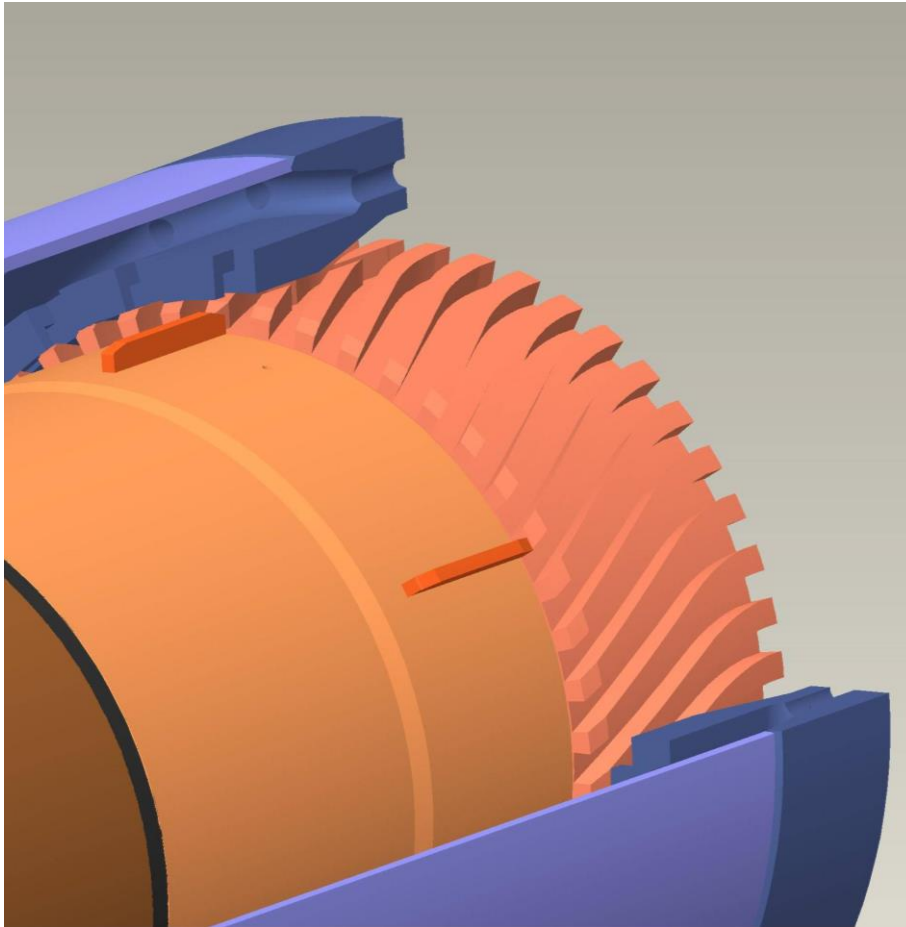
EP 06.778673.1 of June 26, 2006
EP 07.290663.9 of May 23, 2007
FR0852836 of April 28, 2008
FR2009/050593 of April 07, 2009





- A MONOCHANNEL BURNER : *Axial and Radial air are supplied by a same burner channel*
- MORE EFFICIENT IN TERM OF IMPULSE AND SWIRL : *Limited loss of pressure in the burner*
- EASY TO UNDERSTAND, TO USE, TO ADJUST : *2 parameters to be adjusted*





AXIAL AIR INJECTED IN THE FLAME BY HOLES

- ⇒ **CONSTANT CROSS SECTION**
- ⇒ **ADJUSTEMENT BY PRESSURE CONTROL**

ADJUSTABLE RADIAL AIR ANGLE

- ⇒ **NO NEED TO CHANGE RADIAL AIR QUANTITY FOR FLAME SHAPING**
- ⇒ **VERY EASY TO ADJUST FLAME WIDTH**

COAL AND CENTRAL AIR CHANNELS :

- ⇒ **IDENTICAL TO THE ROTAFLAM® RV2**



- BY MOVING BACK THE RADIAL TIP, **WE ADJUST THE FLAME WIDTH**
- BY CONTROLLING THE PRIMARY AIR PRESSURE, **WE ADJUST THE BURNER IMPULSE**

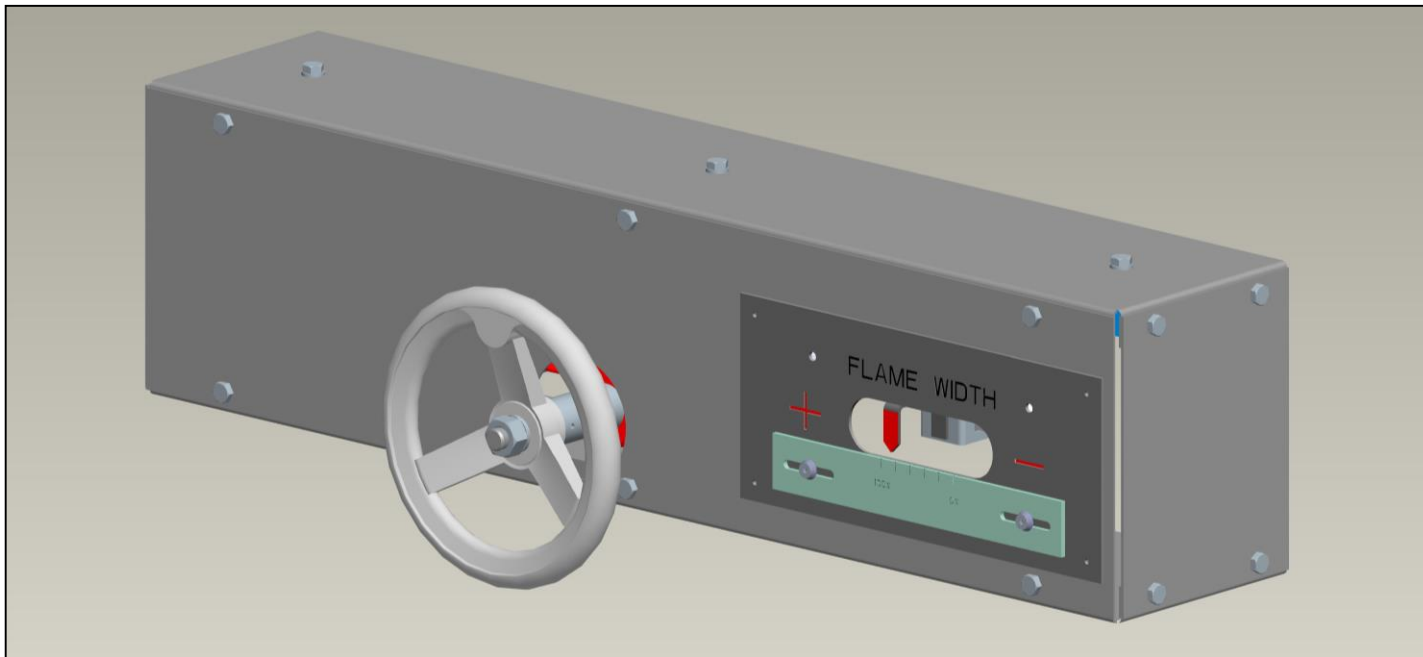
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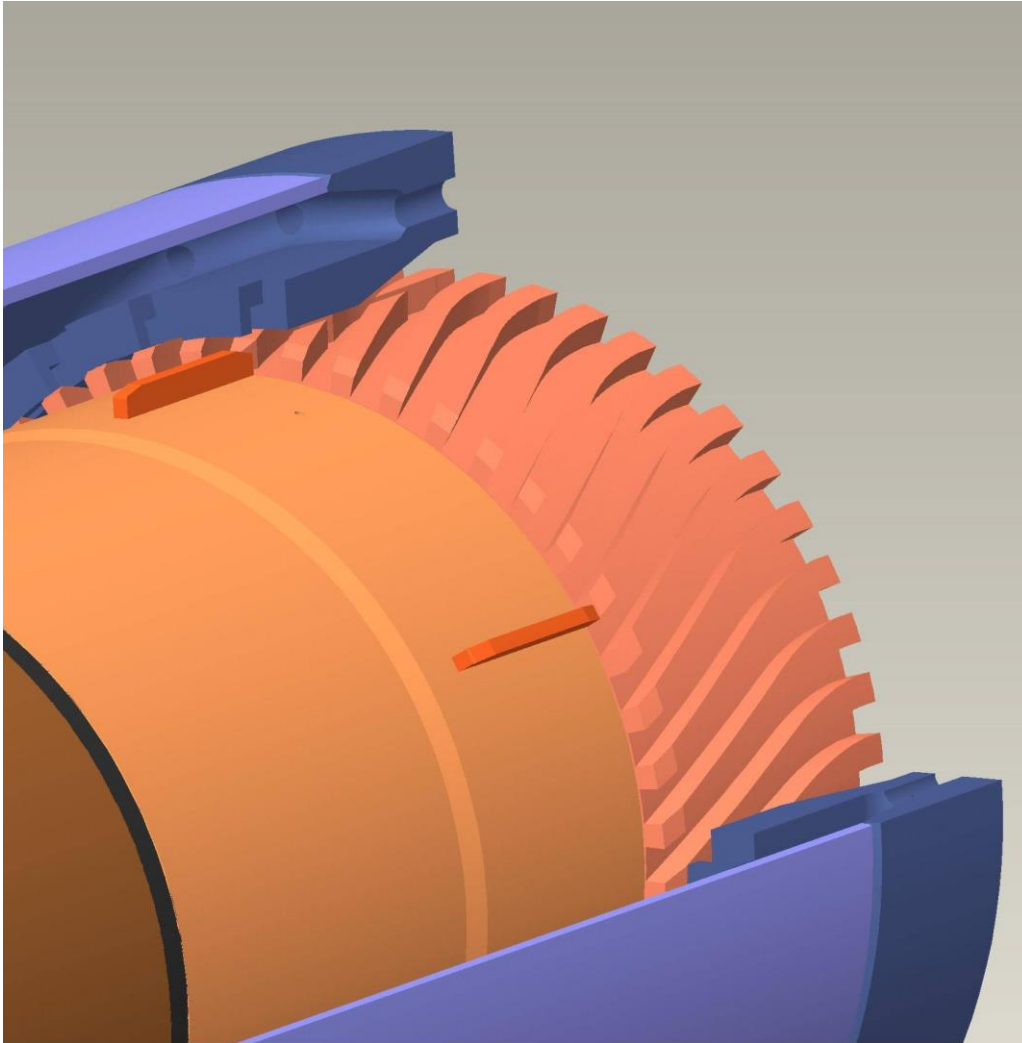
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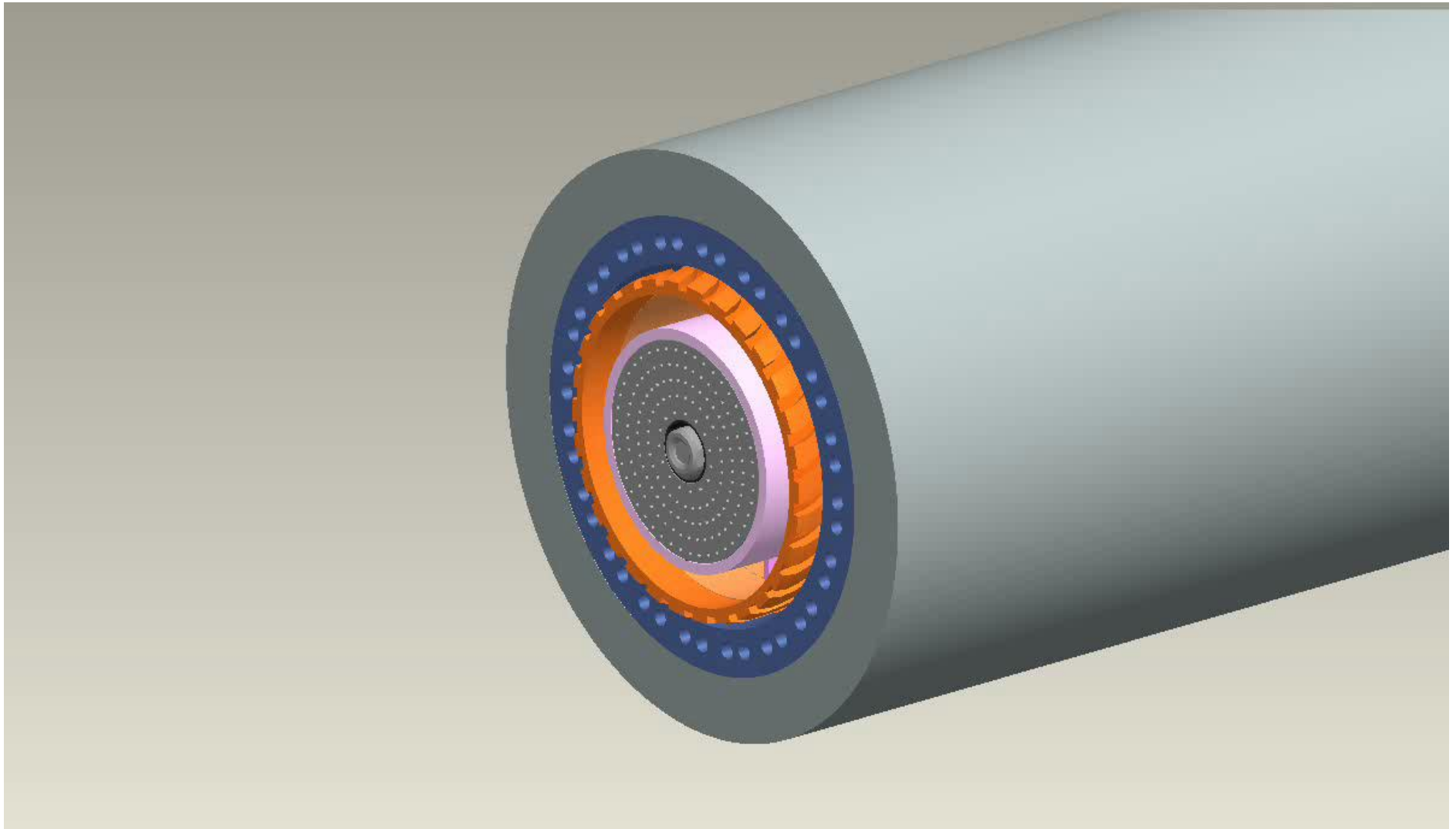
FR0852836 of April 28, 2008

FR2009/050593 of April 07, 2009



The NOVAFLAM® : *The new kiln burner*







→ OUR TYPICAL DESIGN CRITERIA:

MOMENTUM

4-5 N/MW : FO/ GAS (around 7-8 % PA, stoichiometric basis)

6-7 N/MW : COAL, PETCOKE, ANTHRACITE (around 9-10 % PA, stoech basis)

8-9 N/MW : HIGH ASF SUBSTITUTION (around 11-12 % PA, stoech. basis)

SWIRL

Usual : $0.10 < \text{swirl} < 0.3$

AXIAL & RADIAL CROSS SECTION REPARTITION

%_{AXIAL} / %_{RADIAL} repartition from **50** / **50** to **70** / **30**



SPECIFIC IMPULSE CALCULATION

AXIAL MOMENTUM (N) *flame hardness*

$$G_x (N) = Q (kg/s) \times V_{out} \text{ axial} (m/s)$$

$$G_x \text{ total} (N) = G_x \text{ axial} (N) + G_x \text{ radial} (N) + G_x \text{ central} (N)$$

SPECIFIC MOMENTUM (N/MW) *to compare burners with different output heat output*

$$I \text{ total} (N/MW) = G_x \text{ total} (N) / P (MW)$$



SWIRL NUMBER CALCULATION

TANGENTIAL MOMENTUM (N) *amount of swirl motion*

$$G_t \text{ total (N)} = G_x \text{ radial (N)} \times \tan(\alpha)$$

α *swirl angle on the radial tip*

SWIRL NUMBER *number without dimension for swirl characterization*

$$S_N = \frac{G_t \times R_g}{De \times G_x}$$

R_g : gyration radius of swirl channel

$$r_g = \frac{2(re^3 - ri^3)}{3(re^2 - ri^2)}$$

De : equivalent theoretical opening diameter giving with the same flow the same momentum

$$De = \frac{2(Q_{ma} + Q_{mr})}{\sqrt{(\pi \times \rho m \times G_x)}}$$

NOVAFLAM® RECENTLY COMMISSIONED:



NOVAFLAM WITH HIGH ASF SUBSTITUTION :

- *Lumbres and Dannes, France*

NOVAFLAM WITH HIGH ASF SUBSTITUTION :

- *PHOENIX, Germany*

NOVAFLAM WITH "DIFFICULT" KILN (RING FORMATION):

- *HOLCIM Rochefort, France*

NOVAFLAM FOR LARGE CAPACITY LINES :

- *TPI SARABURI, Thailand – 3 x 9000 TPD lines*

NUMEROUS REFERENCES WITH LOW QUALITY COAL :

- *In ASIA : 40 burners in operation*

NOVAFLAM FOR INDIA:

- *DARLAGHAT*

NOVAFLAM FOR INDIA:

- *SITUPARAM*



HOLCIM LUMBRES France

(January 08)



KILN	TYPE	WET LINE
	PROD.(TPD)	800
	SEC. AIR (°C)	750
FUELS		COAL
BURNER REPLACEMENT TARGET		INCREASE IMPREGNATED SAW DUST %



		BEFORE	AFTER
BURNER	TYPE	3 CHANNEL	NOVAFLAM
	PA (%)	10	8-9
	PA pressure (mbar)	220	130 - 170
	Momentum (N/MW)	8	5 - 6

CONFIRMED RESULTS	SAWDUST MULTIPIED x 2 (limited by sawdust availability) Better kiln stability Less primary air, Burner tips are in perfect condition
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HOLCIM DANNES France

(September 08)



KILN	TYPE	LEPOL GRATE, SATELLITE COOLER
	PROD.(TPD)	1 200
	SEC. AIR (°C)	750
FUELS		MIX COAL-PETCOKE+SLUDGE IMPREGNATED SAWDUST / ANIMAL MEAL SOLVENT
BURNER REPLACEMENT TARGET		INCREASE IMPREGNATED SAW DUST %



		BEFORE	AFTER
BURNER	TYPE	3 CHANNEL	NOVAFLAM
	PA (%)	10	9
	PA pressure (mbar)	220	130-180
	Momentum (N/MW)	8	Around 6

CONFIRMED RESULTS	SAWDUST + 70 % (4T/h currently)
	NO MORE RING FORMATION LESS PRIMARY AIR

PHOENIX Germany

(February 10)



KILN	TYPE	DRY, GRATE COOLER
	PROD.(TPD)	1 300
	SEC. AIR (°C)	800
FUELS		COAL FLUFF
BURNER REPLACEMENT TARGET		MORE SIMPLE BURNER



		BEFORE	AFTER
BURNER	TYPE	ROTAFLAM V2	NOVAFLAM
	PA (%)	10	8-9
	PA pressure (mbar)	350 / 250 Axial air fan 90 KW Radial fan 52 KW	150-200 Common fan 90 KW
	Momentum (N/MW)	8	4,5-6
	Swirl	20° / ?	25° / 0.3
	Electrical consumption (kW)	142 KW	90 KW
PROCESS	NOx	470	420
	Urea consumption (kg/hr)	150	70
	CO (ppm)	0	0
	O2 Kiln inlet (%)	5	5
	Kiln inlet temp. (°C)	852	816

CONFIRMED RESULTS

70 % FLUFF WITH A BURNER EASIER TO OPERATE
Reduction by 50% of expensive waste oil consumption to recover a weak kiln



- Simulation in Germany

- **Electrical Consumption**

90 kW instead of 142 kW leads to a cost saving of about :

$0.052 \text{ MW} \times 8000 \text{ h/year} \times 92 \text{ \$/MWh (price - Germany - June 2008)} = 38\,300 \text{ \$ / year} \Rightarrow$
 $30\,000 \text{ €/year}$

- **CO2 Saving :**

404 kg/CO₂ /MWh (GHG Protocol -- Germany)

$\Rightarrow 404 \times 0.052 \times 8000 = 168,8 \text{ t CO}_2/\text{year} \Rightarrow$ only 14€/ton CO₂ (current CO₂ price)

$\Rightarrow 2\,300 \text{ € /Year (Low)}$

- With the same operating condition the **cost saving is about 32 000 € /Year.**



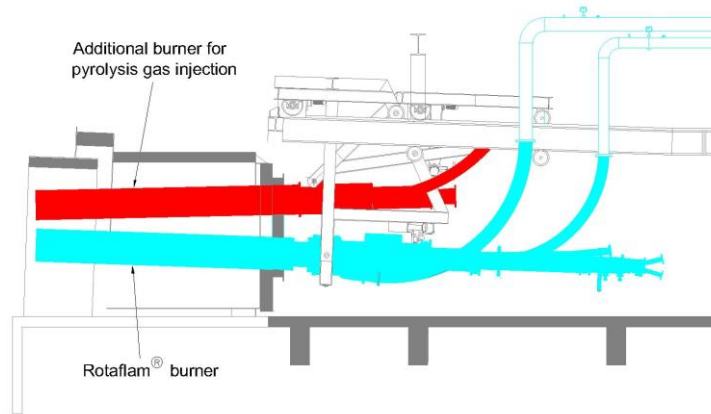
- If similar situation in Switzerland (high % hydro electricity => high electrical cost)
 - **Electrical Consumption**

90 kW instead of 142 kW leads to a cost saving of about :
 $0.052 \text{ MW} \times 8000 \text{ h/year} \times 154 \text{ \$/MWh (price EIA - Switzerland - June 2010)} = 64\,000 \text{ \$ / year}$
==> 50 000 € /Year.
 - **CO2 Saving :**

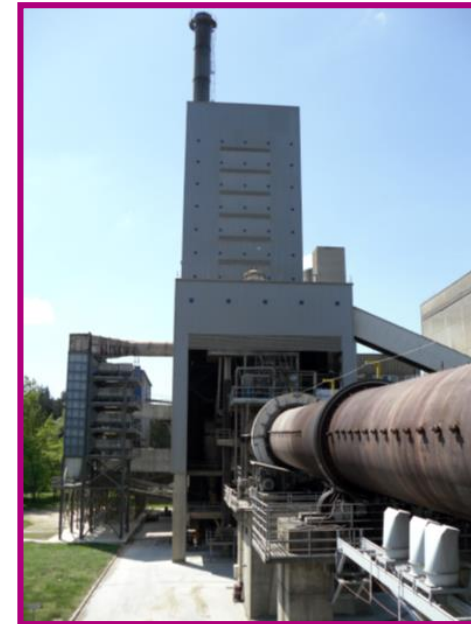
$26 \text{ kg/CO}_2 \text{ /MWh (GHG Protocol - Switzerland)} ==> 26 * 0.052 * 8000 = 10,8 \text{ t CO}_2\text{/year}$
only 14€/ton CO2 ==> 364 € (negligeable)
 - With the same operating condition the **cost saving is about 50 000 € /Year.**



PYROLYSIS BURNER



NOVAFLAM (ASF + COAL)



KILN	TYPE	LEPOL GRATE, SATELLITE COOLER
	PROD.(TPD)	1 200
	SEC. AIR (°C)	1000
FUELS		MIX COAL-PETCOKE+SLUDGE IMPREGNATED SAWDUST / ANIMAL MEAL SOLVENT + PYROLYSIS GAS
BURNER REPLACEMENT TARGET		SUBSTITUTE 20 % COAL BY PETCOKE WITHOUT RING FORMATION



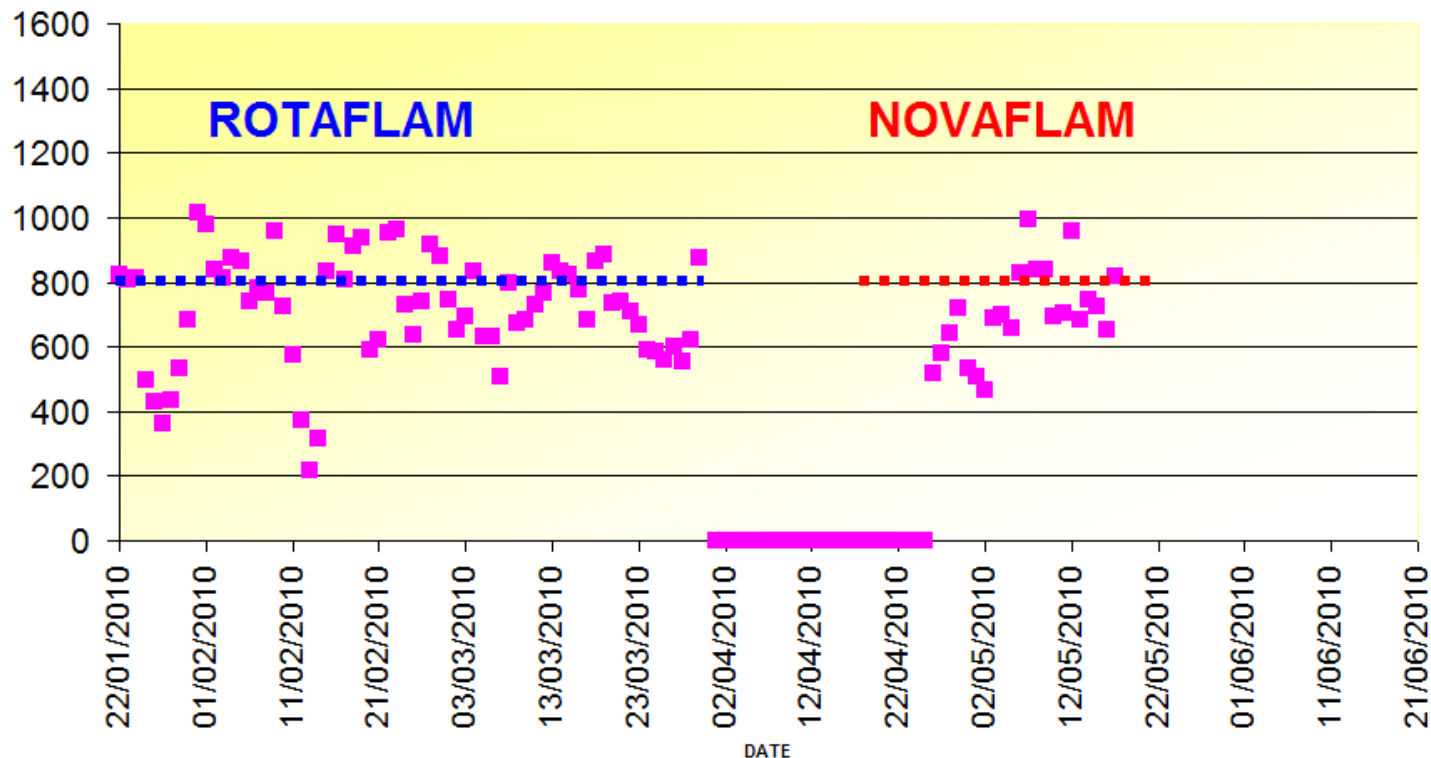
		BEFORE	AFTER
BURNER	TYPE	ROTAFLAM	NOVAFLAM
	PA (%) stoec.bas	17,5	11,5-13
	PA pressure (mbar)	300 (axial) / 170 (rad fan)	170- 220
	Swirl number	0.06	0.05
	Momentum (N/MW)	12	7 - 8,5
	Estim .Elec cons. (kW)	80	45-60
EMISSION	NOx kiln inlet (mg/Nm3@10%O2)	800	800

CONFIRMED RESULTS	PROCESS MORE STABLE
	Up to 30% COAL SUBSTITUTION, FLAME MORE COMPACT
	LESS PRIMARY AIR, 25-40 % LESS ELECTRICAL CONSUMPTION



WHAT ABOUT THE NO_x EMISSION ?

- *If NO_x isn't a major issue, burner optimisation (less primary air flow) is sufficient to keep NO_x at the same level than the ROTAFLAM*



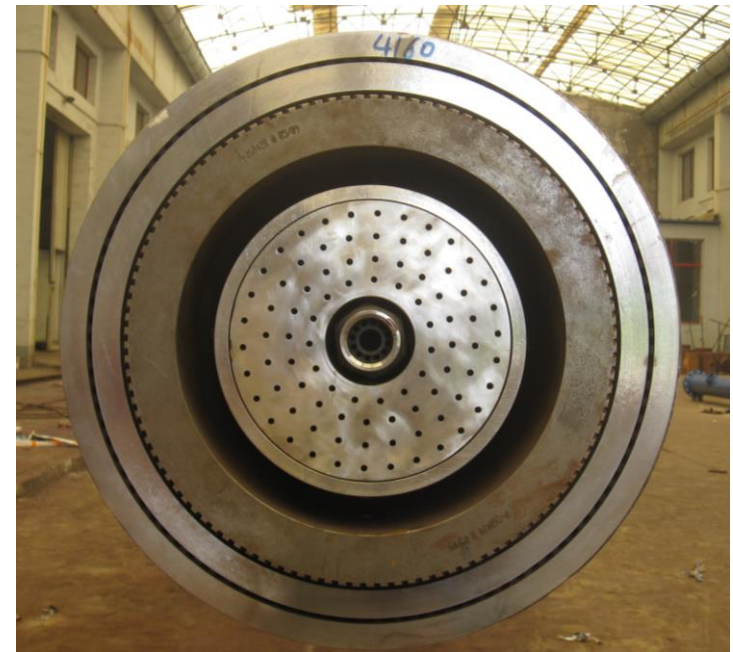
■ NO_x kiln inlet HOLCIM ROCHEFORT (mg/Nm³@10%O₂)



If NOx is a major issue The NOVAFLAM can be specifically designed to reduce NOx

→ The **NOVAFLAM LOW NOx** applies the following principles:

- Specific tip design
- Lower primary air flow
- High pulverized fuel concentration
- Minimum "slot" effect



**First NOVAFLAM LowNox
in Kazakhstan**



→ Opinion of D.Mac Phail, plant manager :

" When compared to the ROTAFLAM burner, the implementation of the new NOVAFLAM burner contributes:

- To allow using 30 % petcoke*
- To improve kiln stability*
- To achieve a flame centred in the kiln, with little impact from the Pyrolysis burner located above it*
- To have an easily adjustable burner, well mastered by the operators*
- To reduce the primary air rate & electrical consumption "*



KILN	TYPE	DRY LINES (Kiln Diameter = 5.6 m)
	PROD.(TPD)	8 500 - 9 000 (Max.)
	SEC. AIR (°C)	1 100
FUELS		COAL (24 T/h) / RDF (18 T/h)
BURNER REPLACEMENT TARGET		HIGHER CLINKER QUALITY FIRING FLUFF (NOT YET STARTED)



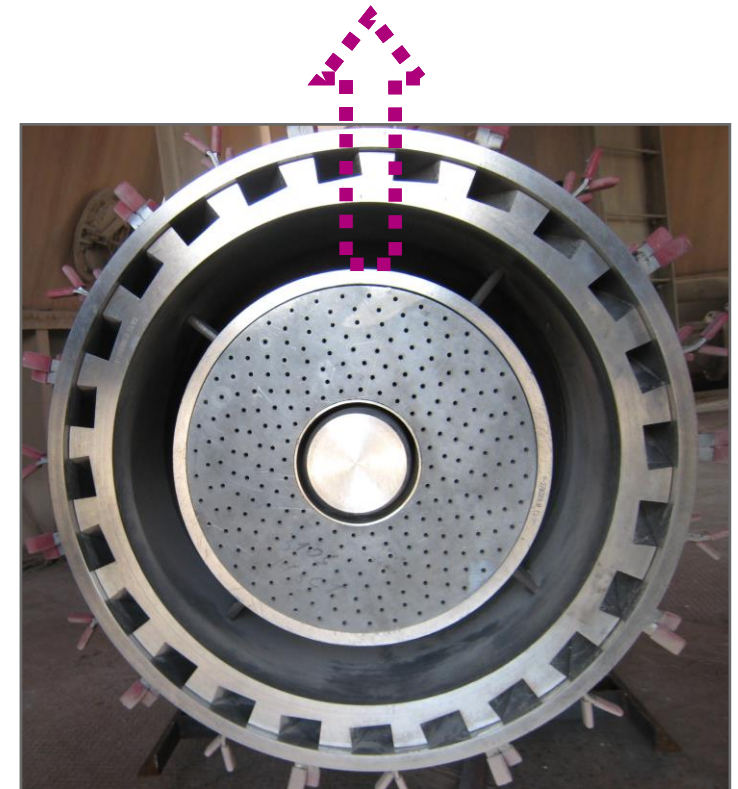
		BEFORE	AFTER
BURNER	TYPE	OTHER'S	NOVAFLAM
	PA (%)	9	12.5*
	PA pressure (mbar)	110	200
	swirl		0.22
	Momentum (N/MW)	4	8

RESULTS <i>(After 1 year operation)</i>	→ HIGHER CLINKER QUALITY → KILN MORE STABLE → 5 % LOWER SPECIFIC CONSUMPTION
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** Primary air % higher than usual for coal firing, as design is for fluff firing*



RDF pipe (future)





ZAOZHUANG WOFENG China

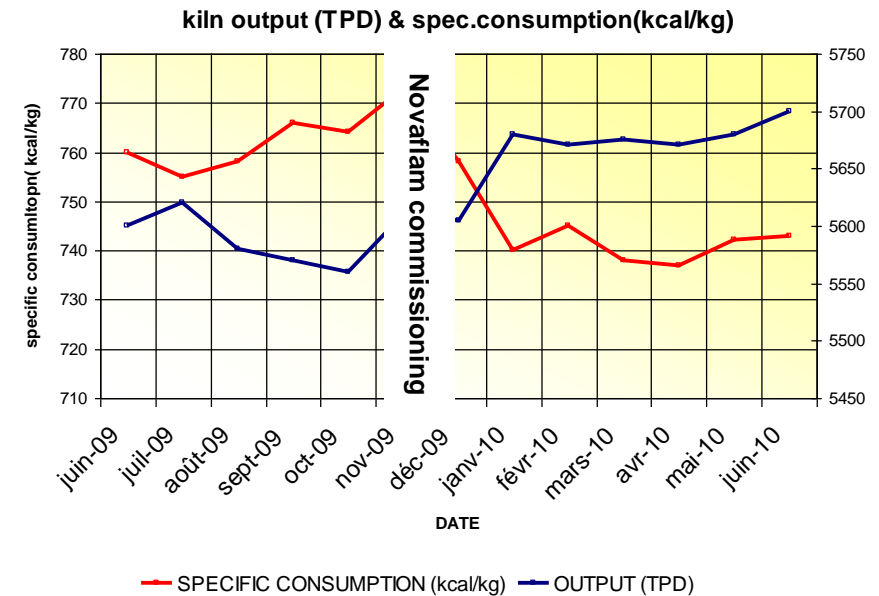
(January 10)



KILN	TYPE	DRY, GRATE COOLER
	PROD.(TPD)	5500
	SEC. AIR (°C)	1100
FUELS		COAL
BURNER REPLACEMENT TARGET		DECREASE SPECIFIC CONSUMPTION



		BEFORE	AFTER
BURNER	TYPE	Nanjing design	NOVAFLAM
	PA (%)	?	12
	PA pressure (mbar)	?	220
	swirl		0,23
	Momentum (N/MW)	?	8



CONFIRMED RESULTS

*Lower specific consumption
(760 to 740 kcal/kg)*

Higher production (5600 to 5700 tpd)



DALIAN Tianrui China

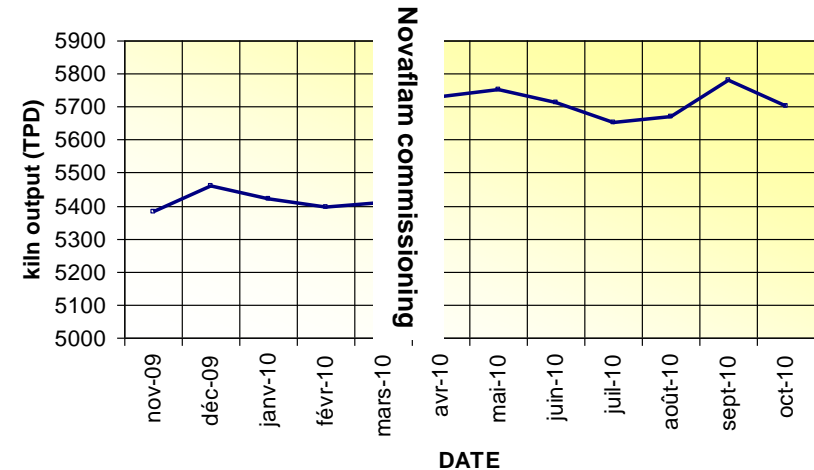
(April 10)



KILN	TYPE	DRY, GRATE COOLER
	PROD.(TPD)	5500
	SEC. AIR (°C)	1000
FUELS		COAL
BURNER REPLACEMENT TARGET		INCREASE PRODUCTION



		BEFORE	AFTER
BURNER	TYPE	?	NOVAFLAM
	PA (%)	?	9,5
	PA pressure (mbar)	?	210
	swirl		0,25
	Momentum (N/MW)	?	6,5



CONFIRMED RESULTS

5% Higher production

*Less reducing condition
(yellow clinker has disappeared)*



- The **NOVAFLAM®** burner is **simple to adjust**

- The **NOVAFLAM®** burner allows:
 - a **very high % of Alternative Solid Fuels**
 - **minimum electric consumption**

The NOVAFLAM[®] burner : a lower Carbon assessment



CO₂ emission



SPECIFIC CONSUMPTION

Reduced (average 3 %)

CO₂ ↓



USE of higher BIOMASS FUEL %

CO₂ ↓



**CO₂
Reduced
!**



ELECTRIC CONSUMPTION



**SOLID FUEL
CONVEYING LINES**

Concentration can be increased

Electric Consumption: less 15%



PRIMARY AIR FAN

Pressure can be reduced

Flow reduced

Electric Consumption: less 30/40%



**Consumed
electricity
Reduced!**

With our warm thanks!

