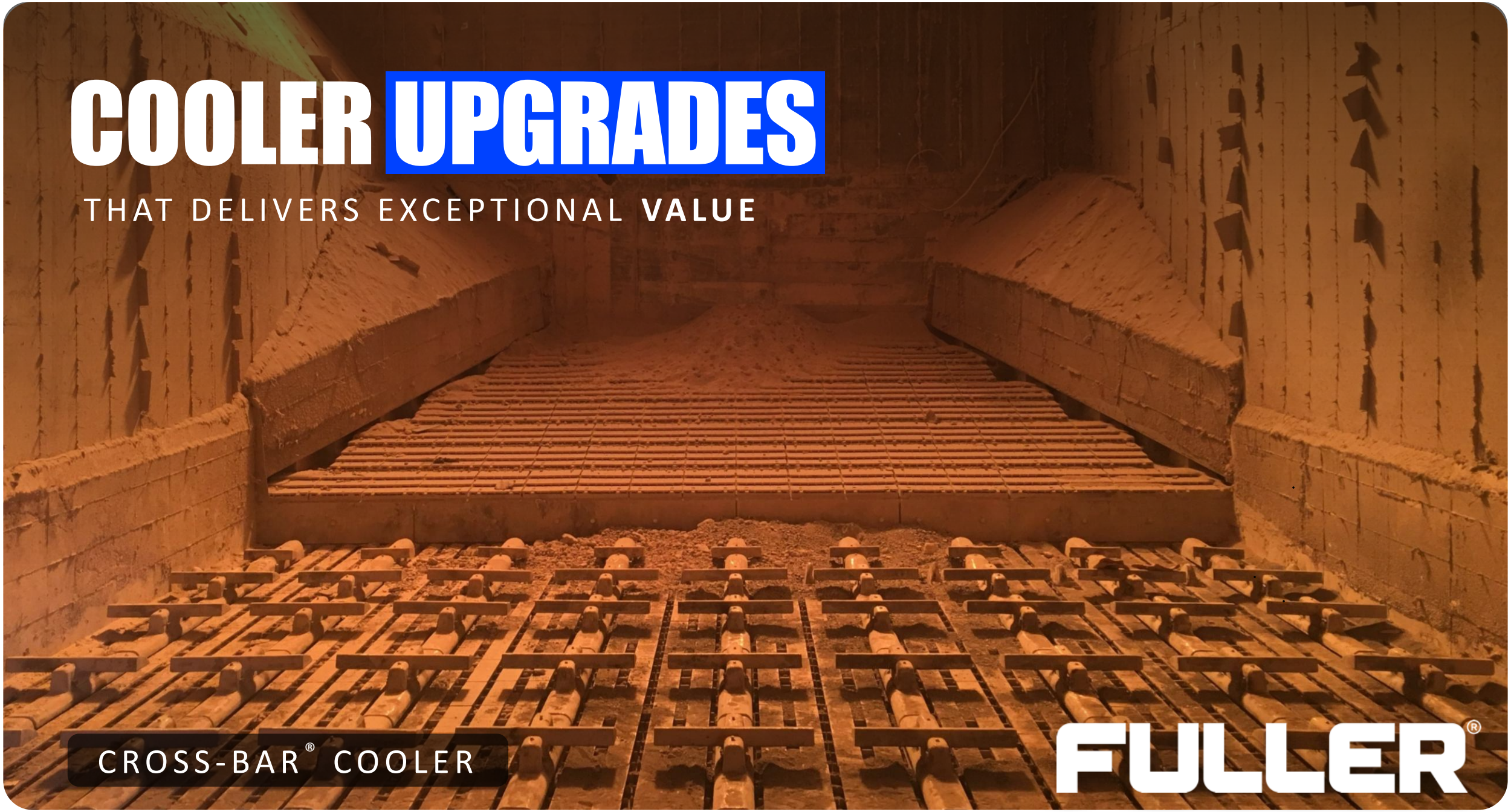
COOLER UPGRADES
THAT DELIVERS EXCEPTIONAL VALUE
CROSS-BAR® COOLER
FULLER®

Topics

01 Introduction of Cross-Bar® Coolers

02 Cross-Bar® Cooler Features

03 Cooler Upgrades and benefits

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DEVELOPMENT OF CROSS-BAR® COOLERS

01 SF™ Cross-Bar® cooler

02 Multi-Movable™ Cross-Bar® cooler

03 Cross-Bar® cooler

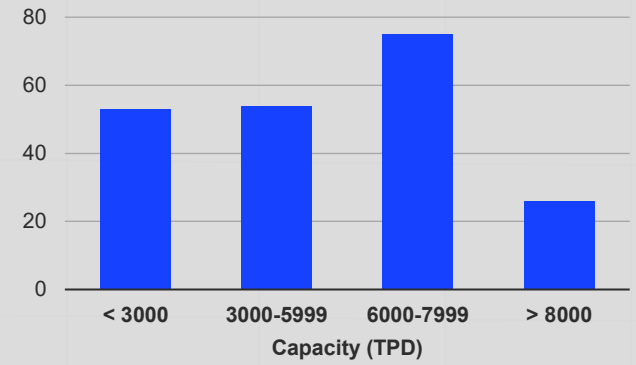
EVERY PART OF THE COOLER DESIGNED TO ENSURE THE HIGHEST AVAILABILITY

FULLER®

OVER 25 YEARS OF PROVEN RESULTS

More than
490
Cross-Bar type coolers
sold since 1997

Total installed capacity
~700
million tons
clinker per year



100
Cross-Bar coolers in the size range
6.000-13.000 tpd

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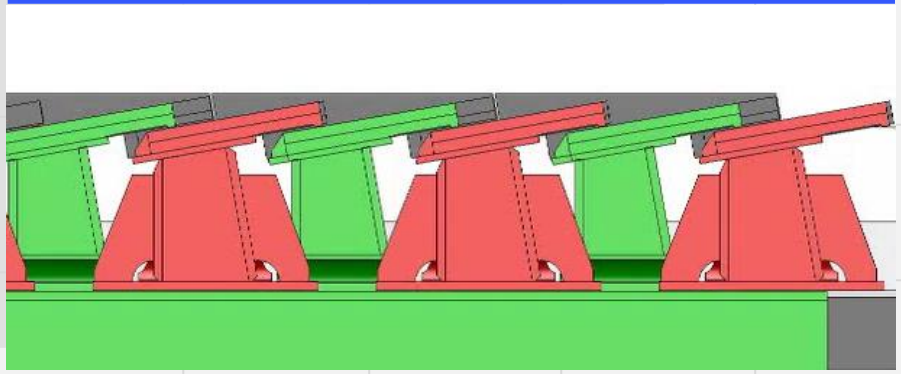
HOW IS CROSS-BAR COOLER DIFFERENT FROM TRADITIONAL COOLERS?

- Reciprocating cross-bars, located above the **stationary** air distribution system, convey the clinker.
- Gradual **wear does not impact** the cooler's operation or thermal efficiency.
- Ensures **consistent performance** over time.
- **No fall through** of clinker and no under grate conveyor.

Cross-Bar® cooler

Grate cooler



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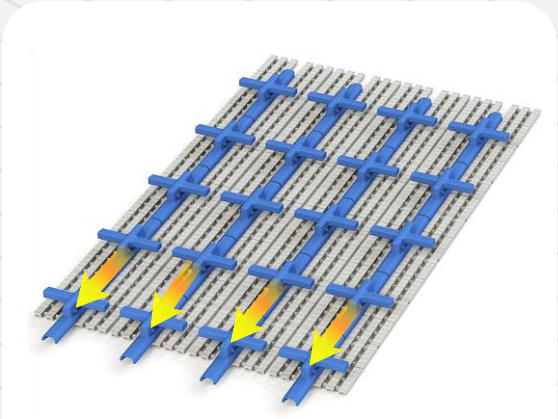
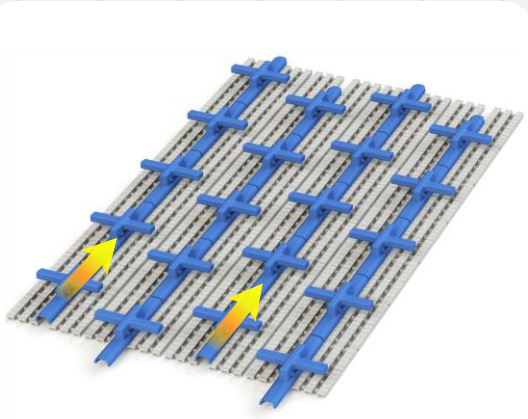
WORKING PRINCIPLE

- Adjustable stroke length of each drive to best match operating requirements
- Ability to operate even if a cooler drive is stopped



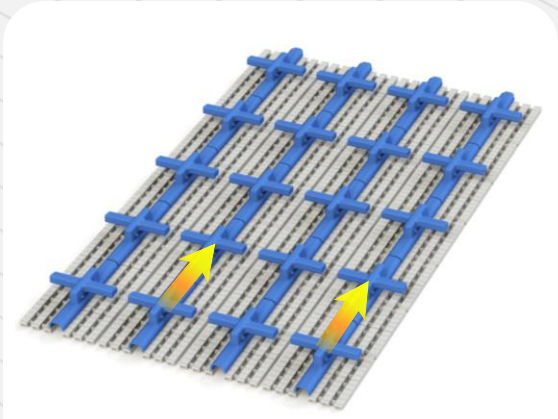
STEP 01

All bars move forward



STEP 02

Every other lane moves backwards



STEP 03

Remaining lanes move backwards

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CROSS-BAR® COOLER

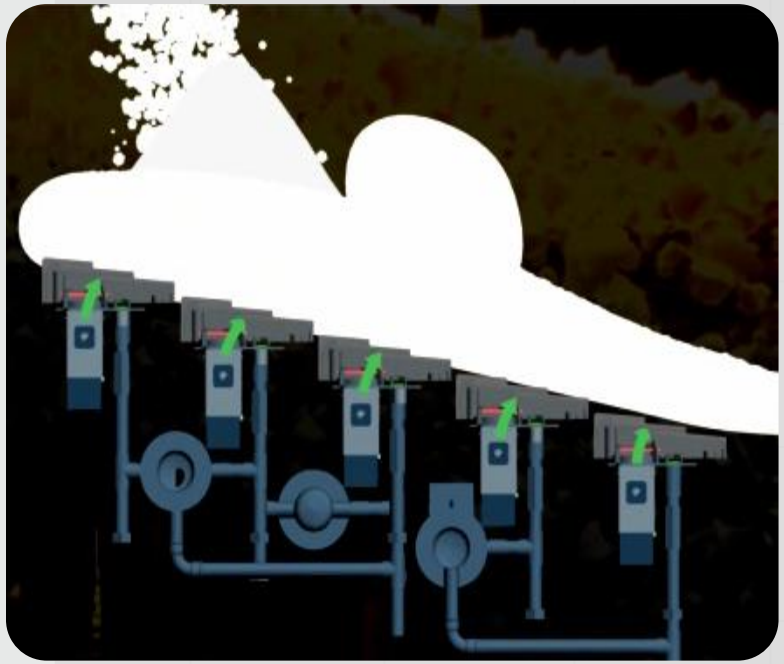
KEY FEATURES

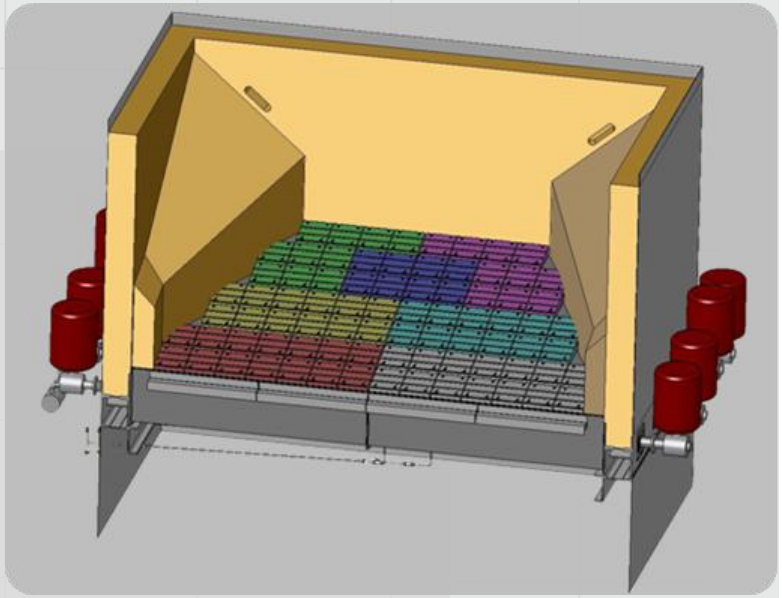
- Air Blast Controlled inlet
- Mechanical flow regulators (MFR’s)
- Stationary, sealed grate line
- Separate cooling and conveying mechanism
- Horizontal design with optimized transport method
- Hot air recirculation

FULLER®

01 ABC INLET AIR BLAST CONTROLLED

STAND-ALONE PRODUCT





- Eliminates snowmen and prevents dead zones where traditional blasters in back wall cannot reach
- MFR cooling process supplemented by an air blast released directly to the grates and the clinker bed
- Flexible control by blasting in zones with variable intensity
- Ensures uniform clinker distribution
- High clinker bed

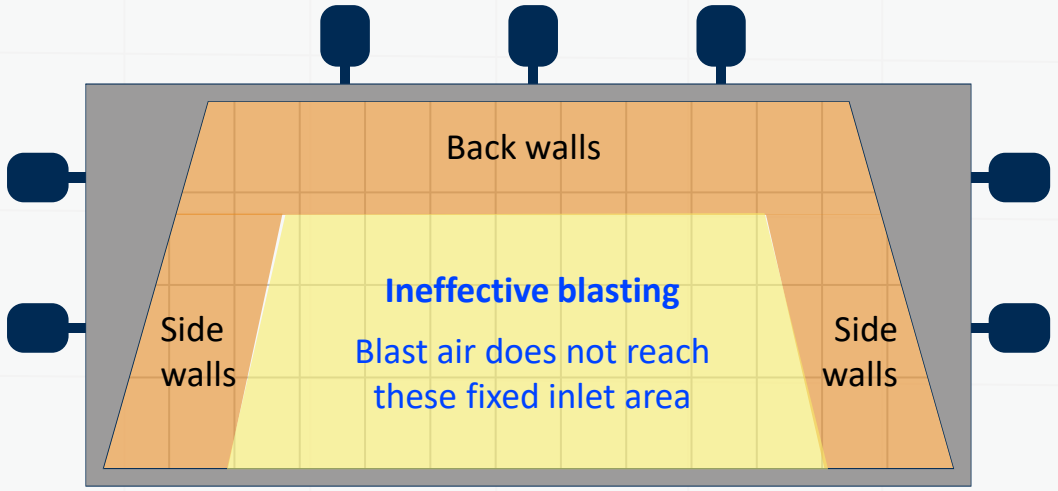
HIGH RELIABILITY
HIGH RECUPERATION

FULLER®

OTHER SUPPLIER'S FIXED INLET

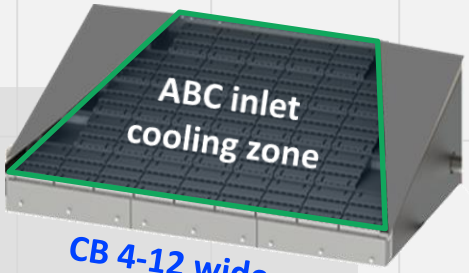
(AIR BLASTER ARRANGEMENT)

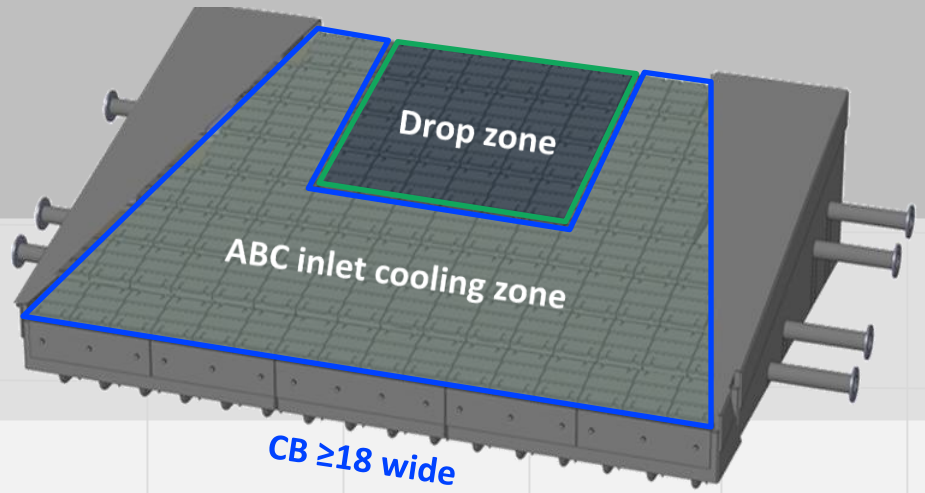
- Side/back wall blaster reach only 0.5m, can’t reach the entire inlet zone.
- Ineffective in eradicating the root cause for agglomeration over grates.
- Snowman formation exists.

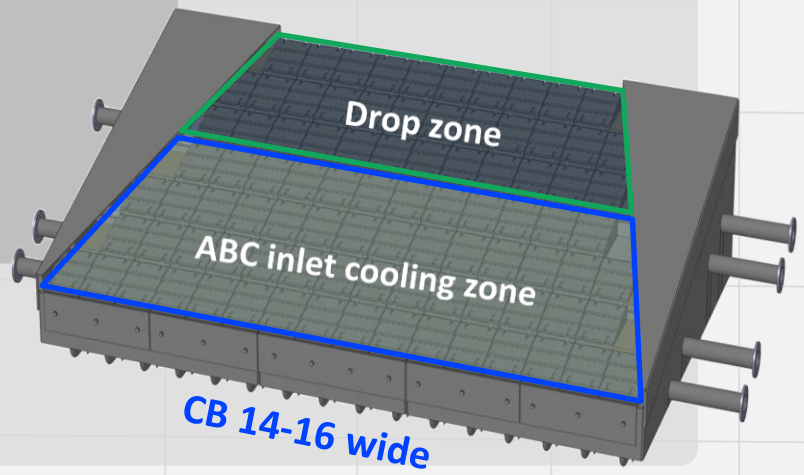


ABC INLET- IMPACT ZONE

- ABC inlet loading: 450 – 650 tpd/m²
- Compartment split: dedicated fan for clinker drop zone
- High clinker bed and dedicated fan extracts the maximum amount of heat from the hot clinker.
- Sufficient cooling of clinker before it reaches Cross-Bar section







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✓ Folax | ✓ Coolax | ✓ SF | ✓ MMC | ✓ CB | ✓ Non-FULLER

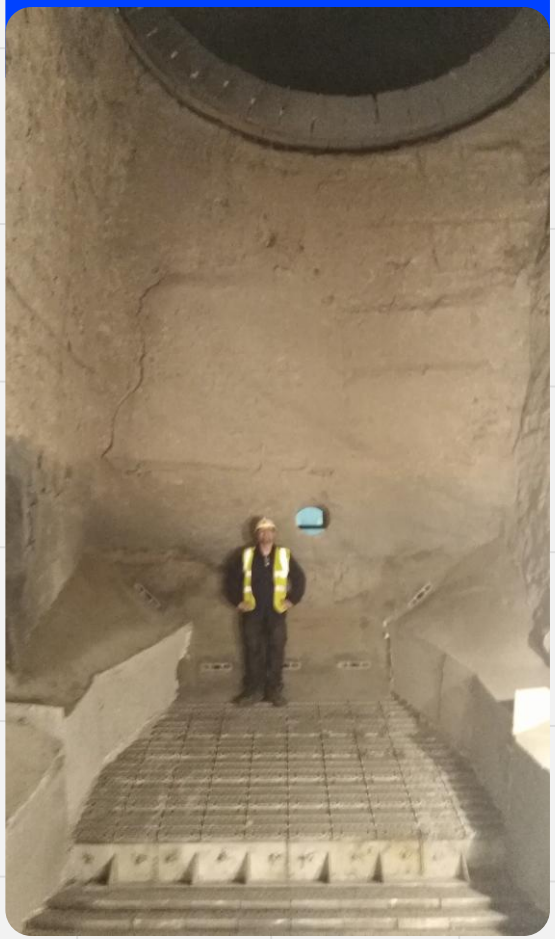
AFTER ABC INLET UPGRADE

	Before	After
FIXED INLET	Other supplier	**ABC inlet**
TIME SPENT AT INLET AREA (HRS/DAY)	9	0
KILN DOWNTIME DUE TO SNOWMEN (HRS./YEAR)	**>100**	**0**

SNOWMEN TILL THE KILN OUTLET

SNOWMEN VIEW FROM COOLER

AFTER ABC INLET



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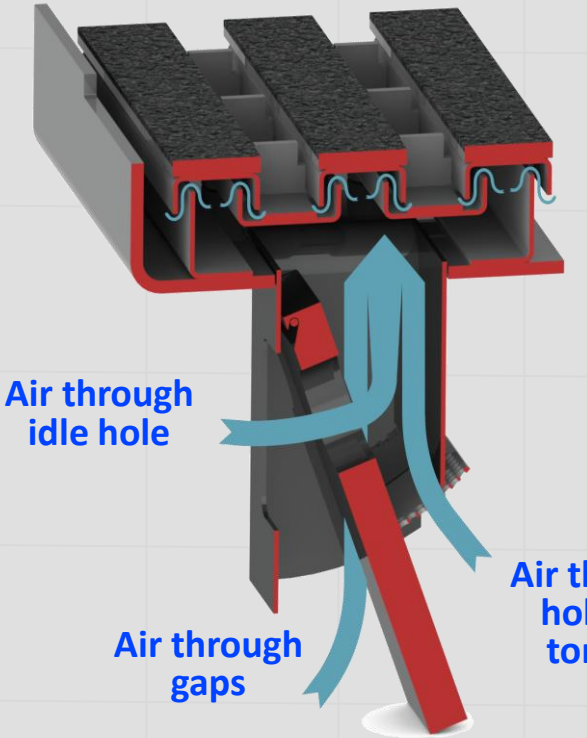
02 MECHANICAL FLOW REGULATOR - MFR

Adjusting in response to conditions above the grate line to allow required airflow

- Optimized heat recuperation
- Reduced cooling air input
- Avoiding red rivers
- Avoiding blow-throughs



[redacted]

	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
FX1			6	6	6	6	6	6		
FX2			8	16	16	16	16	8		
FX3		8	8	16	16	16	16	8	8	
FX4		8	12	16	16	16	16	12	8	
FX5		8	12	12	12	12	12	12	8	
FX6	8	8	12	12	12	12	12	12	8	8
1	5	8	9	9	9	9	9	9	8	5
2	5	8	9	9	9	9	9	9	8	5
3	5	8	9	9	9	9	9	9	8	5
4	5	8	9	9	9	9	9	9	8	5
5	5	8	9	9	9	9	9	9	8	5
6	5	8	9	9	9	9	9	9	8	5

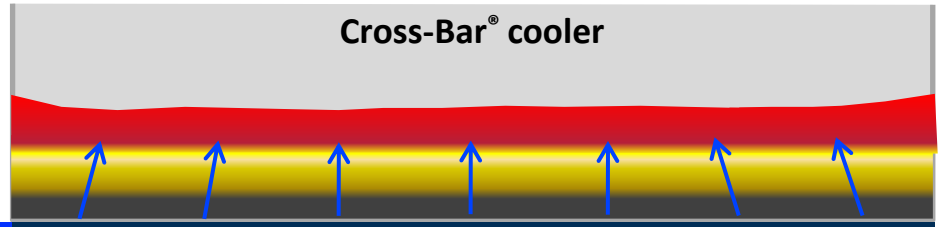
EFFICIENT COOLING

FULLER®

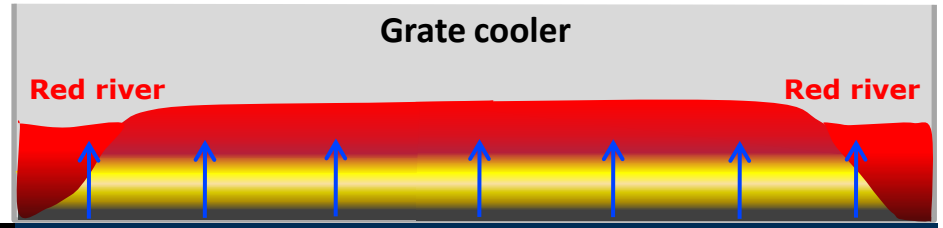
03 HORIZONTAL AND OPTIMIZED TRANSPORT

- Horizontal drive
- Adjustable stroke length of drives along the width
- Controllable clinker distribution

REDUCE RED RIVER

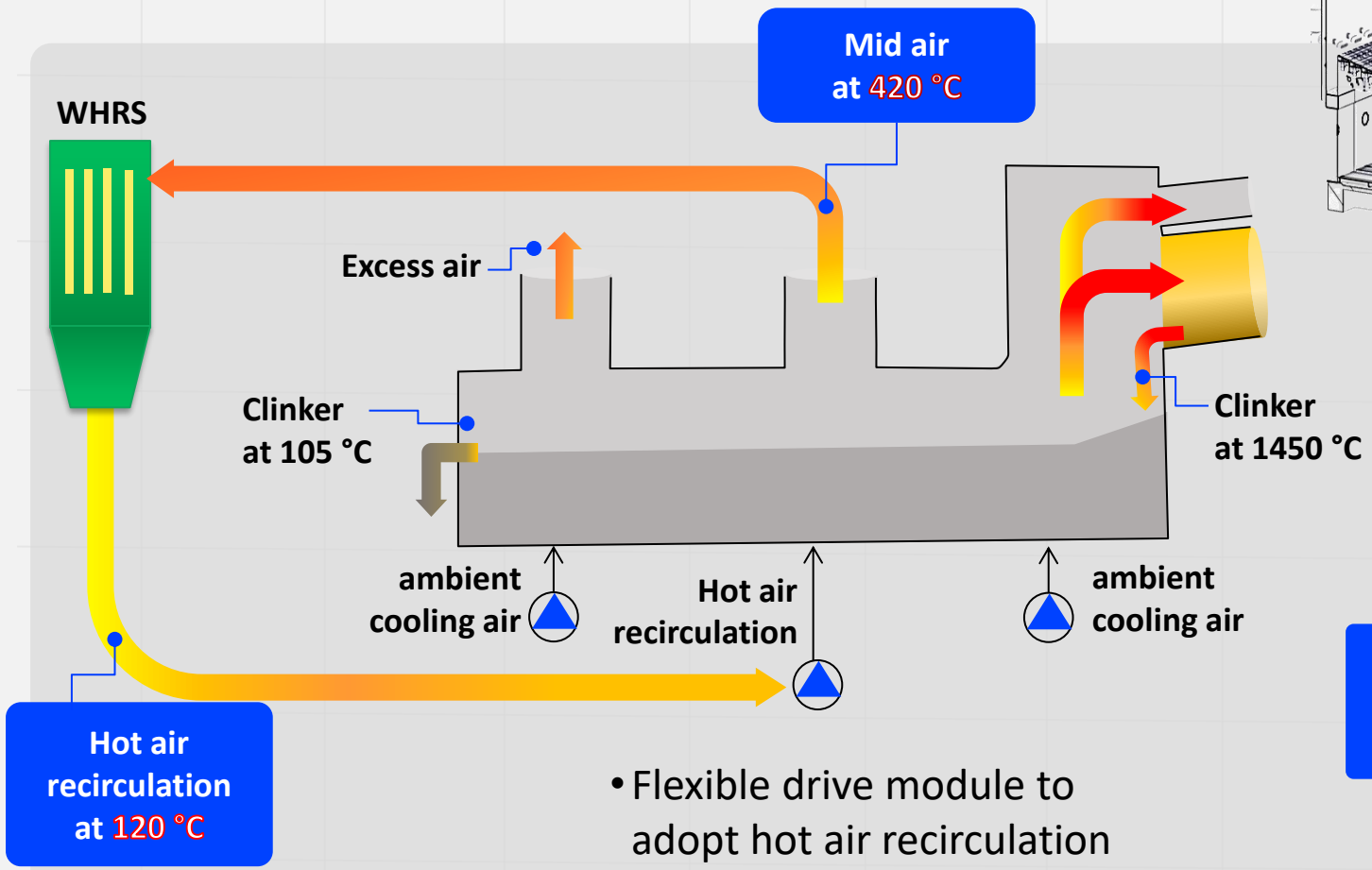


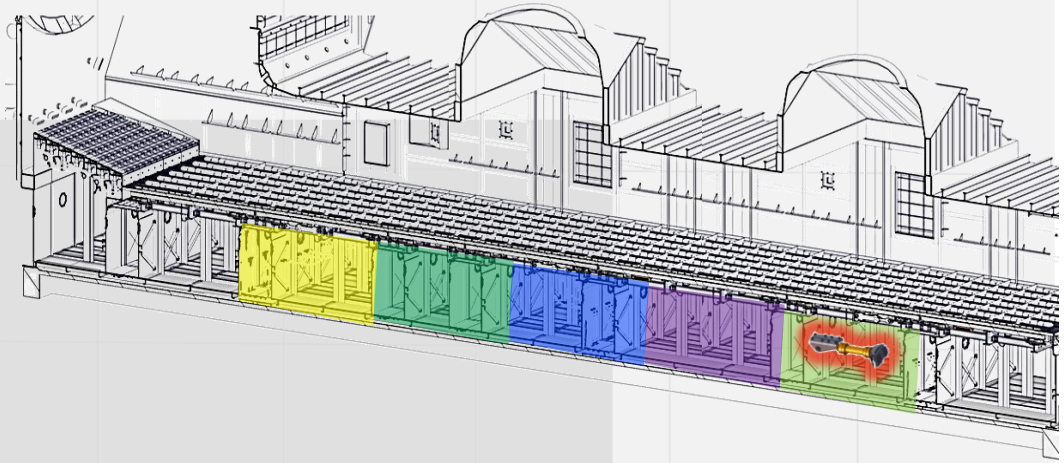
Drive	1	2	3	4	5	6	7
Stroke length	200	260	300	300	300	260	200



Drive	1
Stroke length	130

04 HOT AIR RECIRCULATION





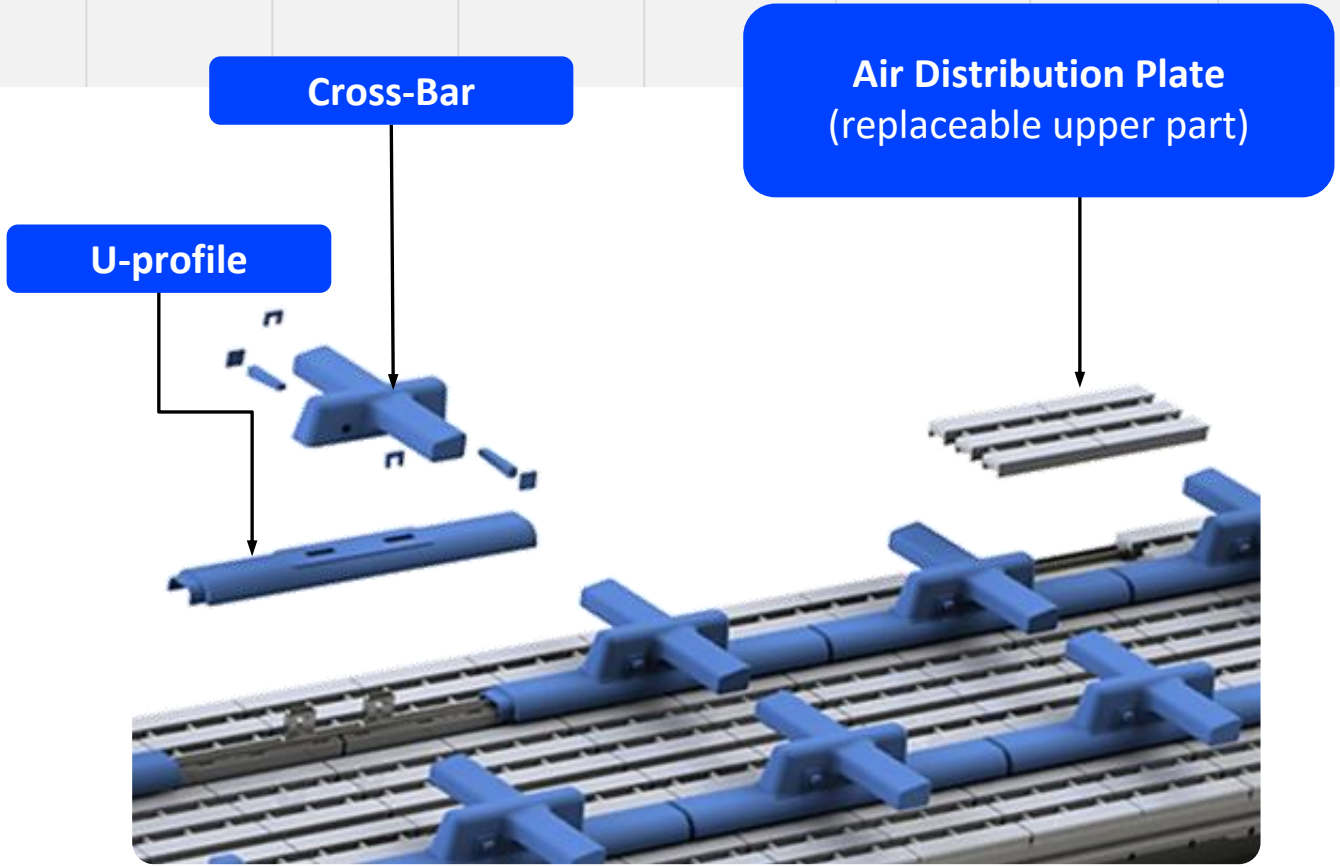
- Flexible drive module to adopt hot air recirculation

BOOSTS POWER GENERATION

FULLER®

LOW, PREDICTABLE MAINTENANCE

- Few wear components with known wear rates.
- Typical wear life 3-5 years.
- Simple and easy assembly.
- Cast parts can be hand-carried.



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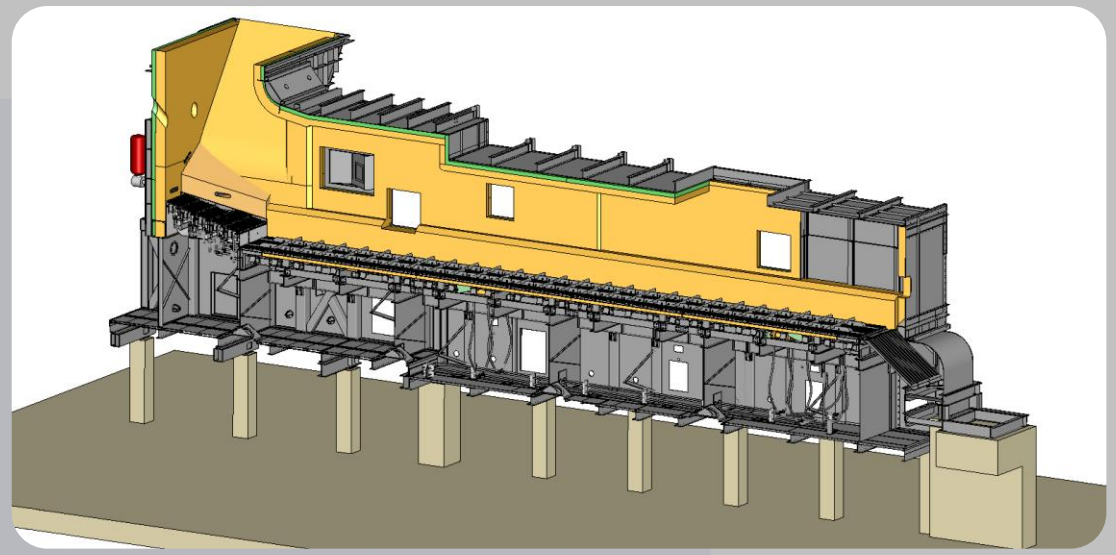
Inside box / Partial retrofit

✓ Folax | ✓ Coolax | ✓ SF | ✓ MMC | ✗ CB | ✓ Non-FULLER

- Retain existing casing
- CB modules are shop assembled
- Easy handling
- Can be installed in sloped arrangement
- Removal and Installation less than 30 days
- Partial cooler retrofit



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COOLER PERFORMANCE

Capacity	tpd	11,992
Clinker outlet temperature	°C	106
Specific fuel consumption	Kcal/kgcl	680
Specific power consumption (fans, cooler drive, HRB)	Kwh/ton of clinker	4.9
Cooler efficiency	η	74

FULLER®

SF™ CROSS-BAR® COOLER UPGRADE

✗ Folax | ✗ Coolax | ✓ SF | ✗ MMC | ✗ CB | ✗ Non-FULLER

POTENTIAL BENEFITS

- Greater throughput in a highly loaded SF™ Cross-Bar® cooler
- Fewer cast parts and longer lifetime for all SF™ Cross-Bar® Coolers

FULLER®

HOW IS HIGHER TRANSPORT EFFICIENCY ACHIEVED IN THE SF™ CROSS-BAR® COOLER UPGRADE?

SF™ cooler

- One movable and one stationary bar
- Less transport efficiency of clinker
- Each bar covers the width of 4 grates (1.2 m)

Increase Productivity

SF™ Cross-Bar® upgrade cooler

- All bars are movable
- Higher transport efficiency
  - Reduced cooler speed
  - Life of wear parts extended by 30 to 50%
- Each bar covers the width of 2 grates (0.6 m)

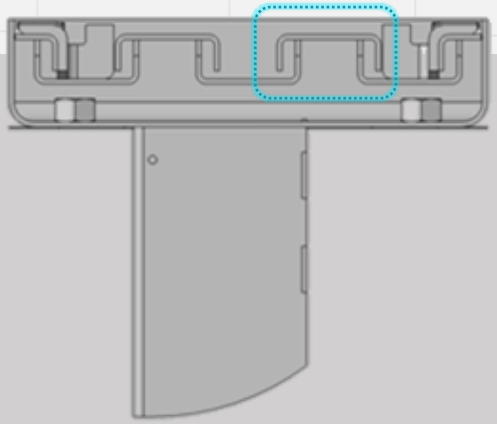
FULLER®

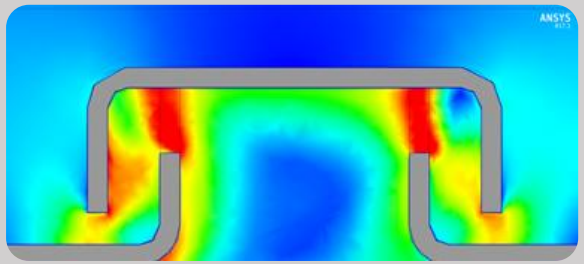
WAVE GRATES

✗ Folax | ✗ Coolax | ✓ SF | ✓ MMC | ✗ CB | ✓ SF-CB | ✗ Non-FULLER

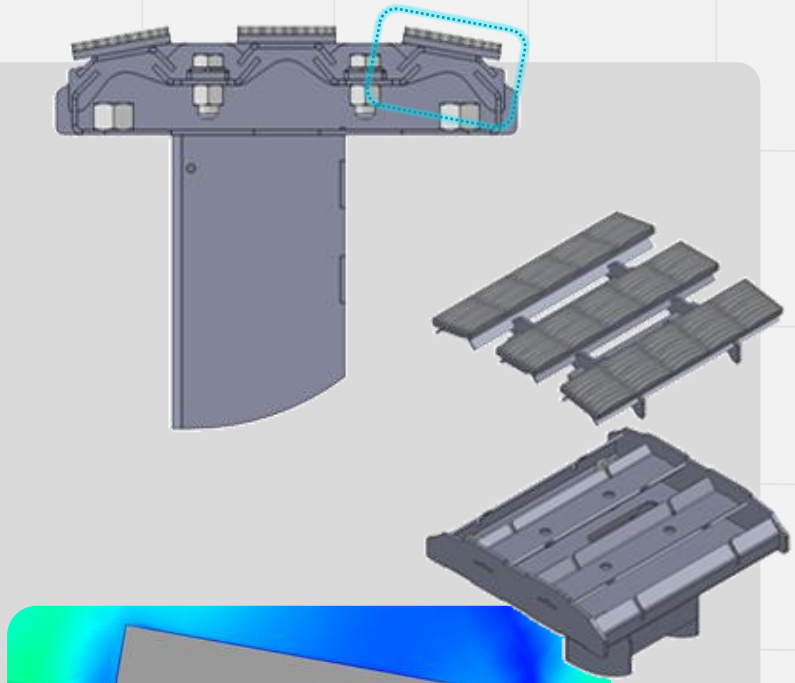
KEY BENEFITS

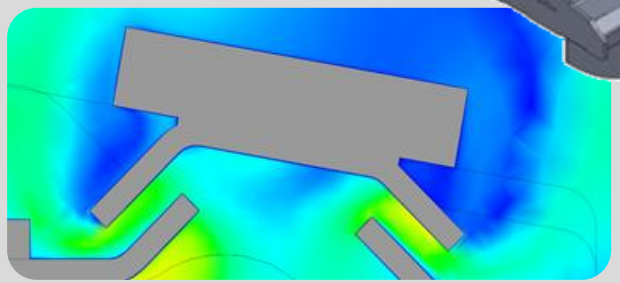
- Longer wear lifetime
- Easy maintenance
- Reduced power consumption-8% ↓
- Fast, simple Installation





Old grate plate





Wave Grate

FULLER®

SIGNIFICANT SAVINGS ON POWER CONSUMPTION

SIGNIFICANT SAVINGS ON POWER CONSUMPTION

- Reduced power consumption by ~8%
- Potential to reduce specific power of the cooler fans up to **0.5kWh/t**
  - Considering complete cooler with new Wave Grates

Reduce Operation cost

	Before	After	Benefits
Production (tpd)	6500	6500	-
Drive speed (spm)	14.0	14.0	-
Fan flow (Nm^3/min)	599.0	599.0	-
Power (kW)	80.1	72.3	**-9.7%**

FULLER®

ADDITIONAL COOLING OF CLINKER IN A HEAVILY LOADED COOLER

ALTERNATIVE OPTION

Alternatively, the reduced pressure drop can be used for additional cooling of clinker in a heavily loaded cooler

- Potential increase in heat recuperation efficiency
- Potential in reducing clinker exit temperature

NOTE
MFRs need to be modified for the new air flow

Increase Productivity

	Before	After	Benefits
Production (tpd)	6500	6500	-
Drive speed (spm)	14.0	14.0	-
Fan flow (Nm^3/min)	599.0	657.1	**+9.7%**
Power (kW)	80.1	80.4	-

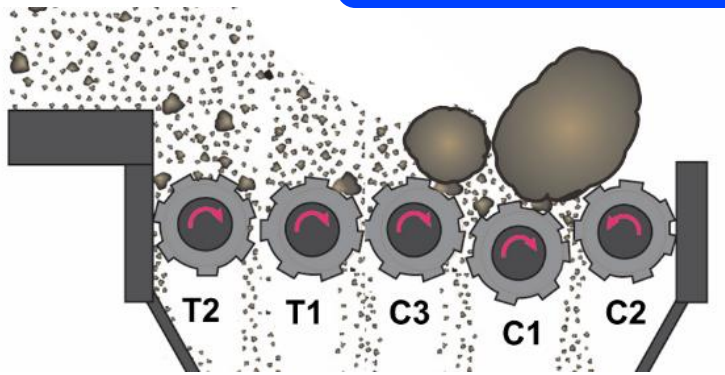
FULLER®

HEAVY-DUTY ROLL BREAKER

✓ Folax | ✓ Coolax | ✓ SF | ✓ MMC | ✓ CB | ✓ Non-FULLER

- Crush very large lumps without stopping the cooler
- Unique lowered C1 roll position for effective crushing
- Overload reversal for safety
- Low speed for long wear life: 3-5 years
- Rollout design for easy maintenance
- End- and mid-cooler applications available
- Addition of roller for increased production

HIGH RELIABILITY



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UPGRADES & BENEFITS

ABC inlet upgrade	Snowmen elimination, reduced specific heat consumption
Inside box retrofit	Improved cooler efficiency, fast installation
SF-CB upgrade	Increased conveying capacity, reduced wear parts
Wave grate upgrade	Reduced power consumption, increased wear life
HRB retrofit	Reduced downtime and maintenance

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