中国建材

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Energy saving and emission reduction renovation and upgrading of cement industry and case analysis

China National Building Material Equipment Group Co., Ltd.

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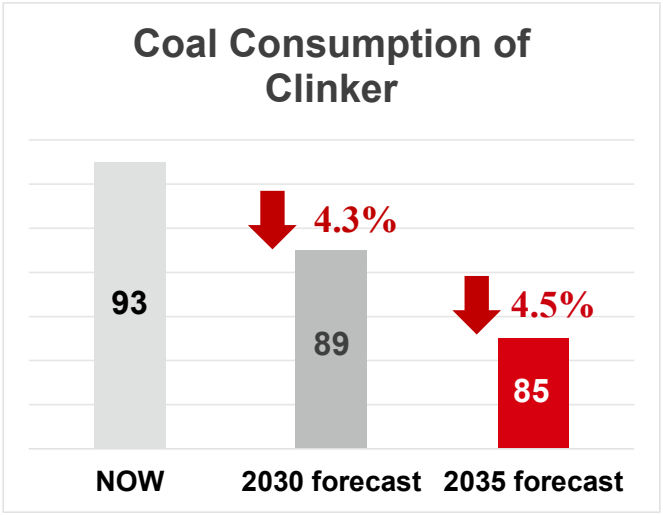
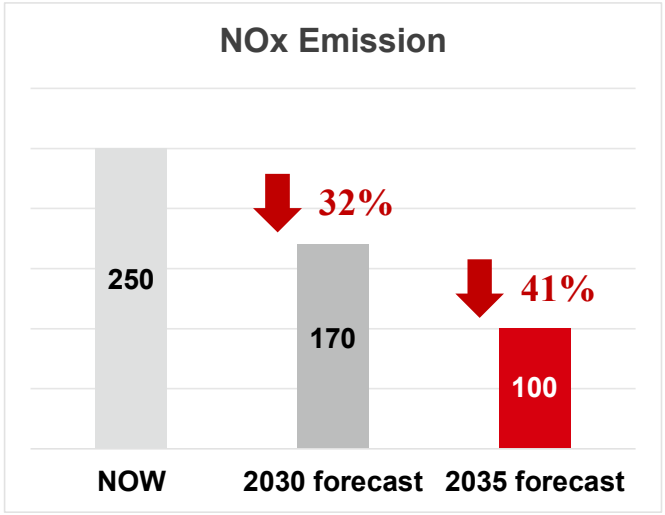
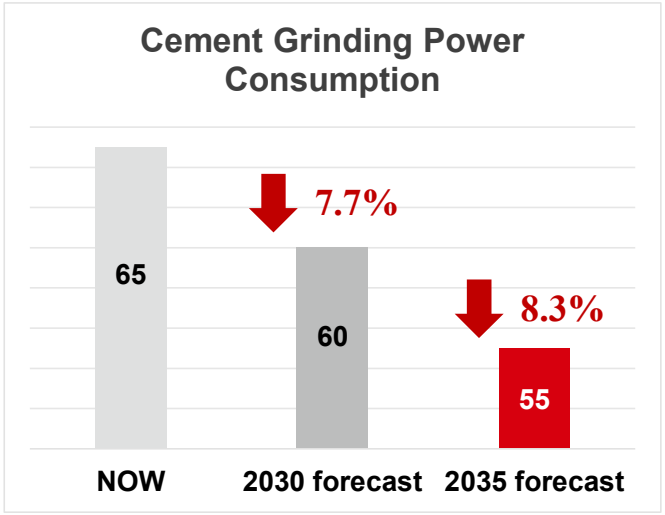
2024.5

Outlook of Renovation Technology

- **Energy conservation and emission reduction** is an eternal topic in the cement industry.
- Improving the competitiveness of cement enterprises through renovation and upgrading, ensuring the company's profit , and leading the development of the cement industry.







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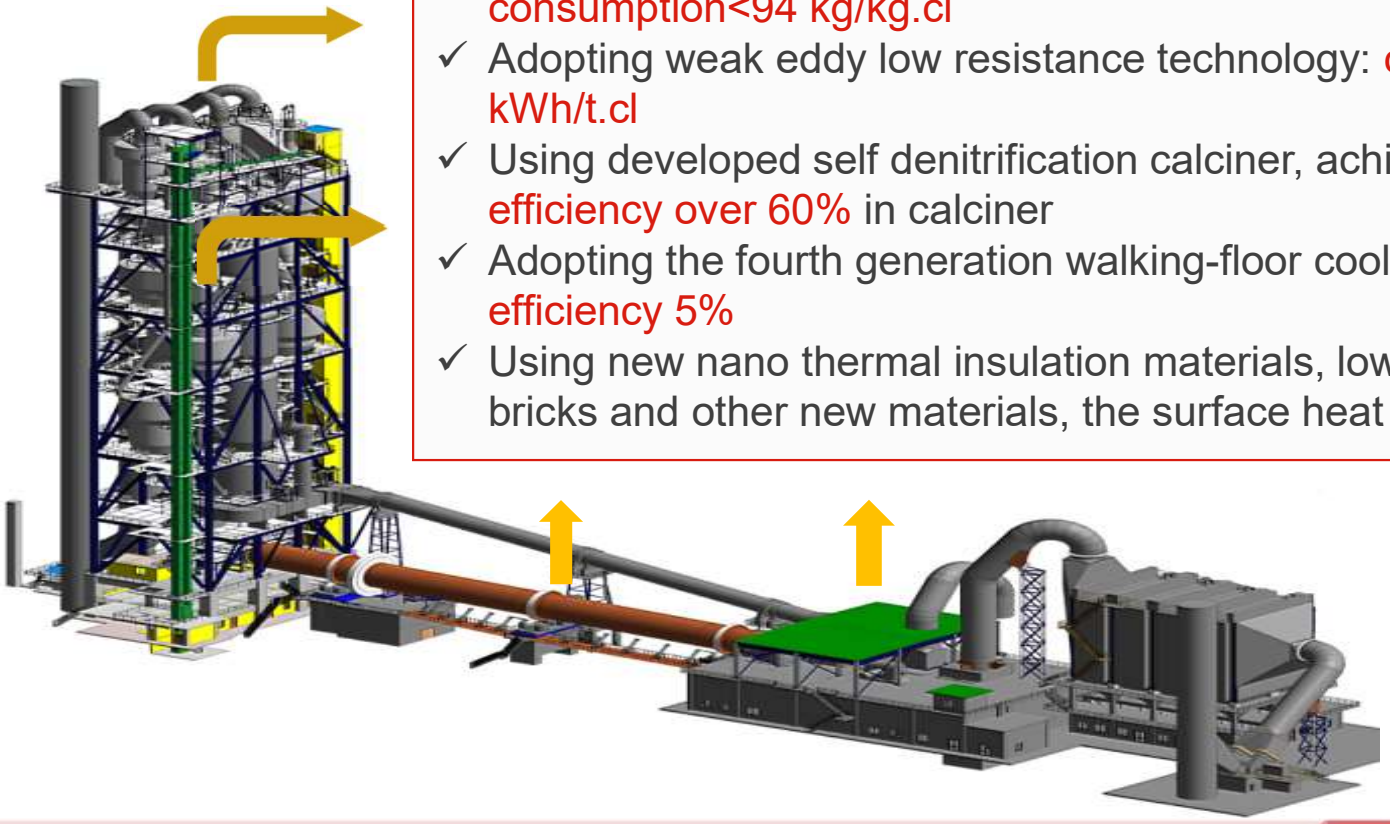
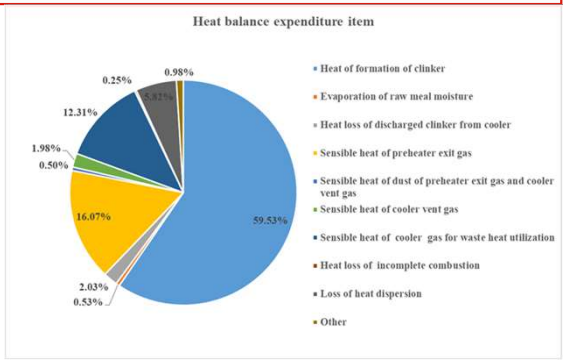
1.Technical Renovation of the Pyro-system

Overall solution for technical renovation of the pyro-system

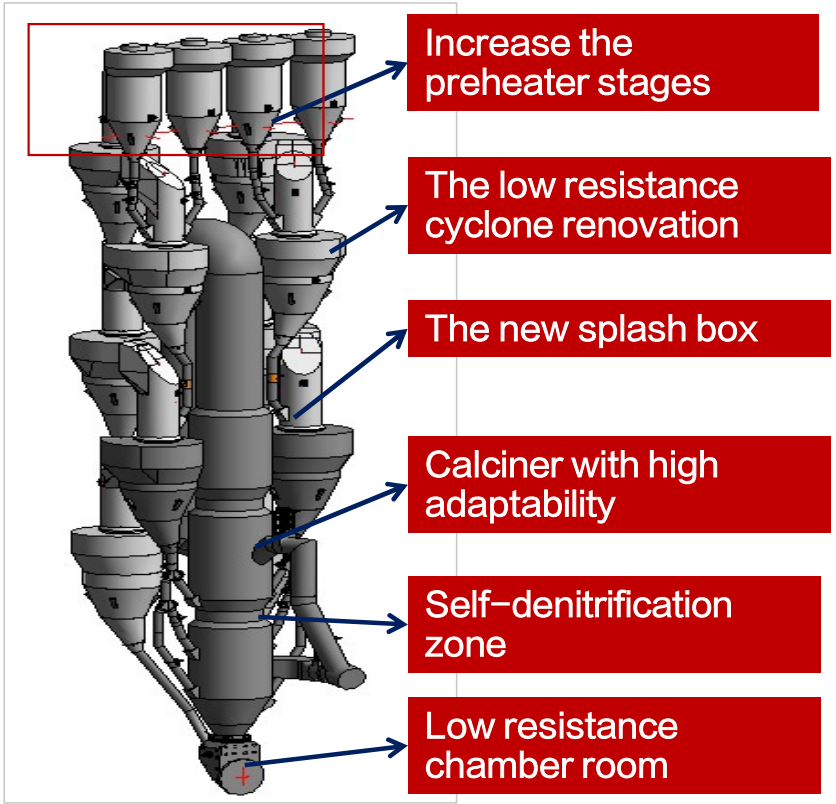


- ✓ Using second-generation equipment for firing technology: standard coal consumption<94 kg/kg.cl
- ✓ Adopting weak eddy low resistance technology: clinker power consumption<40.5 kWh/t.cl
- ✓ Using developed self denitrification calciner, achieving self-denitrification efficiency over 60% in calciner
- ✓ Adopting the fourth generation walking-floor cooler, rising the heat recovery efficiency 5%
- ✓ Using new nano thermal insulation materials, low thermal conductivity composite bricks and other new materials, the surface heat dissipation is reduced by 20%



1.Technical Renovation of the Pyro-system

1.1 High energy efficiency and low-carbon preheater and calciner system

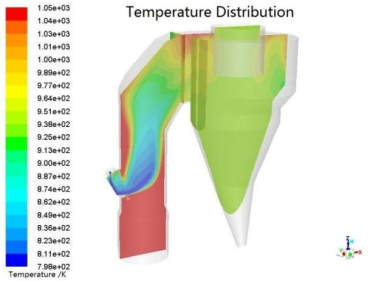


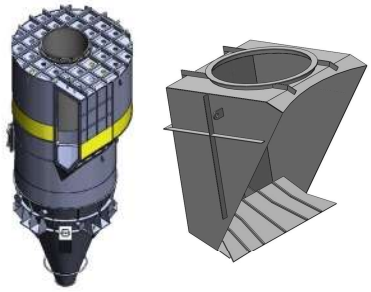
NO.	Content of renovation	
1	Optimization of calciner (self-denitrification)	Increase height and expand capacity
2		Optimization of the tertiary air duct
3		Optimization of coal burner
4	Preheaters	Enlarge the cyclones' inlet
5		Change the splash box
6		Optimization of material valve
7	Increase the preheater stages	Change 5-stages to 6-stages
8	Thermal insulation materials	Nano thermal insulation materials
9		Energy saving composite bricks for rotatory kiln
10	Optimization of raw material	Mineralizers, etc
11	Kiln burner	Low primary air burner
12		Rich oxygen combustion technology

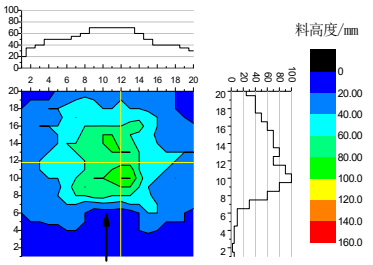
Reduce the coal consumption of clinker by about 3–10 kgce/t. cl (depending on the renovation content)

1.Technical Renovation of the Pyro-system

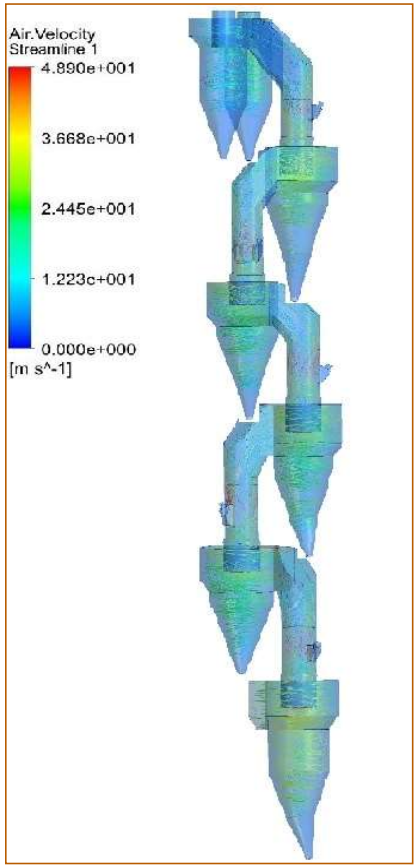
1.1 High energy efficiency and low-carbon preheater and calciner system

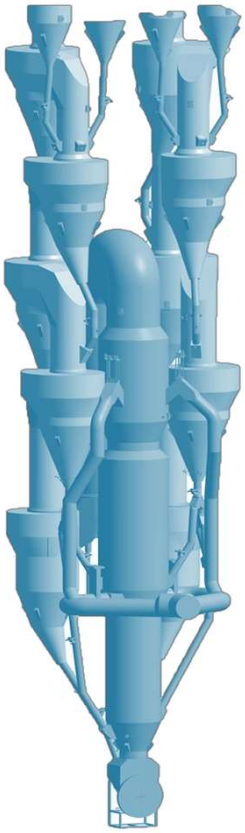






5度插入200mm撒料分布图





Fuel saving

- ✓ Improve the efficiency of gas-solid heat transfer by air locking valve and splash box
- ✓ Optimizing the cyclones structure
- ✓ Adopting the latest insulation material
- ✓ Preheaters outlet: temperature ≤ 260 ℃, dust content ≤ 60g/Nm3, CO ≤ 200ppm

Energy saving

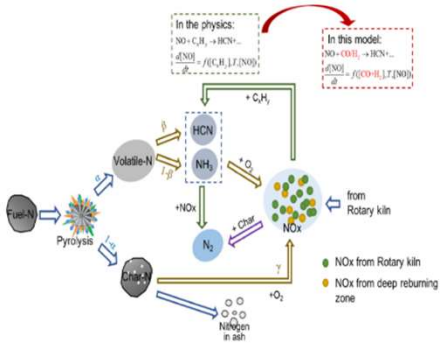
- ✓ Optimize the inlet and outlet air speed and inner tube diameter of the cyclone lower the resistance
- ✓ Reduce internal air leakage: the calciner outlet O_2 ≤ 2.0%, preheters outlet O_2 ≤ 2.5%
- ✓ Preheaters outlet: pressure ≤ 5000Pa (standerd capacity)

Intelligent control

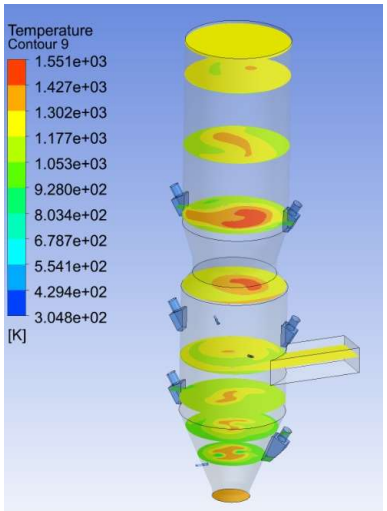
- ✓ Early stage: computational simulation is used to study the flow field
- ✓ Design: using the digital methods to carry out the deign
- ✓ Production: Using expert system to optimize the operating parameters

1.Technical Renovation of the Pyro-system

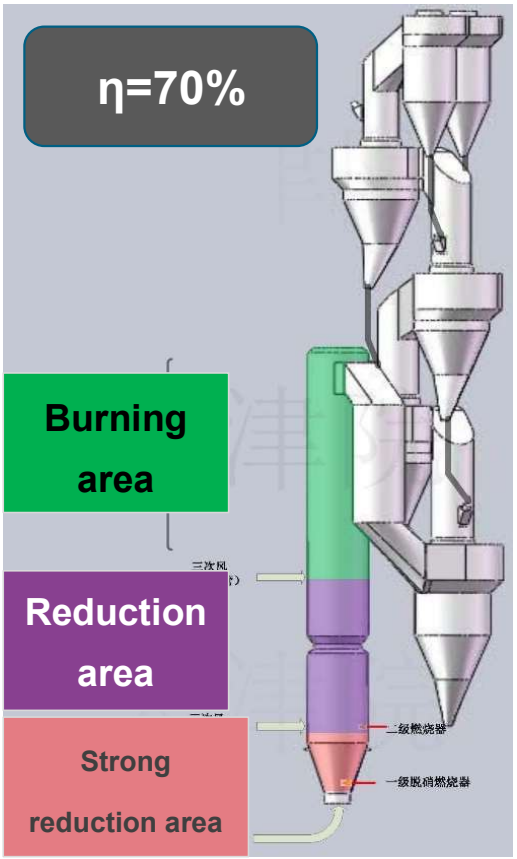
1.2 Calciner optimizing and self-denitrification technology



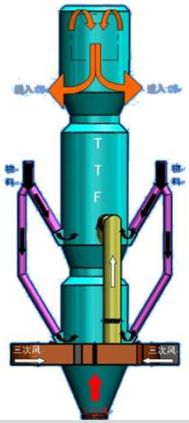
Denitration principle



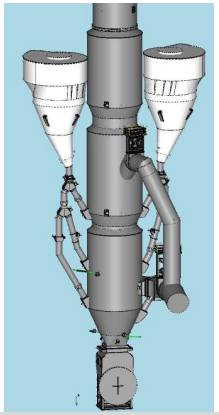
Self-denitrification design



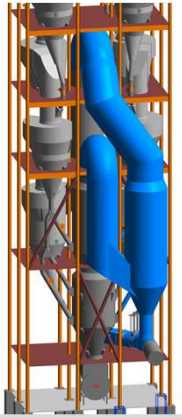
Original DD calciner



1st-generation calciner



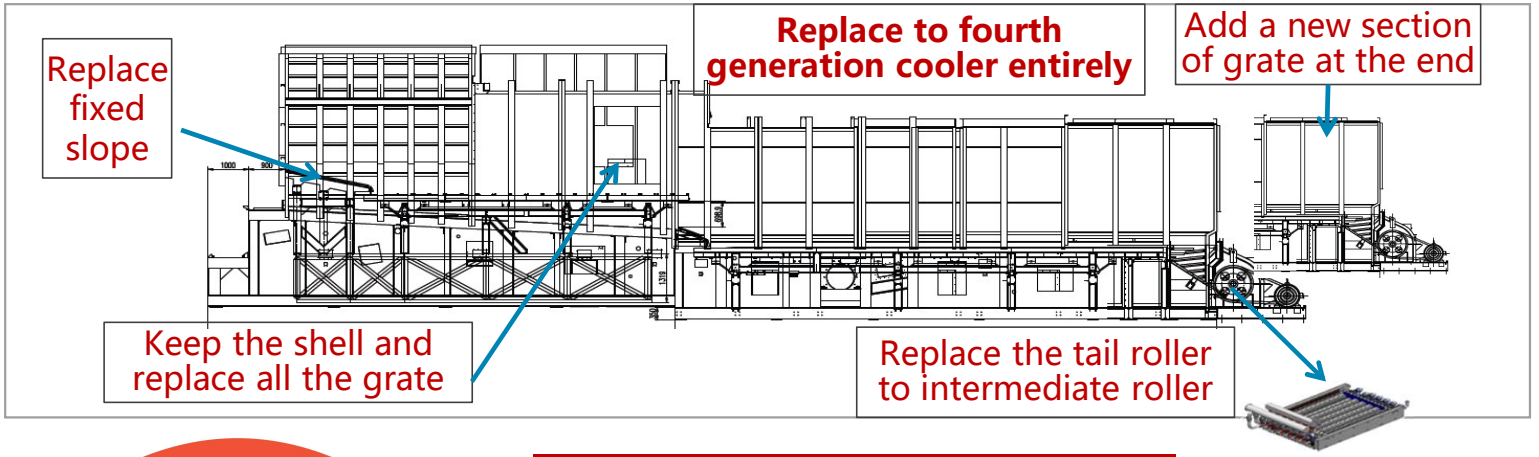
2nd-generation calciner



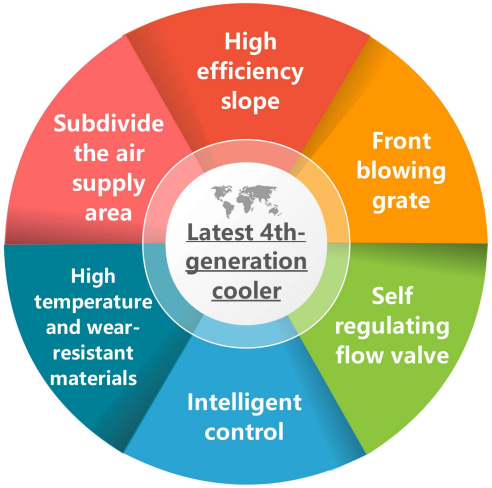
3rd-generation calciner

1.Technical Renovation of the Pyro-system

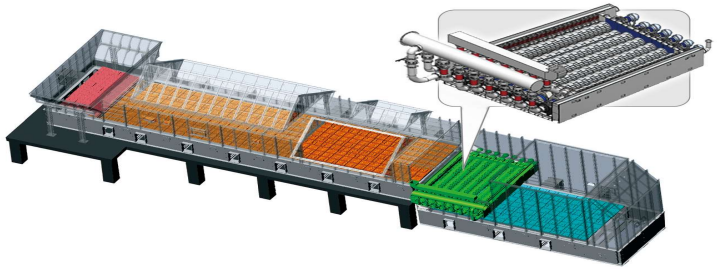
1.3 Cooler modification



The sales of the fourth generation cooler has exceeded 400 units, with over 200 units modification.



Realize multiple types of combinations to meet different levels of needs!!



NO.		Content of renovation
1	modificat-ion of cooler	Replace fixed slope
2		Keep the shell and replace all the grate
3		Add a new section of grate at the end
4		Replace the tail roller to intermediate roller
5		Replace to fourth generation cooler entirely

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2. Renovation Cases of Pyro-system

six-stages

■ Typical case for 10000tpd technical renovation project: **Xuzhou CUCC**

◆Original: Capacity is 10000t/d. The preheater (five stages) and kiln (6.0×90 m) were built in 2004.

◆Renovation: **Upgrade the five stages preheater to six stages preheater; Enlarge the calciner; Replace tertiary air duct and kilnlet chamber; Reduce the resistence of cylones and calciner; Upgrade cooler to Sinowalk cooler; Speed up the rotary kiln.**

◆The total construction period: **120 days**. After the renovation, the plant was put into operation in August, 2022.

Before

After

2. Renovation Cases of Pyro-system

- Typical case for 10000tpd technical renovation project: **Xuzhou CUCC**

Item	Original	Upgrade	Effect
Capacity(t/d)	10000	12900	↑2900
Heat consumption(kgce/kg.cl)	107	93	↓14
Power consumption(kW•h/t.cl)	56	49.54	↓6.5
Temperature of top cyclone(℃)	345	262	↓83
Pressure of preheater outlet(Pa)	-5200	-5500	6staged
CO at calciner outlet(ppm)	3000	41~380	↓2600
Clinker temperature(℃)	200	80	↓120
NOx emission at calciner(mg/Nm^3)	600	250~350	↓~300
NOx emission at chimney(mg/Nm^3)	~60	50(25)	↓10(35)
Waste heat power generation (kW•h/t.cl)	~31	24.5	To be renovated

2. Renovation Cases of Pyro-system

■ Typical case for 5000tpd technical renovation project: **Taishan CUCC**

six-stages

◆Original: Capacity is 5500t/d.

◆Renovation: **Upgrade the five stages preheater to six stages preheater; Enlarge the calciner; Replace tertiary air duct and kilnlet chamber; Reduce the resistence of cylones and calciner; Upgrade cooler to Sinowalk cooler; Speed up the rotary kiln.**

Item	Original	Upgrade	Effect
Capacity(t/d)	5500	6300	↑14.5%
Heat consumption(kgce/kg.cl)	112	94.9	↓18%
Power consumption(kW•h/t.cl)	60	47.2	↓27%
Temperature of secondary air(℃)	1050	1165	↑115
Temperature of tertiary air(℃)	950	1069	↑119
Strenth of clinker (MPa)	54	57	↑3
Clinker temperature(℃)	200	99	↓101
NOx emmsion(mg/Nm³)	70	47	↓49%

2. Renovation Cases of Pyro-system

■ Typical case for 3500tpd technical renovation project: **Sihui Junma**

◆Renovation: **Enlarge the calciner; Replace cooler entirely;Modification of cylones to lower resistence;Replace tertiary air duct & kilnlet chamber; Adjust the position of meal chute of C2 cyclone.**

◆Construction period: **65days.**

Item	Original	Upgrade	Effect
Capacity(t/d)	3600	4800	↑1200
Heat consumption(kgce/kg.cl)	123.5	102	↓21.5
Power consumption(kW•h/t.cl)	64	57	↓7
Temperature of preheater outlet(℃)	347	330	↓17
Pressure of preheater outlet(Pa)	-6000	-5700	↓300
Clinker temperature(℃)	180	90	↓90
Ammonia consumption(kg/t.cl)	0.65	0.5	↓0.15

2. Renovation Cases of Pyro-system

■ Typical case for 6000tpd technical renovation project: **2# line in Nanyang CUCC**

◆Renovation: **Enlarge the calciner; Modification of cylones to lower resistence; Replace kiln burner & cooler; Replace tertiary air duct & kilnlet chamber.**

◆Construction period: **65 days**.

Item	Original	Upgrade	Effect
Capacity(t/d)	6150	7590	↑1440
Heat consumption(kgce/kg.cl)	106	101	↓5
Power consumption(kW•h/t.cl)	53	47.8	↓5.2
Temperature of preheater outlet(℃)	340	310	↓30
Pressure of preheater outlet(Pa)	-6000	-5500	↓500
Clinker temperature(℃)	190	90	↓100
NOx emission at calciner(mg/Nm^3)	477	260	↓217
NOx emission at chimney(mg/Nm^3)	80~100	38.51	↓50
Ammonia consumption(kg/t.cl)	4.1	3.8	↓0.3

2. Renovation Cases of Pyro-system

- Typical case for cooler technical renovation project: **Changxing South Cement**

◆Renovation: Upgrade the original 3rd-generation cooler to **fourth-generation intermediate crush cooler**.

◆Construction period: **46 days**.

Item	Original	Upgrade	Effect
Capacity(t/d)	5000	5800	↑800
Clinker temperature(℃)	155	63.42+A	↓60
Temperature of secondary air(℃)	1050	1192	↑142
Heat consumption (kgce/kg.cl)			↓2.153

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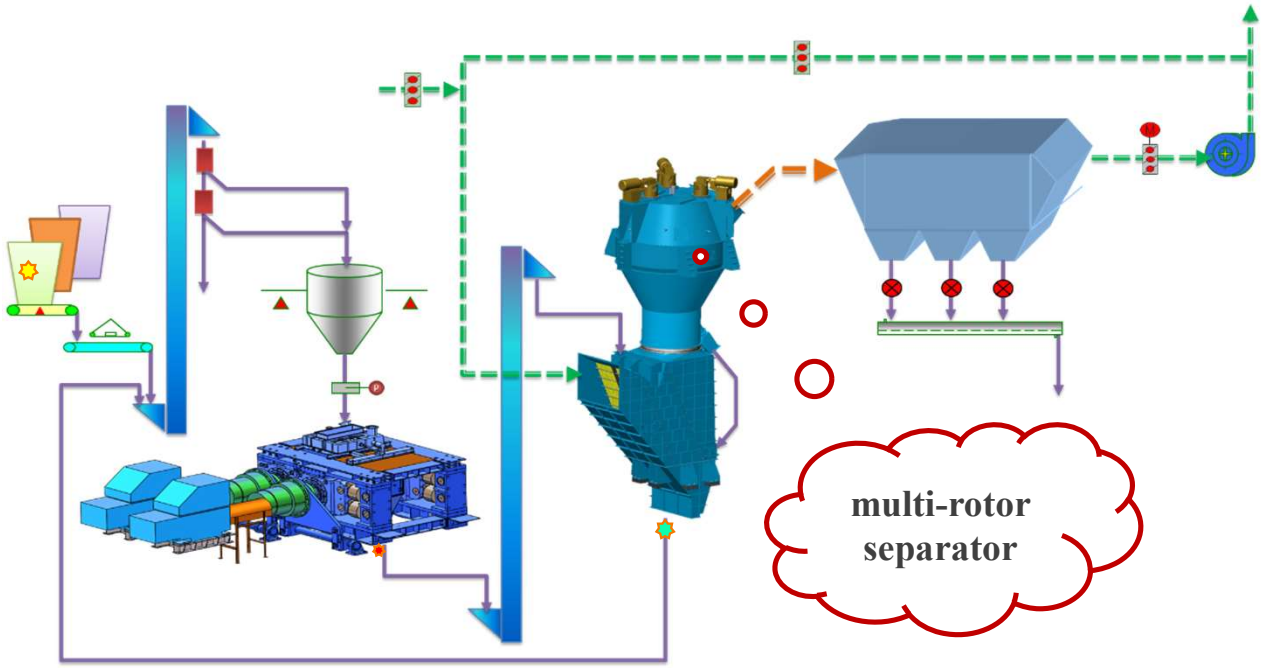
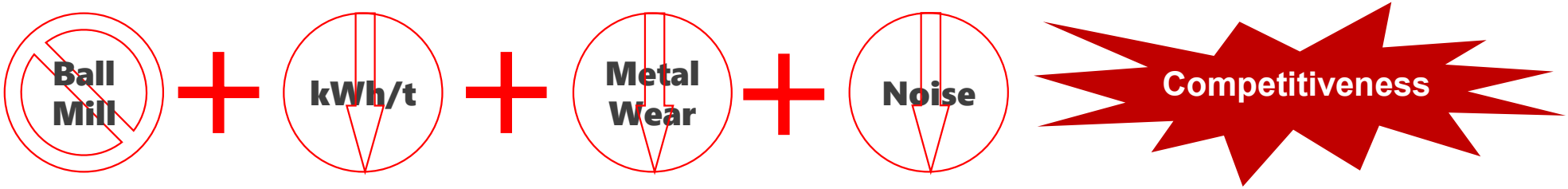
3. Roller press cement finished grinding technology

3.1 Summary

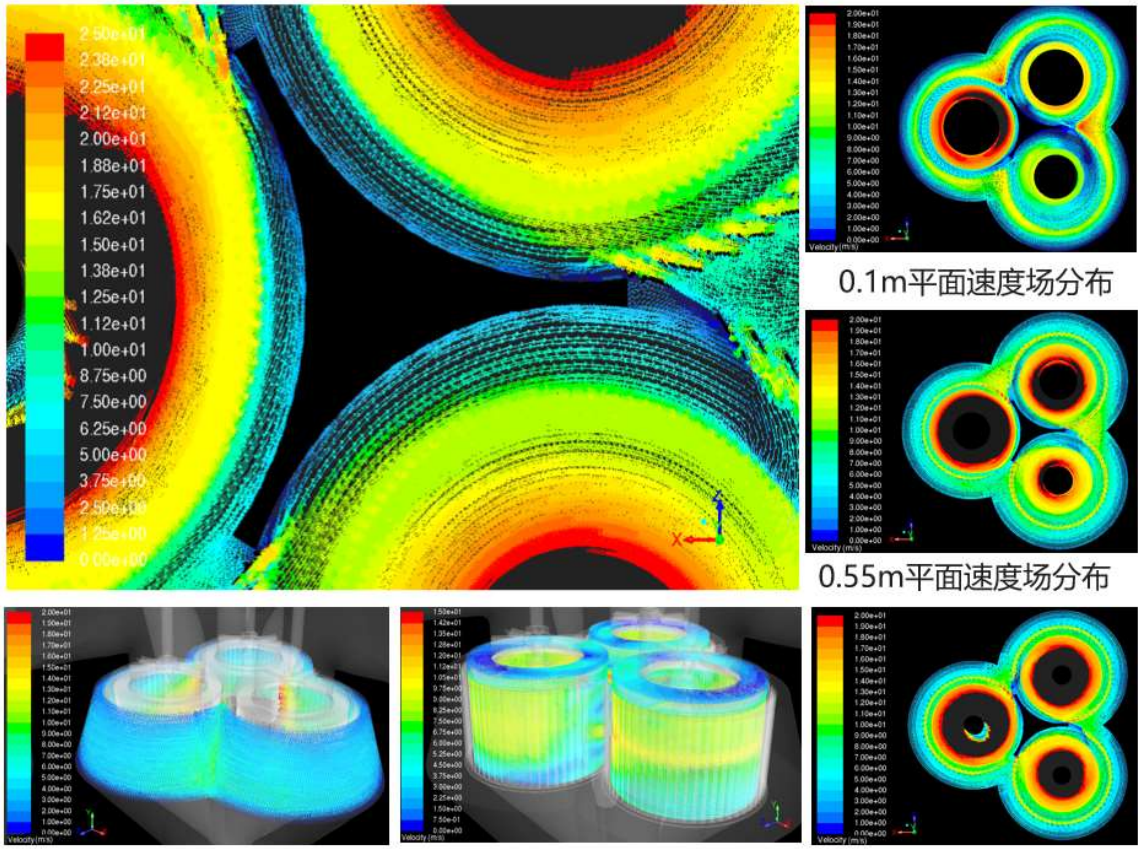
- Cement products are all made by roller press
- The performance of the cement is controlled by multi-rotor separator
- System power consumption is 20% lower than combined grinding system
- The product temperature is 20 ℃ lower than system with ball mill



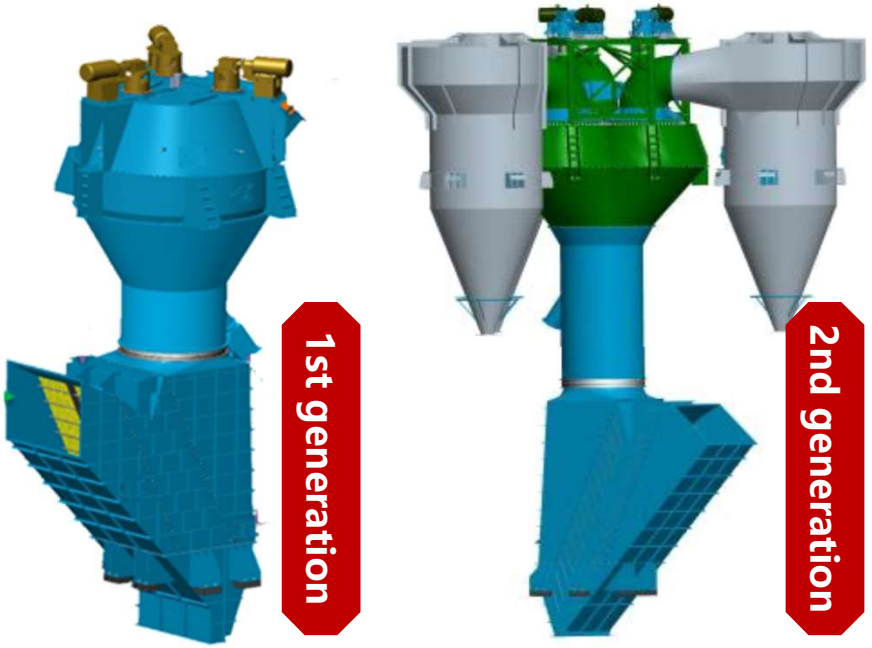


3. Roller press cement finished grinding technology

3.2 multi-rotor separator

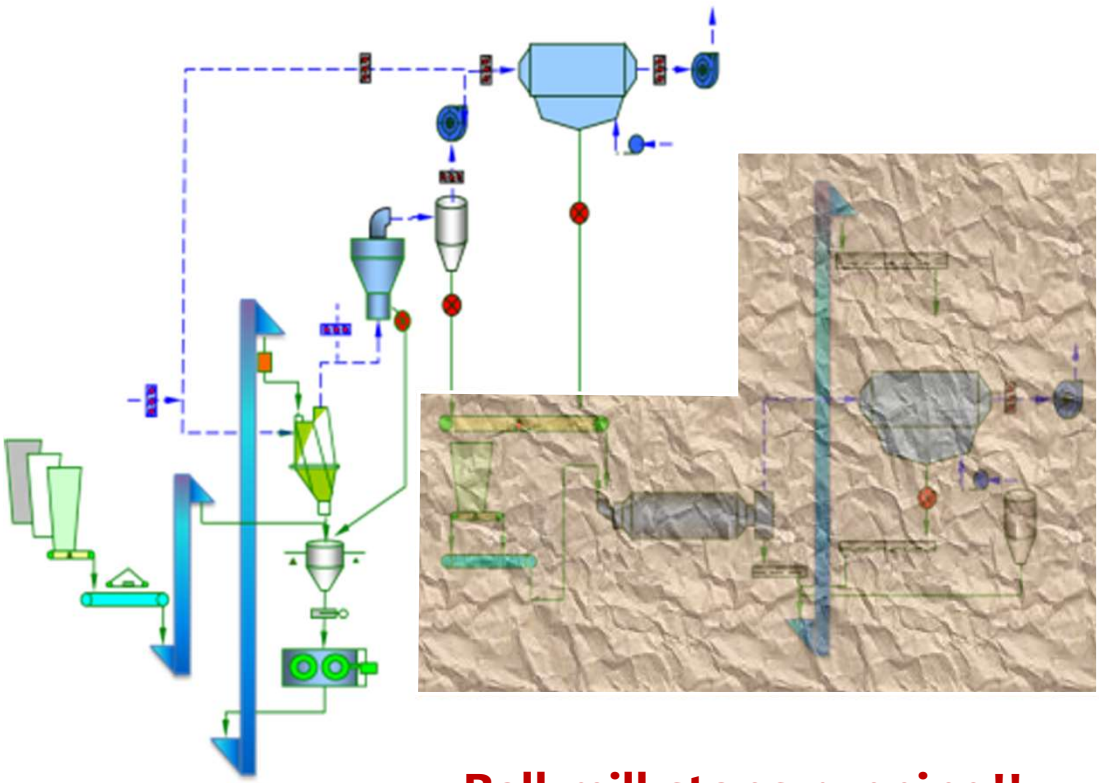


- 3 rotors independent drive independent control
- reasonable structure pressure loss is lower , separation efficiency is higher
- particle size distribution is adjusted stepless, performance of the product is better



3. Roller press cement finished grinding technology

3.3 Reference1： TRP180-140 cement finished grinding system



Ball mill stops running!!

Roller Press	TRP180-140
Roller Press size	φ1800mm×1400mm
motor of roller press	2×1400 kW
separator	240000 m³/h
circulating fan	265000 m³/h
Ball mill size	φ3.8m×13m
motor of ball mill	2500 kW

3. Roller press cement finished grinding technology

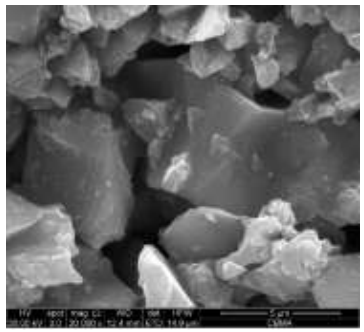
3.3 Reference1： TRP180-140 cement finished grinding system

clinker	limestone	Gypsum	slag powder
78~81%	2~4%	3.5~5%	10~12%

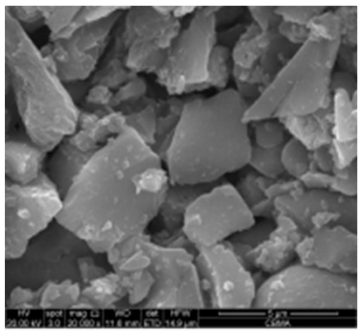
running mode		finished grinding	combined grinding
cement type		P·O42.5	
output	t/h	152.5	195.1
System power consumption	kWh/t	22.6	26.2
R45um	%	5~6	4~5
Blaine	m^2/kg	350	350

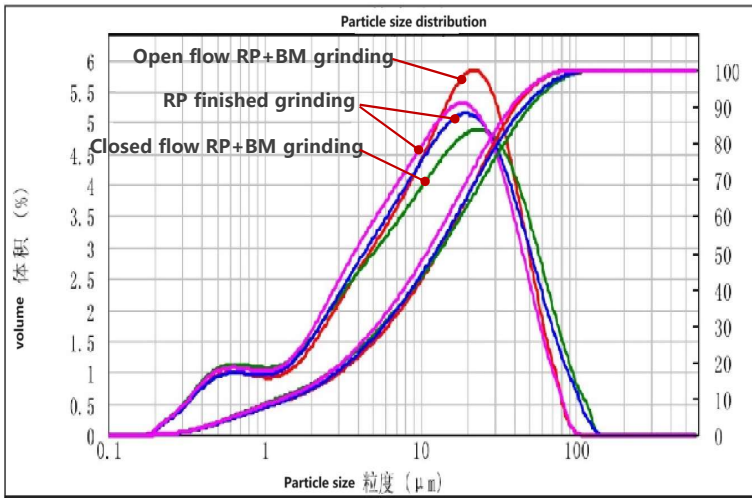
Comparison of test results of cement physical properties			
Compare items	combined grinding (open flow)	combined grinding (closed flow)	finished grinding
water requirement	26.5~27.5	27.6~28.6	27.5~28
cement fluidity	260~270	250~290	250~280

RP finished



Open flow BM





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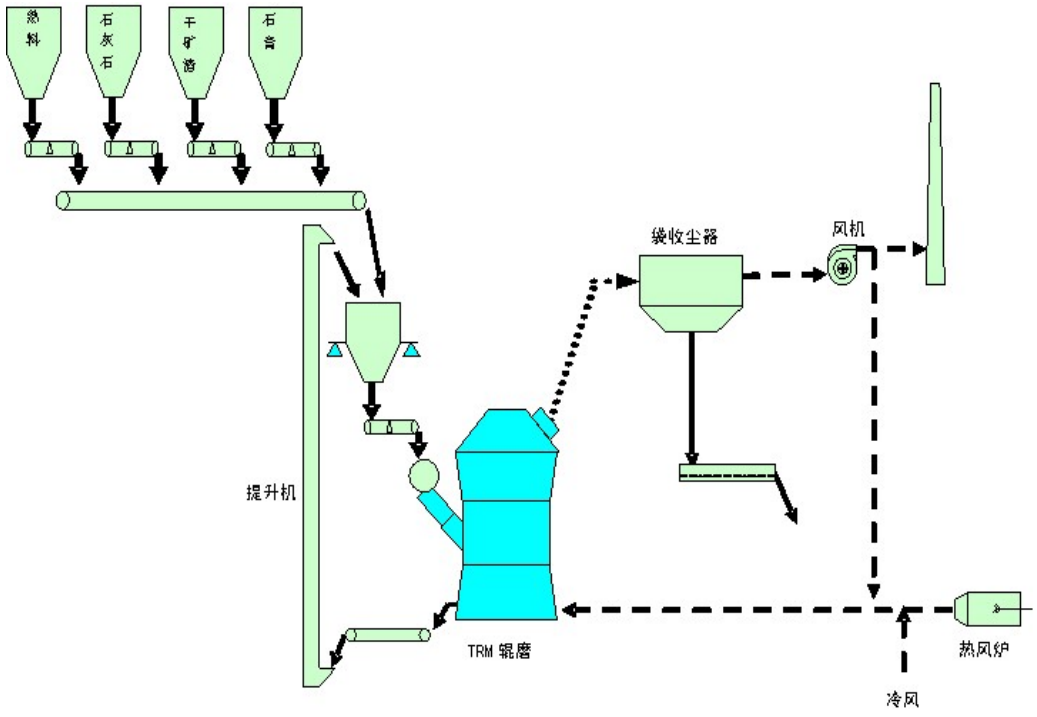
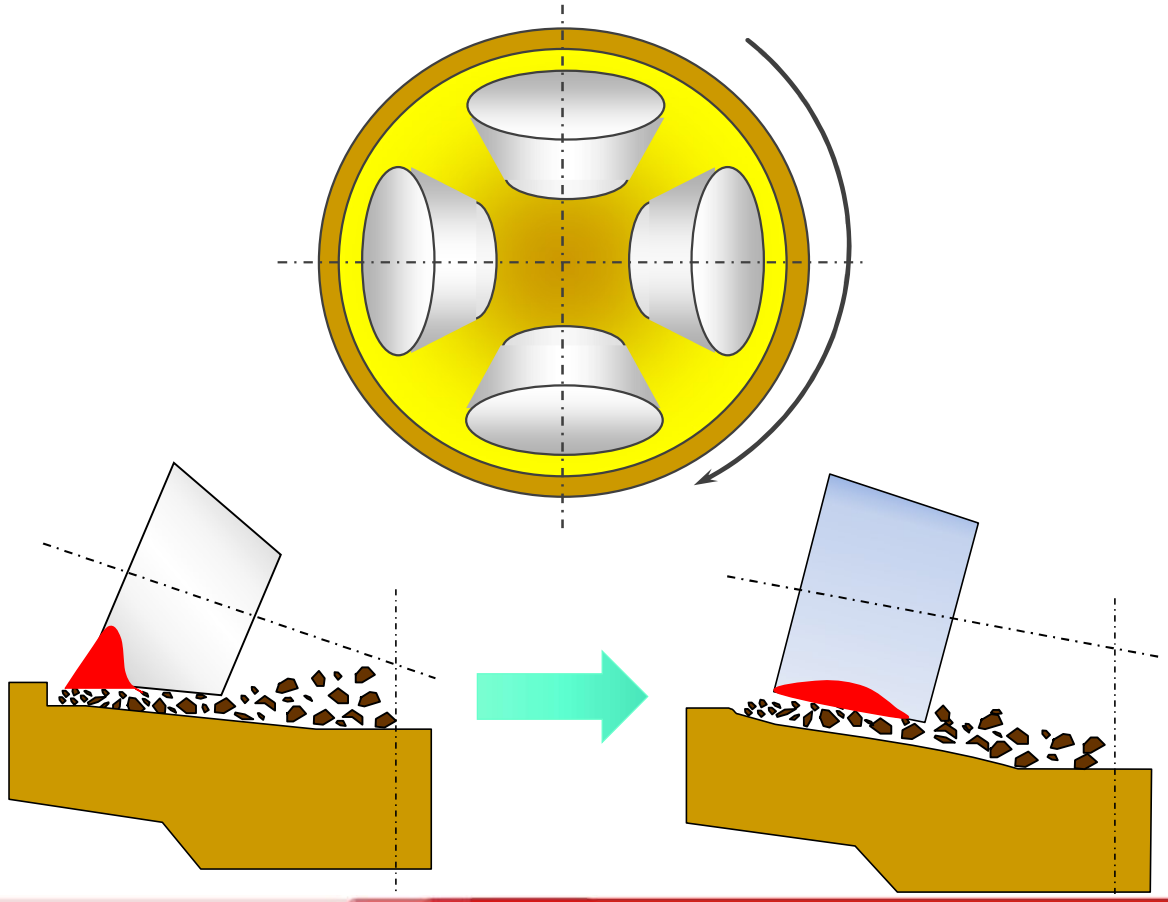
4. Roller mill cement finished grinding technology

4.1 Summary of Vertical Roller Mill Finish Grinding

Technical Characteristics

51 references





4. Roller mill cement finished grinding technology

4.2 Reference1：TRMK60.3 cement finished grinding

TRMK60.3(6300kW) in TH cement			
Item	**Clinker**	**FGD**	**Limestone**
Proportion, %	90	6.5	3.5

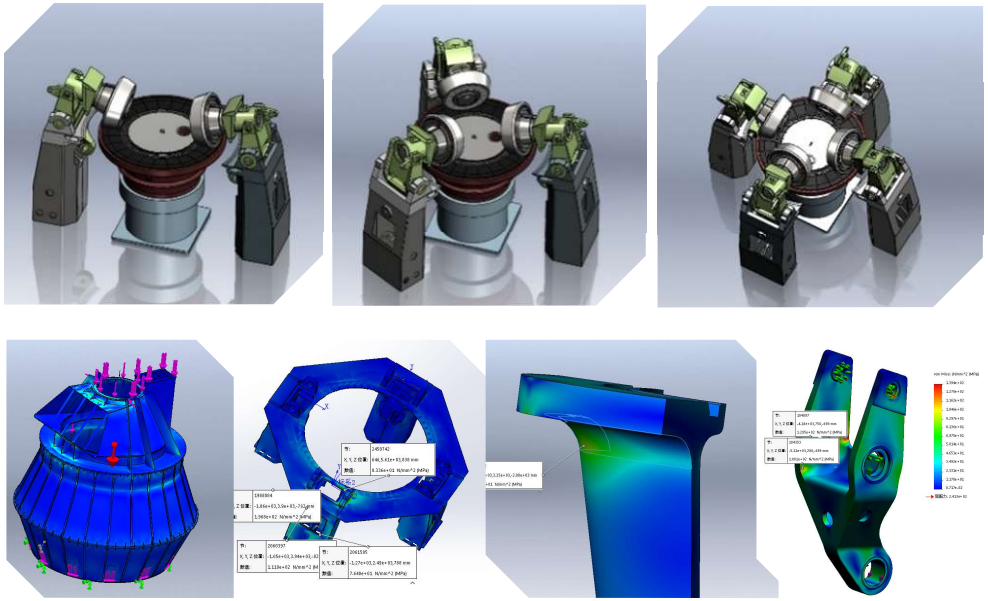
Item	Guarantee	Operation
Output, t/h	260	280
SSB,m^2/kg	350	370
SPC, kWh/t	/	26.5
NC,%	/	25.8
Output@3500cm^2/g, t/h		300

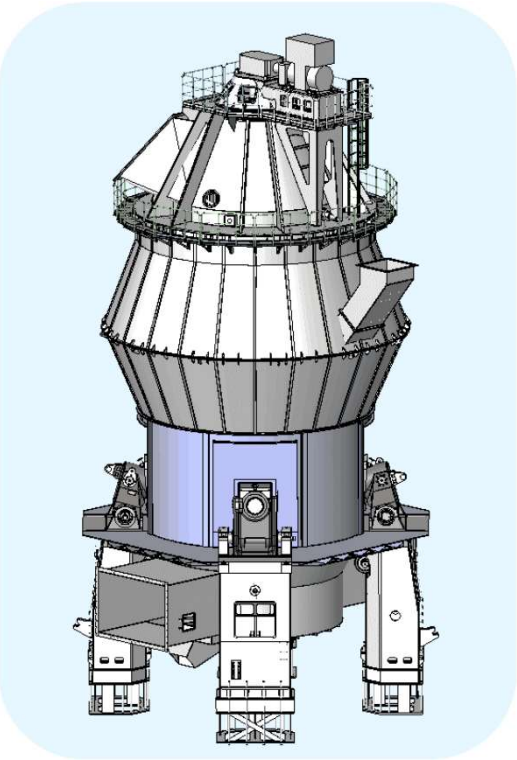
3. Roller mill cement finished grinding technology

3.3 Reference2：TRMK70.4 cement finished grinding

Large size based on **New drive**

- ✓Modular Design
- ✓Finite element calculation for key parts
- ✓Fluid calculation for system
- ✓On-line monitoring





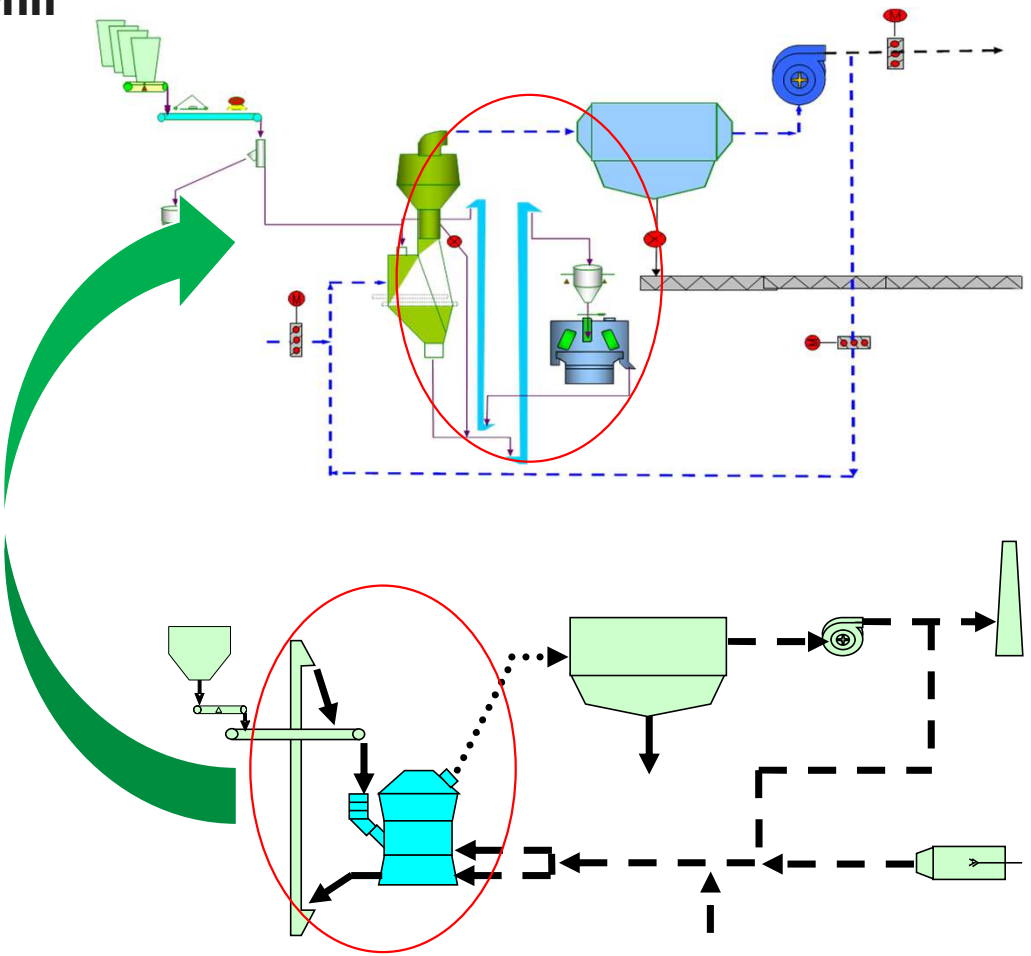
Item		Parameter
Model		TRMK70.4
Installed Power	kW	8800
Cement type		PO42.5
Capacity	t/h	400
Mill main motor Pc	kWh/t	18-21
System Pc	kWh/t	25-30

4. Roller mill cement finished grinding technology

4.4 External Circulation Vertical Roller Mill

Technology features

- Pressure drop decrease by 2500Pa
- Air flow decrease by 40%
- Power consumption decrease by **3kWh/t**



PO42.5 Cement	IC-VRM	EC-VRM	Difference
Output, t/h	160	160	
Blaine,m^2/kg	350	350	
SPC, kWh/t	26±1	23±1	-3

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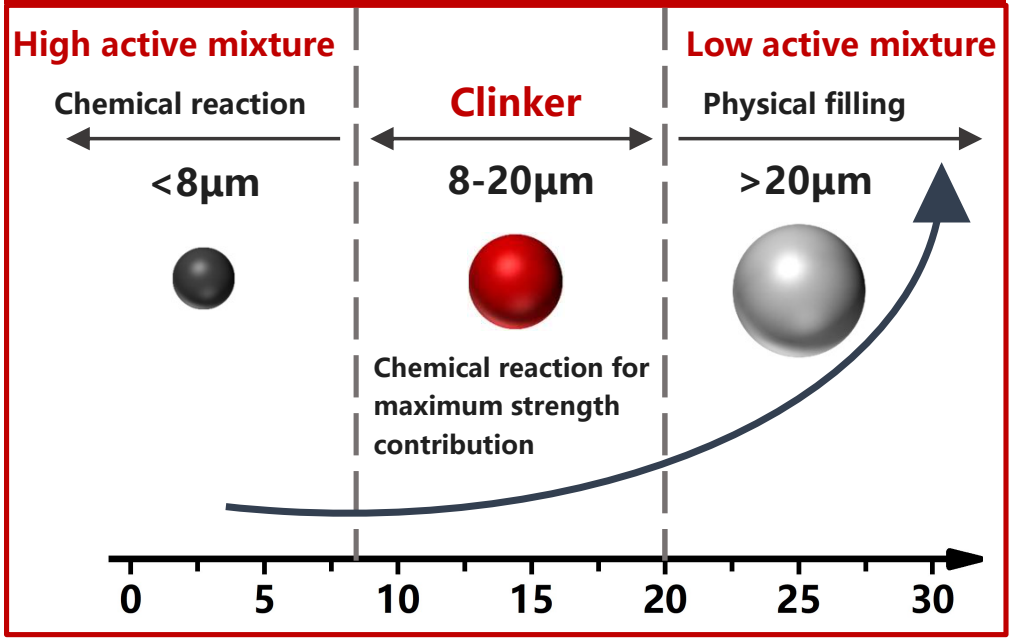
5. Separate grinding technology for cement

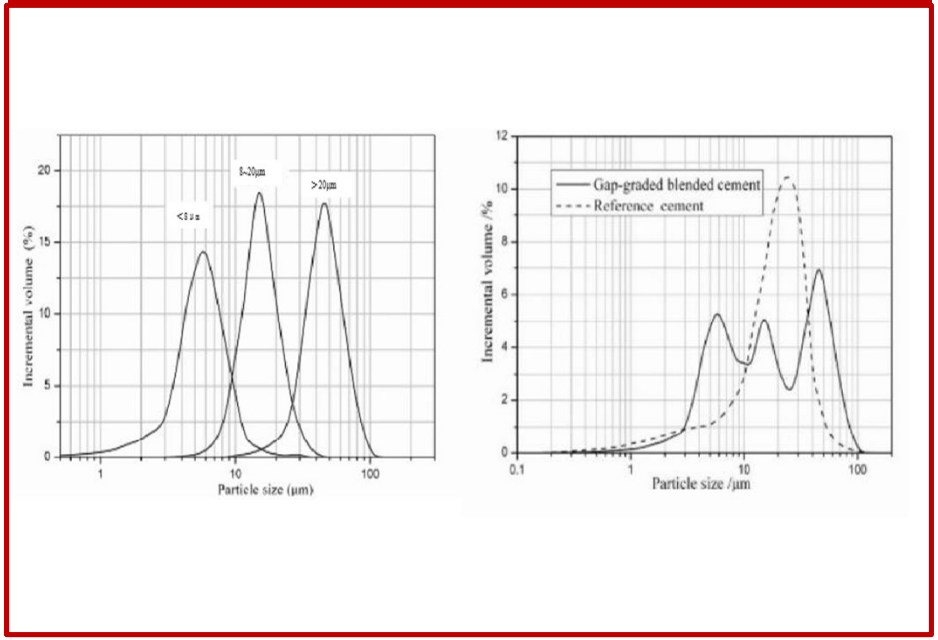
5.1 Technical Route

◆ Graded design for cementitious materials



Match cement composition by activity

◆ Optimized Particle Size Distribution

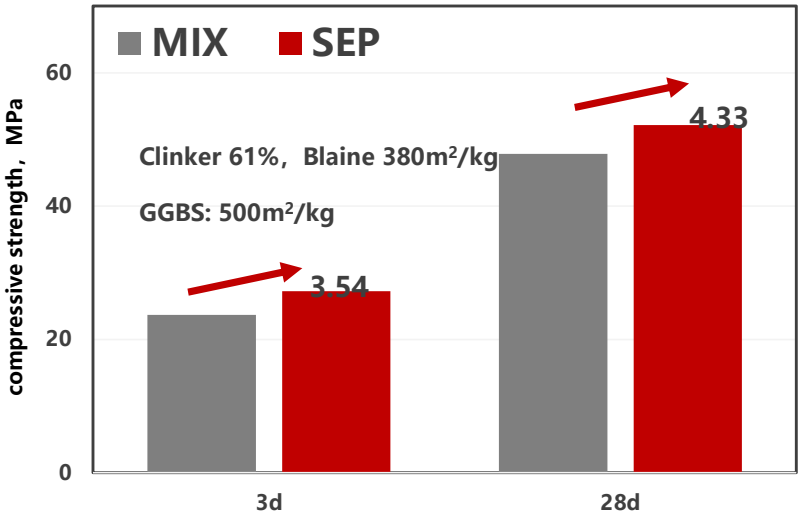


Multi-interval composite particle size distribution

5. Separate grinding technology for cement

5.2 Experimental Study

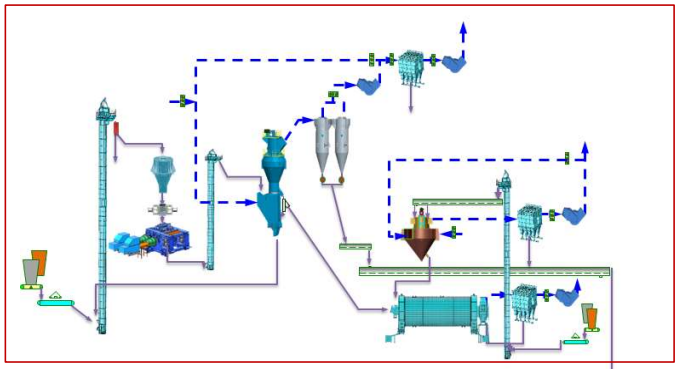
- The key is to grind finer clinker and GGBS.
- Compared with mixed grinding, compressive strength is 3.0MPa higher at 3d and 3.5MPa higher at 28d.
- For P•O42.5, the proportion of "clinker + GGBS " can be reduced by 14% (3d>27MPa, 28d>50MPa)

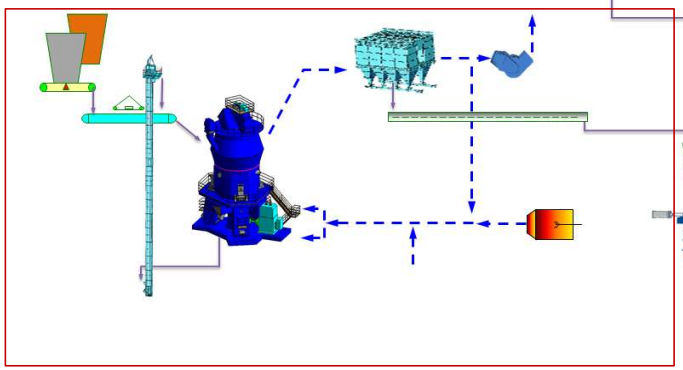


Item	Clinker ,%	GGBS, %	Clinker+ GGBS,%	SSB,m²/kg	$R_{45\mu m}$, %	NC,%	3d,MPa	28d,MPa
MIX M1--42.5	72.5	8.5	81	364	5.5	27.6	27.8	51.4
MIX M2--42.5	65.7	10.0	75.7	374	6.2	28.2	25.2	47.2
SEP S1--42.5	61	6	67 (low14%)	395	9.2	26.5	27.2	52.2
SEP S1--42.5	55.1	12	67.1 (low9%)	380	12.0	27.3	24.9	51.0

5. Separate grinding technology for cement

5.3 Reference1： Wuhan Yangluo，operation in 2022





RP+BM grinding system

Clinker89%+Gypsum5%+Limestone5%

Blaine: 360~390m²/kg， $R_{45\mu m}$5~8%

Output: 340t/h

SPC:~23kWh/t

VRM final grinding system

GGBS

Blaine: 420~450m²/kg (/guameite 10%)

Output: 101t/h

SPC: 33~34kWh/t

mixing

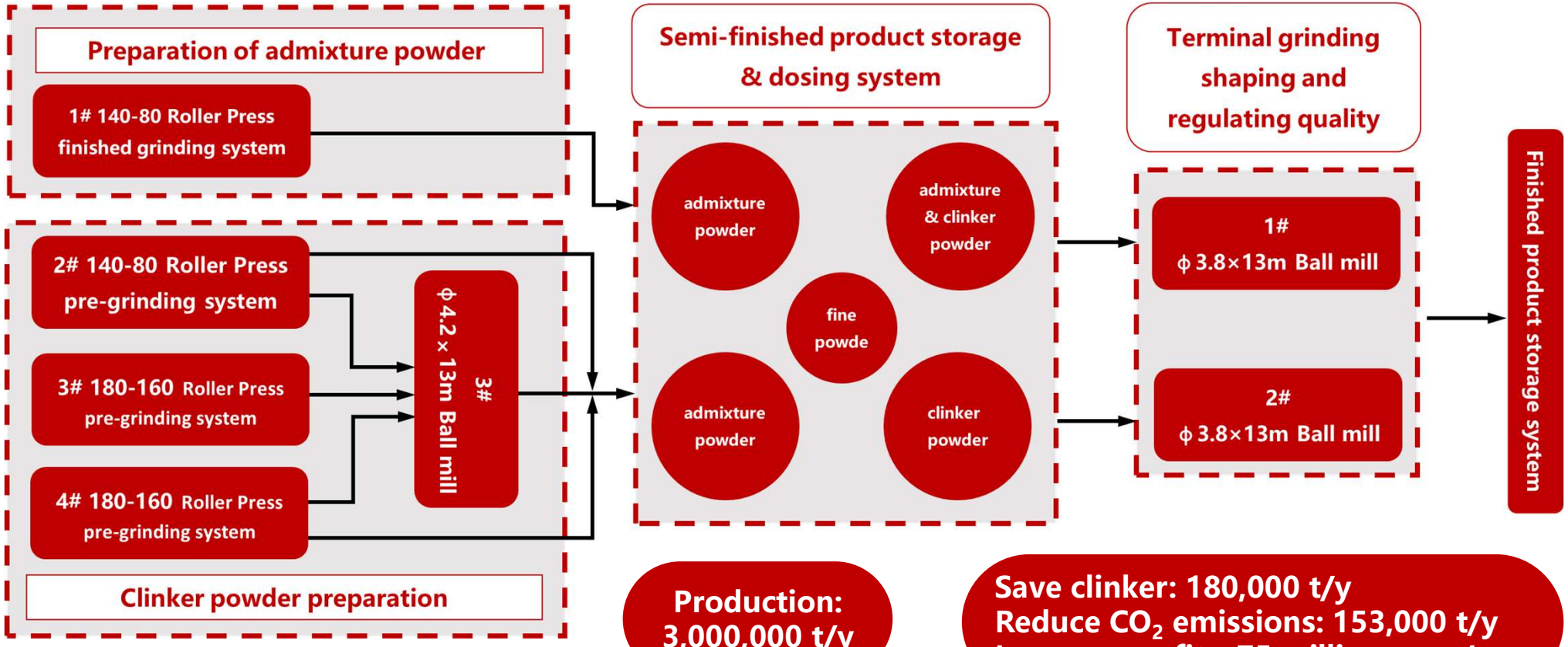
PO42.5 PC42.5
PC32.5 PM32.5

clinker ratio
Reduced by 4~7%

5. Separate grinding technology for cement

5.4 Reference2： Meizhou Huangma

Clinker consumption reduced by 5%~8%



Production: 3,000,000 t/y

Save clinker: 180,000 t/y
Reduce CO_2 emissions: 153,000 t/y
Increase profits: 75 million yuan/y

CO_2 emission is 850kg per ton of clinker

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Materials create a beautiful world

Thanks