

# ***SHOTCRETE TECHNOLOGY***

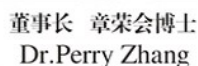
不定形耐火材料湿法喷注技术



UNSHAPED  
REFRACTORY  
MATERIALS



**联合荣大企业集团**  
Allied Rongda Enterprises

## Company profile



联合荣大整体通过ISO9001质量管理体系认证，总部检测中心通过国家实验室认可委员会认可，和商标为北京市著名商标。

Adhering to the principle of service “help customers solve problems with high efficiency”, and insisting on the business philosophy "High-quality personnel, Efficient management, High-quality products, High-tech service", the Group provides the customers with service of high quality wholeheartedly!



High-Level Talents    High-Efficiency Manage    High-Quality Products    High-Technology Service





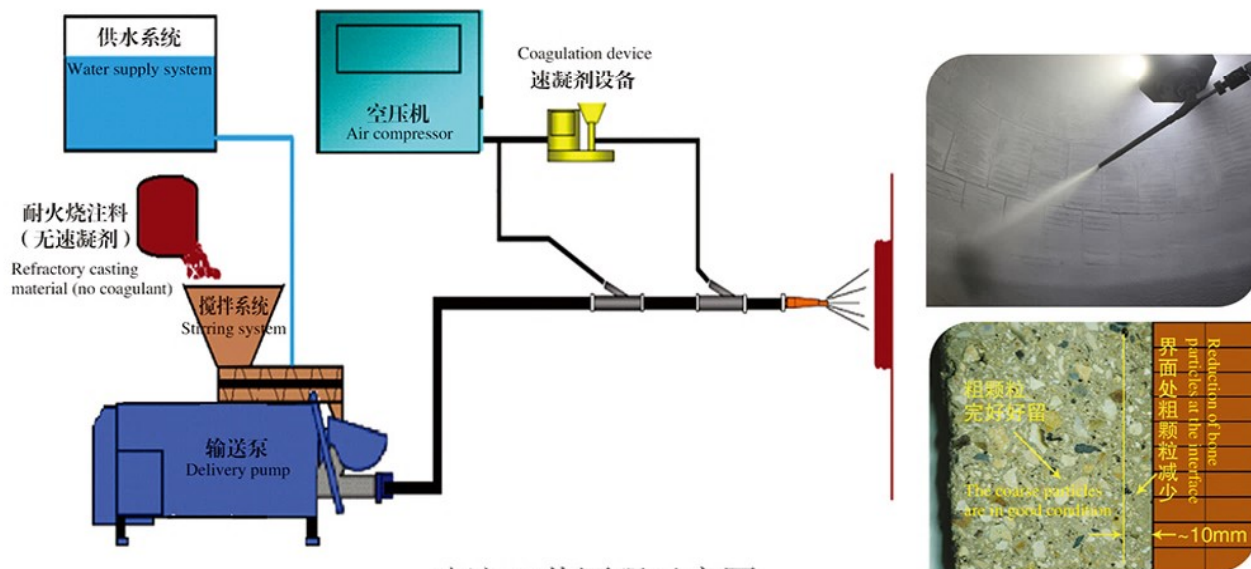
## 喷注施工工艺原理

### Technology Principle of Shotcrete Construction

喷注=喷涂法实现混凝土浇注 (Shotcrete=Shot Concrete)

预混均匀的自流料，经由管道输送至喷枪，在靠近喷枪口部位引入高压气体和速凝剂，自流料在被喷出的同时与充分雾化的速凝剂混合，瞬间丧失流动性，黏附到基材表面并快速固化

Pre-mixed uniform flow of materials, through the pipeline to the spray gun. At the close of the nozzle, the high pressure gas and accelerating agent are introduced, and the flow of the material is mixed with the full atomization, the instant loss of fluidity, adhesion to the surface of the substrate and rapid solidifying.



喷注工艺原理示意图  
Schematic diagram of shotcrete process principle

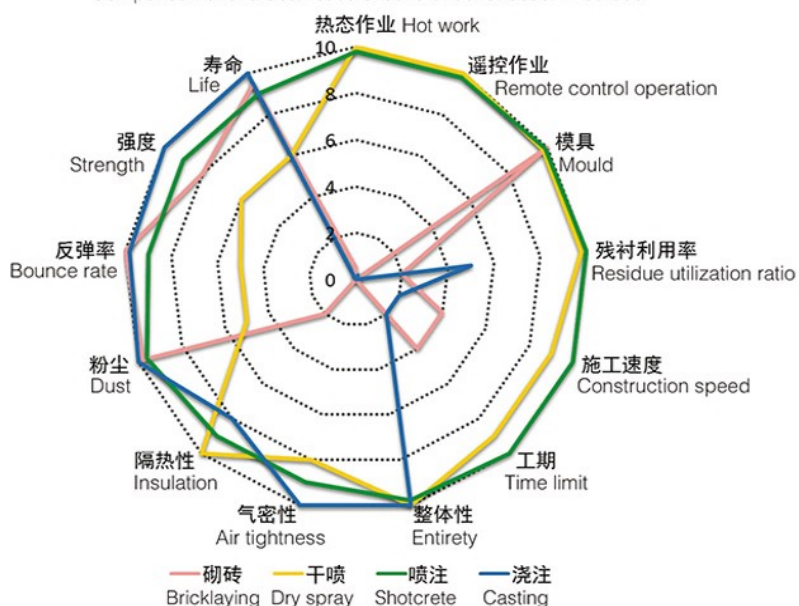


## 喷注施工技术优势

### Technology advantage of shotcrete

#### 几种施工方式特性比较

Comparison of characteristics of several construction methods



## 喷注造衬应用范围

### Application range of shotcrete

- ◆ 高炉造衬  
Blast furnace lining
- ◆ 出铁场铁沟热态修补  
Iron factory iron trough hot repair
- ◆ 铁水罐、鱼雷罐造衬及维修  
Molten iron tank, torpedo tank lining and maintenance
- ◆ 热风管道修补及造衬  
Hot air pipe repair and lining
- ◆ 石灰窑内衬修复  
Lining repair of lime kiln
- ◆ 转炉内衬修补  
Converter lining repair
- ◆ 钢包修补及造衬  
Ladle repair and lining
- ◆ 加热炉修补  
Repair of heating furnace
- ◆ 烟囱造衬  
Stack lining

# 高炉喷注造衬技术 Shotcrete Technology For Blast Furnace Lining

## 针对高炉各部位不同使用环境进行材料选择及方案设计

Selecting materials and designing schemes which point at different application parts of Blast Furnace

### 上升管、下降管 RISER PIPE, DROP PIPE

RGP-CN低铁高强喷注料  
RGP-CN low iron and High strength  
Spray coating

### 炉身上部 UPPER SHAFT

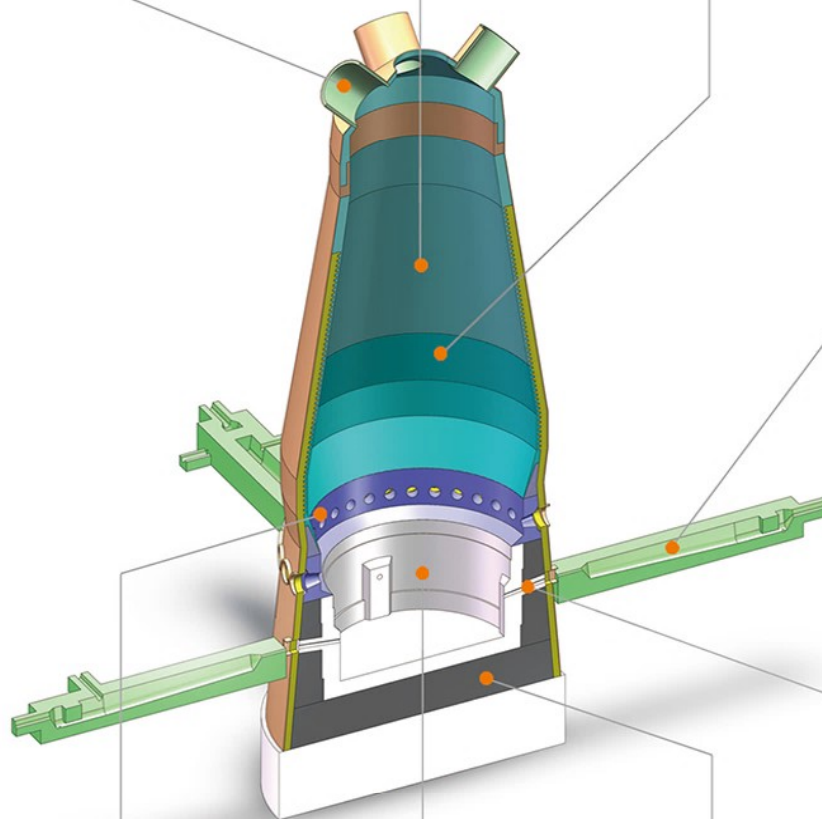
RGP-CM低铁莫来石高强喷注料  
RGP-CM low iron and High strength  
Spray coating

### 炉身中下部 LOWER PART OF THE BODY

RGP-CA刚玉碳化硅质喷注料  
RGP-CA Corundum silicon carbide  
Spray coating

### 铁沟 IRON TROUGH

RGP-CG主沟修补喷注料  
RGP-CG Main channel repair spray  
coating



### 风口区域 TUYERE AREA

RGP-SF风口修复喷注料  
RGP-SF tuyere area repair spray  
coating

### 炉缸陶瓷杯 THE CERAMIC CUP HEARTH

RGP-SG溶胶结合刚玉  
碳化硅质泵送料  
RGP-SG, Corundum silicon carbide  
pump Castables

### 炭砖 CARBON BRICK

RGP-SD高导热泵送料  
RGP-SD, High heat conduction heat  
pump-feed Castables

### 铁口 IRON MOUTH

RGP-CK铁口修复喷注料  
RGP-CK, iron mouth repair spray  
materials

## 材料特性: Material properties

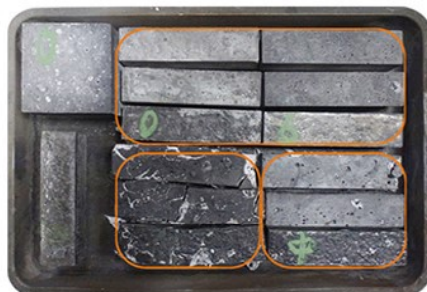
### 高炉中上部材料特性: Characteristics of material in the upper and middle of blast furnace

强度高, 耐磨性、抗冲击性好, 抗CO侵蚀性能优异。

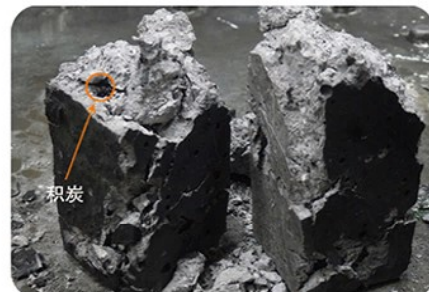
High strength, wear resistance, good impact resistance, Excellent resistance to CO corrosion resistance.



抗CO侵蚀前  
Before CO erosion



抗CO侵蚀后  
After CO corrosion



抗CO侵蚀性能差的试样自行崩裂  
Samples of poor CO-erosion resistance to crack





### 高炉下部喷注料特性:

#### Characteristics of injection material in the lower part of blast furnace

耐高温、抗渣铁侵蚀、易形成渣铁保护。

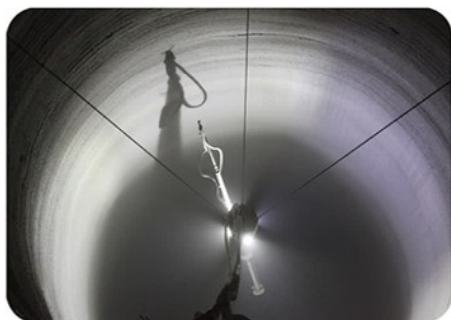
High temperature resistance, slag iron erosion, easy to form slag iron protection.

### 风口部位喷注修复:

#### Injection repair of air outlet

对破损风口组合砖修补或完全取代。

Repair or replace the damaged composite brick.



### 技术工程队伍: Technical construction team

5支专业化队伍, 10套专业化设备

Five professional teams, ten sets of specialized equipment.

### 辉煌业绩: Outstanding achievement

截至2017年2月底, 喷注造衬技术已在国内外280余座高炉 (180-4038m<sup>3</sup>) 上成功应用。

Until the End of Feb. 2017, the remote shotcreting lining technology has been successfully applied in more than 280 blast furnaces at domestic and abroad.

### 效果: Application Result

### 几座高炉喷注前后几项关键运行指标对比

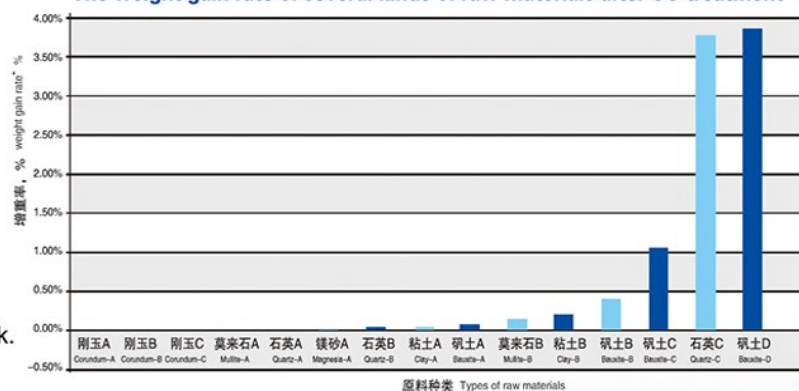
Comparison of several key operating indexes before and after shotcrete of several blast furnaces

| 厂家<br>Manufacturer                                       | A  |   | B  |   | C  |   | D  |   |
|--|--|---|--|---|--|---|--|---|
| 炉容 (m <sup>3</sup> )<br>Volume                           | 450  |   | 1260   |   | 2500   |   | 4038   |   |
| 项目<br>Item   | 喷注前<br>2个月以上<br>Before shotcrete<br>More than 2 months | 喷注后<br>3-6个月<br>After shotcrete<br>3-6 months | 喷注前<br>2个月以上<br>Before shotcrete<br>More than 2 months | 喷注后<br>9-12个月<br>After shotcrete<br>9-12 months | 喷注前<br>2个月以上<br>Before shotcrete<br>More than 2 months | 喷注后<br>3-6个月<br>After shotcrete<br>3-6 months | 喷注前<br>2个月以上<br>Before shotcrete<br>More than 2 months | 喷注后<br>3-6个月<br>After shotcrete<br>3-6 months |
| 煤比 (kg/t)<br>Coal ratio                                  | 110  | 110   | 139  | 155   | 90   | 120   | 137  | 130   |
| 焦比 (kg/t)<br>Coke ratio                                  | 535  | 474   | 414  | 376   | 410  | 360   | 344  | 320   |
| 燃料比 (kg/tFe)<br>Fuel ratio                               | 660  | 610   | 577  | 547   | 550  | 520   | 547  | 510   |
| 冷却水温差 (°C)<br>Temperature difference<br>of cooling water | 10   | 6   | 4  | 3   | 9  | 5   |  |   |
| 利用系数 (t/m <sup>3</sup> .d)<br>Utilization coefficient    | 2.80   | 2.98  | 2.56   | 2.70  | 1.92   | 2.24  | 1.60   | 2.00  |
| 煤气利用率 (%)<br>Gas utilization rate                        | 45   | 47  |  |   |  |   | 44   | 50  |
| 富氧率 (%)<br>oxygen enrichment                             | 1.00   | 1.00  | 2.40   | 2.90  |  |   |  |   |
| 负荷<br>load   | 2.90   | 3.10  | 4.17   | 4.58  |  |   |  |   |

说明: 0-3个月数据为开炉运行稳定后数据 Description: 0-3 month data is in stable operation data

### 几种原料经CO处理后增重率 (450°C × 72h)

The weight gain rate of several kinds of raw materials after CO treatment

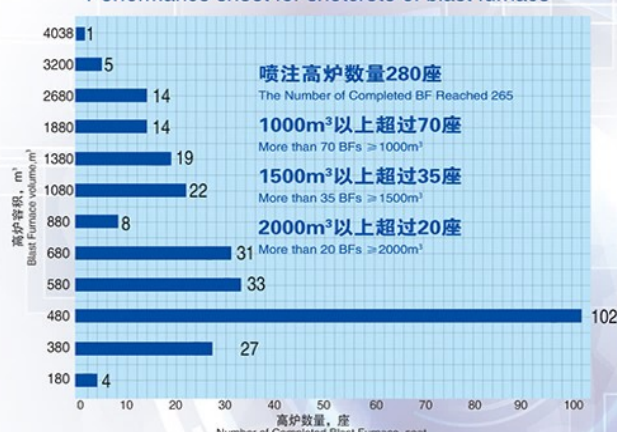


### 几种原料抗CO侵蚀性能对比

Comparison of several materials against CO corrosion resistance

### 高炉湿法喷注业绩表

Performance sheet for shotcrete of blast furnace



| 高炉容积, m <sup>3</sup> | 180 | 380 | 480 | 580 | 680 | 880 | 1080 | 1380 | 1880 | 2680 | 3200 | 4038 |
|----------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 高炉数量, 座              | 4   | 27  | 102 | 33  | 31  | 8   | 22   | 19   | 14   | 14   | 5    | 1    |



# 出铁场铁沟热态喷注修补技术

Iron factory iron groove hot shotcreting repair technology



## 工艺特点：

Process characteristics

- 不休风，出铁间隙施工，不影响产量  
Keep blowing, tapping space construction, does not affect the yield
- 热态作业，对铁沟基体损伤小  
Hot work, small damage to the iron matrix
- 节省材料，最大限度利用残衬  
To save materials, to maximize the use of residual lining
- 材料免烘烤，防爆  
Material exempt from baking, explosion proof



使用后期铁沟（单铁口小高炉）  
Late stage of iron trough  
(single iron of mouthsmall blast furnace)



铁沟热态喷注修补  
Hot shotcreting repair of iron trough



修补完毕  
After Construction

# 石灰窑喷注造衬技术

Shotcrete Technology of lining for lime kiln

## 石灰窑喷注造衬技术

Shotcrete Technology of lining for lime kiln

- 湿法喷注造衬新技术：一种采用喷射方法实现无模浇注的技术。将湿混均匀的浇注料通过泵送机输送至枪头，在促凝剂的作用下，浇注料瞬间失去流动性，填补内衬损毁部位。

Shotcrete Technology For Blast Furnace Lining: a method of injecting to realize non-mould casting. Wet mixed materials are delivered to the head of the gun through a pumping machine, under the action of the accelerator, the pouring materials instantly loses fluidity and fill the damaged part of the lining.

- 与传统砌筑工艺相比，该工艺不需要将窑内残砖大规模拆除，可直接在残砖表面喷注造衬，修复损毁部位，节省资金。  
The process does not need to large-scale removal of residual brick kiln, can be directly sprayed on the surface of the residual brick lining, repair the damaged parts, the maximum use of residual lining, saving materials.
- 无砖缝，整体性好，避免窜气窜火隐患。  
There is no brick gap, low damage.
- 通过植筋挂网加固，喷注层与残衬形成有效整体，提高结构强度。  
That can improve the strength of reinforcement, and the overall service life, substantially more than dry spraying.
- 施工速度8-15吨/小时，工期短，可快速投产。  
The construction speed is 8-15t/h, short duration, rapid resumption of production.
- 该技术已在高炉领域取代传统干法喷涂造衬工艺被广泛应用。  
The technology has been applied to more than and 300 blast furnaces at home and abroad.



## 石灰窑砖衬损坏情况

The lime kiln lining damage



## 几种典型修复工艺特性比较

Comparison of characteristics of several typical repair processes

| 项目<br>Item                         | 砌砖<br>Bricklaying   | 干喷<br>Dry spray   | 喷注<br>Shotcrete   |
|------------------------------------|---|---|---|
| 残砖利用<br>Residual brick utilization | 不能利用<br>None use  | 可利用<br>Use  | 可利用<br>Use  |
| 局部修复<br>Local repair               | 困难<br>Difficulty  | 容易<br>Easily  | 容易<br>Easily  |
| 修复速度<br>Repair speed               | 40~60天<br>40~60 Days  | 7~10天<br>7~10 Days  | 7~10天<br>7~10 Days  |
| 整体性<br>Entirety                    | 有砖缝<br>Brick gap<br>易漏气<br>Easy to leak<br>热损大<br>Large heat loss | 无砖缝<br>No brick seam<br>不易漏气<br>Not easy to leak<br>热损小<br>Heat loss is small | 无砖缝<br>No brick seam<br>不易漏气<br>Not easy to leak<br>热损小<br>Heat loss is small |
| 强度性能<br>Strength properties        | 40~50MPa<br>40~50MPa  | 30~40MPa<br>30~40MPa  | ≥75MPa<br>≥75MPa  |
| 反弹率<br>Bounce rate                 | 无<br>Nothing  | 15~25%<br>15~25%  | ≤8%<br>≤8%  |
| 粉尘<br>dust                         | 无粉尘<br>No dust  | 粉尘大<br>Large dust   | 无粉尘<br>No dust  |
| 干燥收缩<br>Drying shrinkage           | 基本不变<br>Basically unchanged                                       | 很大<br>Great   | 基本不变<br>Basically unchanged   |

## 石灰窑内衬喷注施工工艺流程

Process flow of shotcreting lining construction in lime kiln

**残衬清洗:** 高压水清洗窑内附着物及松动内衬, 确保喷注造衬达到粘结牢固、整体性好、附着率高、反弹量小的效果。

**Residual lining cleaning:** high pressure water washing kiln attachments and loose lining, to ensure that the spray lining to achieve strong adhesion, high integrity, high adhesion rate, small rebound effect.

**植筋挂网:** 为了提高喷注层结构强度及整体性, 喷注前可植筋挂网。损毁面积较小时可直接喷注。

**Bonded rebars and spread nets:** in order to improve the overall strength of the lining, before shotcreting, it would bond rebars and spread nets. While less damaged area, can be injected directly.

**喷注造衬:** 使用泵送装置输送材料, 喷注速度可达8~15吨/小时。

**Shotcrete lining:** the use of pumping equipment to transport materials, injection speed of up to 8~15t/h.

**养护烘炉:** 自然养护24小时后, 按照设定烘烤曲线进行烘炉。

**Furnace maintenance and Baking:** after maintenance of natural 24h, baking the furnace through the given curve.

## 部分业绩表

Partial User List

| 客户名称<br>Customer name   | 喷注位置<br>Injection position  |
|---|---|
| 天津荣程联合钢铁集团有限公司<br>Tianjin Rockcheck Steel Group Co. Ltd.        | 预热带、煅烧带、冷却带<br>Pre tropical zone, calcination zone, cooling zone                |
| 太原钢铁集团有限公司<br>Taiyuan iron and Steel Group Co., Ltd.            | 预热带、煅烧带、冷却带<br>Pre tropical zone, calcination zone, cooling zone                |
| 攀钢集团成都钢铁有限公司<br>Pangang Group Chengdu Iron & Steel Co., Ltd.    | 预热带、煅烧带、冷却带、混合室<br>Pre tropical, calcination zone, cooling zone, mixing chamber |
| 蒙阴中山矿业有限公司<br>Zhongshan Mengyin Mining Co., Ltd.                | 预热带、煅烧带<br>Pre tropical zone, calcination zone                                  |
| 临沂京华矿业有限公司<br>Linyi JINGWAH Mining Co., Ltd.                    | 预热带、煅烧带<br>Pre tropical zone, calcination zone                                  |
| 江西金城矿业有限公司<br>Jiangxi Jincheng Mining Limited Liability Company | 预热带、煅烧带<br>Pre tropical zone, calcination zone                                  |

## 残衬清洗

Residual lining cleaning



## 植筋挂网

Bonded rebars and spread nets



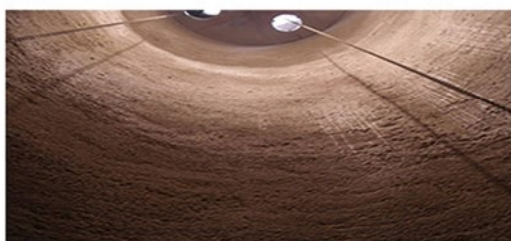
## 喷注造衬

Shotcreting lining



## 养护烘炉

Furnace maintenance and Baking





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