COMBUSTION IMPROVEMENT
MOBOTECPRC
MULTI-POLLUTANT REDUCTION

Mobotec's NOx and SOx Reduction Technology

摩博泰科公司的一体化脱硝脱硫技术

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Overview

概要

Mobotec Products
Mobotec主要产品和技术

- ROFA
  - Combustion Improvement
  - 50% NOx reduction
- ROFA & FSI
  - 60% to 90% SOx reduction
- ROFA & Rotamix & Catalyst
  - 90% NOx reduction

- ROFA
  - 燃烧改进
  - 可脱硝50%
- ROFA & FSI
  - 脱硫60-90%
- ROFA & Rotamix & 催化剂
  - 脱硝90%

Unique Mobotec Qualities
Mobotec技术的独特性

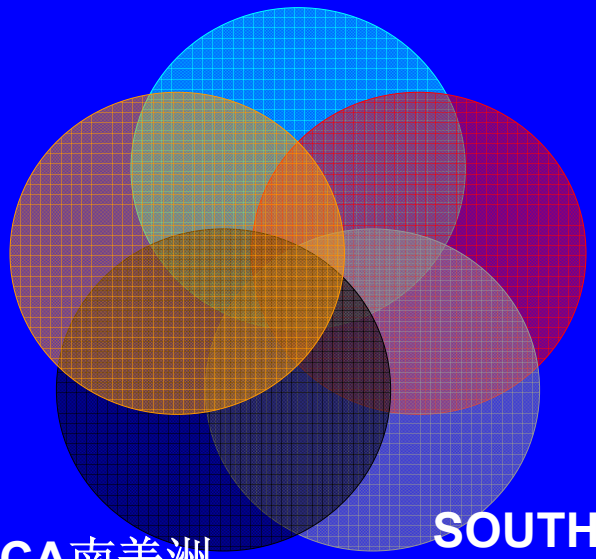
- Low cost solution
  - 60% to 70% less than FGD/SCR solutions
- Fixes Combustion Problems
- Integrated multi-pollutant control
  - SOx
  - NOx
  - CO
  - LOI
  - PM
  - Efficiency
- Proven results
- Small real estate requirement
- Phased Implementation

- 采用低成本技术
  - 低于传统FGD/SCR技术成本的60%到70%
- 解决现有燃烧问题
- 多重污染物控制及效果
  - SOx
  - NOx
  - CO
  - LOI（飞灰含碳量）
  - PM（微小颗粒）
  - 热效率
- 技术经过全面验证
- 占地小
- 分阶段安装

Mobotec Worldwide
Mobotec在世界上的主要分布

NORTH AMERICA一北美洲
Mobotec USA

EUROPE欧洲
Mobotec
International AB



CHINA中国
MobotecPRC

SOUTH AMERICA南美洲
Mobotec USA

SOUTH KOREA南韩
GSC-Mobotec USA
International

Mobotec Company Capabilities
Mobotec 公司的职能范围

- Analysis
  - CFD Modeling
  - Steam Side Thermal Modeling
  - Unit Systems Review
  - Trouble Shooting
- Engineering
  - System Design
  - System Integration
  - Project Management
  - Balance of Plant Engineering
- Construction
  - Management
  - Procurement
  - Fabrication
- Start Up and Tuning

- 理论分析
  - 计算机模拟
  - 蒸汽侧热计算
  - 机组系统评估
  - 解决实际问题
- 工程设计
  - 系统设计
  - 系统整合
  - 项目管理
  - 电厂总体工程布局
- 施工
  - 管理
  - 报价
  - 装配
- 锅炉启动及调试

Technology

技术介绍

NOx Reduction – 脱硝技术

- ROFA (Rotating Opposed Fire Air)
  - Boosted pressure
  - Over fired air
  - Targeted turbulent mixing
  - 50% NOx reduction co-benefit
  - Low real estate requirement
- Rotamix
  - SNCR
  - Urea or Ammonia Injection
  - Intense turbulent mixing
  - 70% to 80% reduction

- ROFA (旋转对冲炉顶风)
  - 增压射流
  - 炉上燃烬风
  - 强烈湍流混合
  - 50%脱硝效率
  - 占地小
- Rotamix
  - 属非选择性催化还原SNCR
  - 喷入尿素或氨
  - 强烈湍流混合
  - 70% to 80%脱硝效率

Features of ROFA – ROFA的特征

- Boost Fan – High velocity
- 25% to 35% of the TAF
- Targeted Turbulence
  - Multiple boxes
  - Multiple nozzles
  - Multiple elevations
  - Asymmetric = Swirl
- Designed by CFD modeling
- Designed by experience

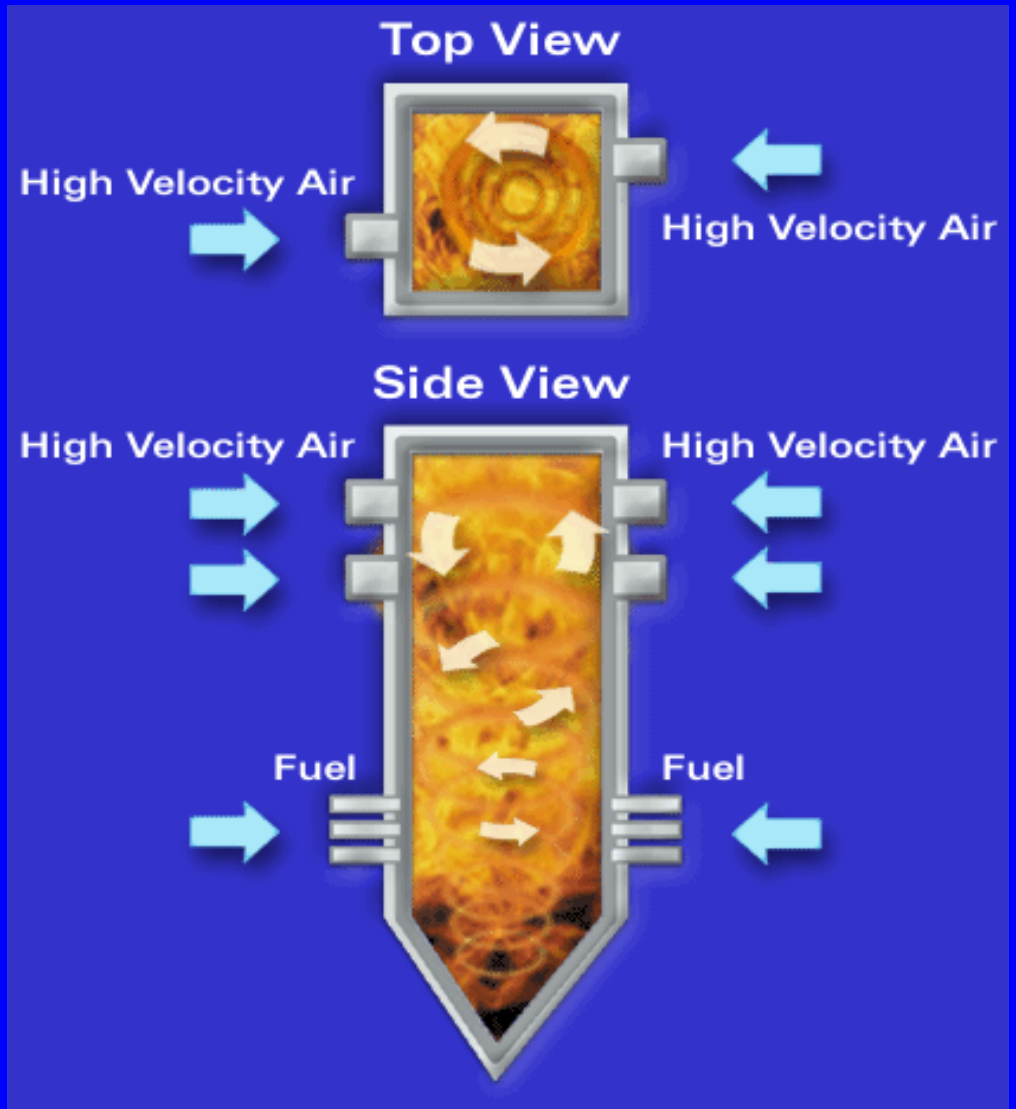
- 增压风机 – 高速射流
- 25% 到 35% 的炉内总风量
- 针对性湍流
  - 多个风箱
  - 多个喷口
  - 安装在不同的高度
  - 轴对称布置 = 旋转流
- 设计依赖于计算机理论模拟
- 设计也依赖于过去的经验

Significantly Better Combustion
燃烧显著改进

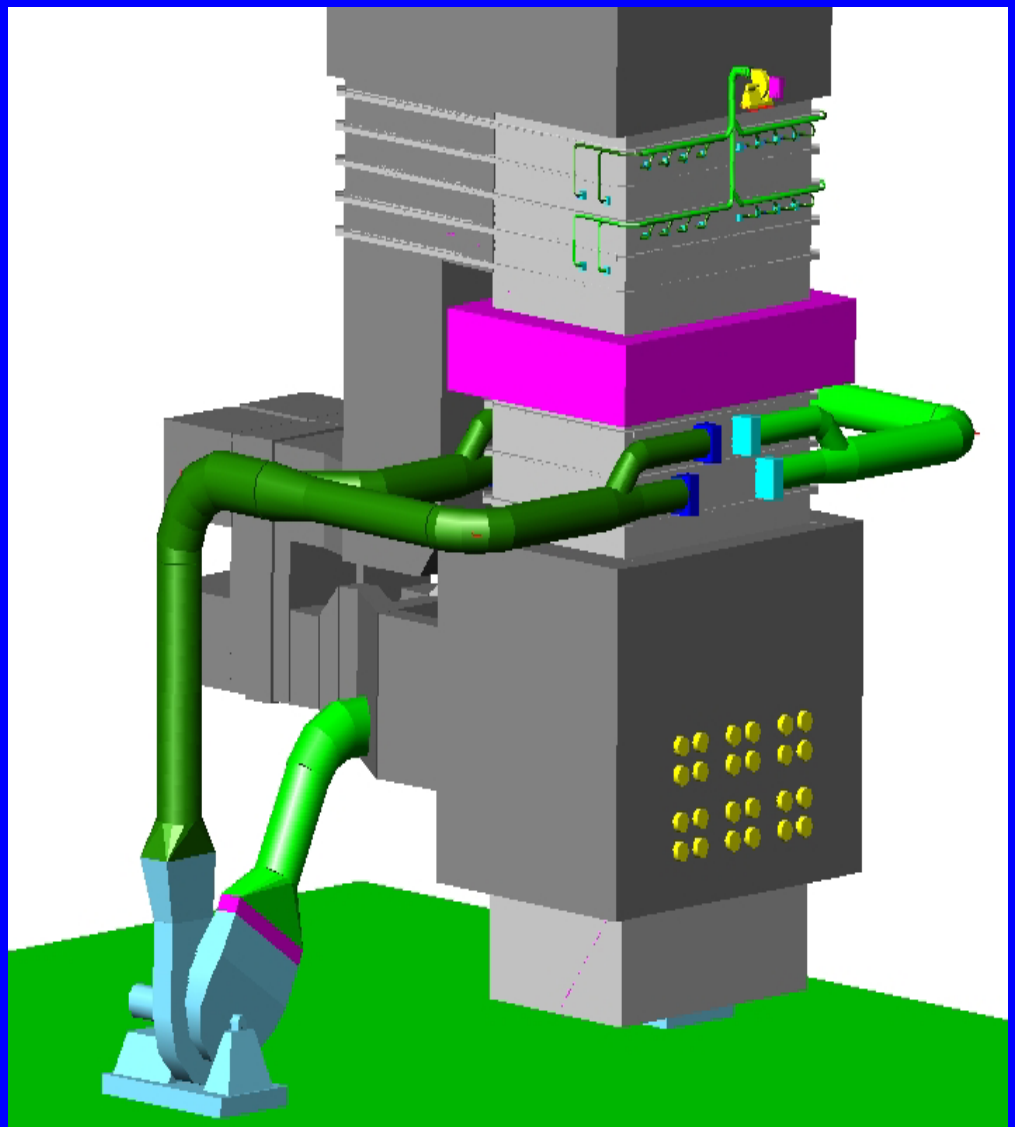
- Change burner settings
  - More burner spin
  - Better lower furnace mixing
- Targeted furnace mixing
  - ROFA (boosted OFA)
  - Lower CO (<50 ppm)
  - Lower O2 (<3%)
  - Better unit efficiency (>1%)
- Longer residence times
  - Lower LOI
  - Lower PM

- 燃烧器调整
  - 更大燃烧器旋转角
  - 更好的炉膛下部混合
- 有目标性的炉膛混合
  - 借助于ROFA高速射流
  - 低 CO (<50 ppm)
  - 可降低氧浓度(<3%)
  - 锅炉效率提高 (>1%)
- 停留时间长
  - 减少飞灰含碳量
  - 飞灰量也降低

ROFA 流动示意模型


Top View
High Velocity Air
High Velocity Air
Side View
High Velocity Air
High Velocity Air
Fuel
Fuel

600 MW Opposed Fired Unit
60万千瓦对冲式火焰锅炉



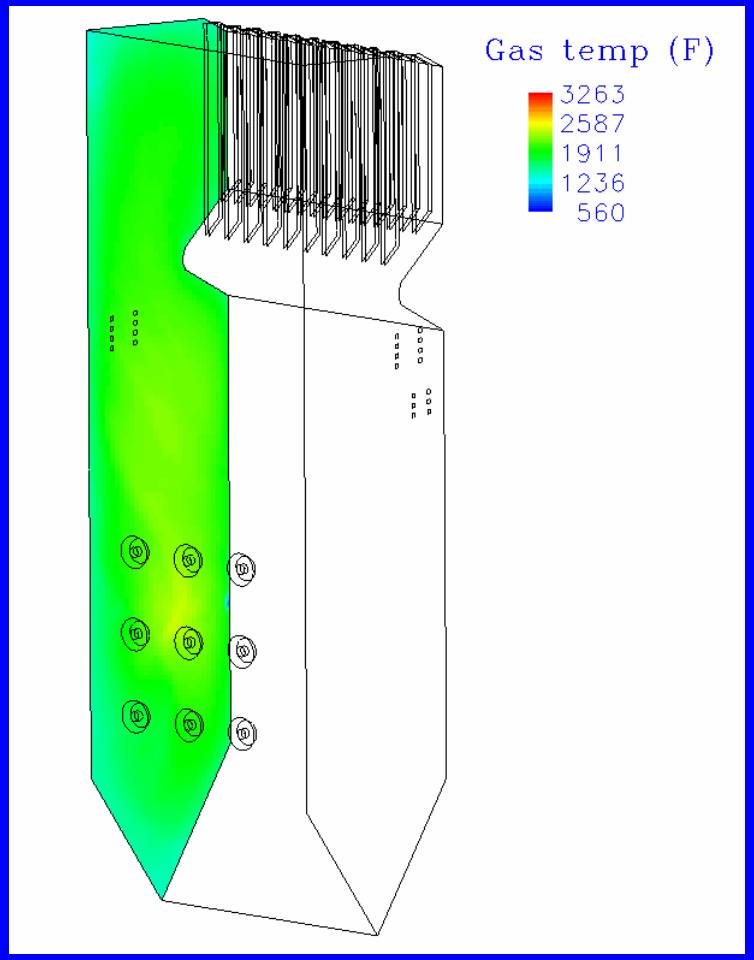
Cape Fear 5 & 6

Cape Fear 6 Duct Work

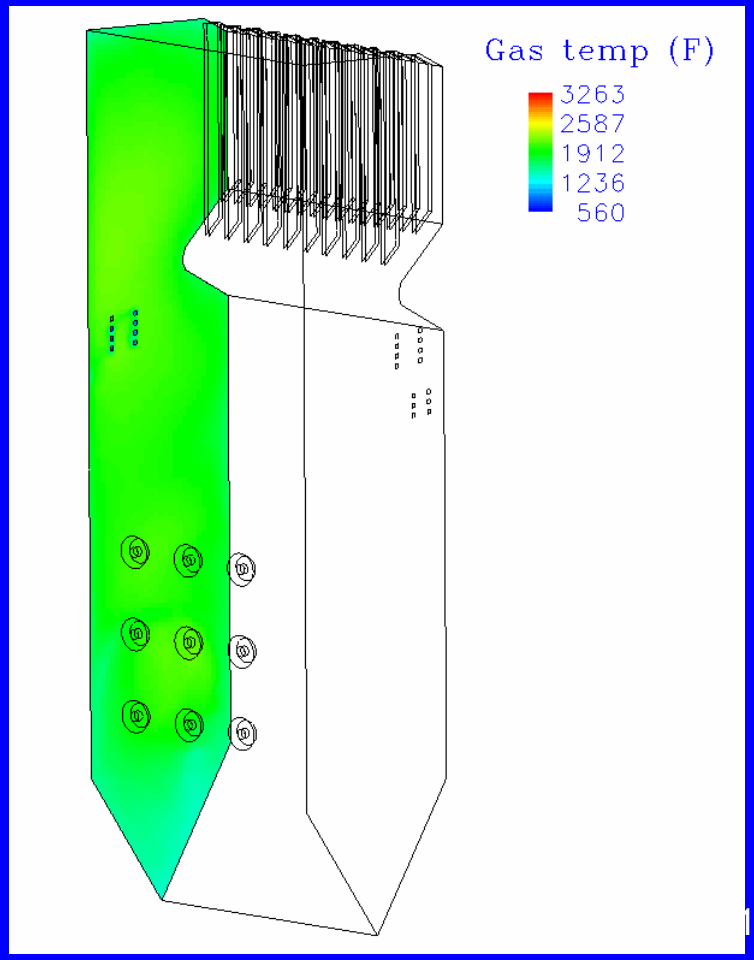
Cape Fear 6 Fan

Temperature – 温度分布

Without ROFA
无ROFA

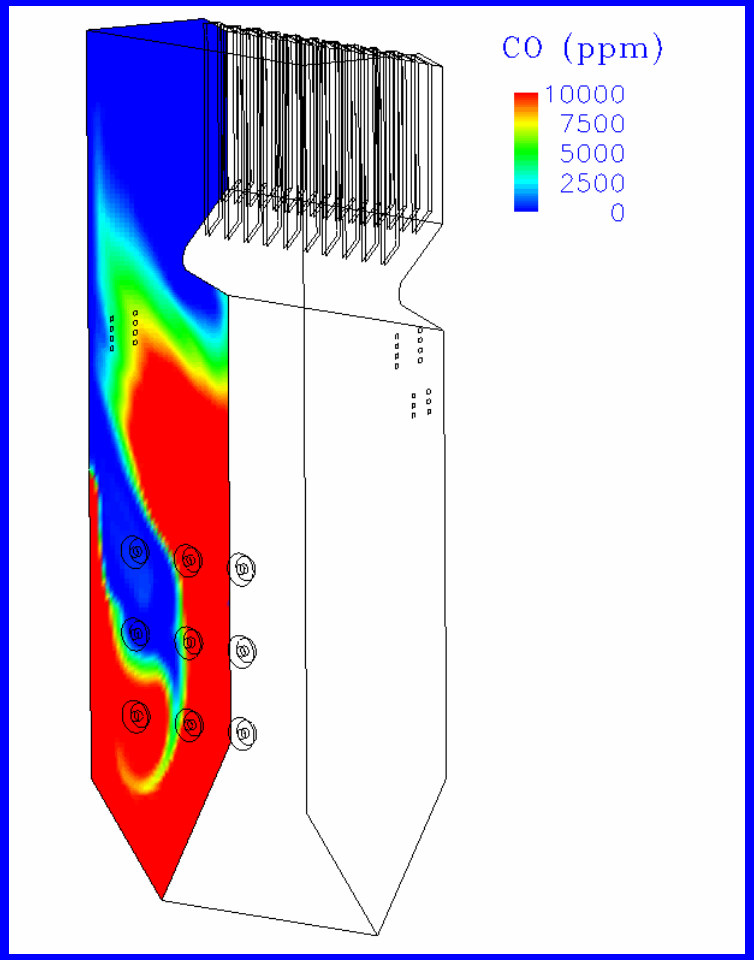


With ROFA
有ROFA

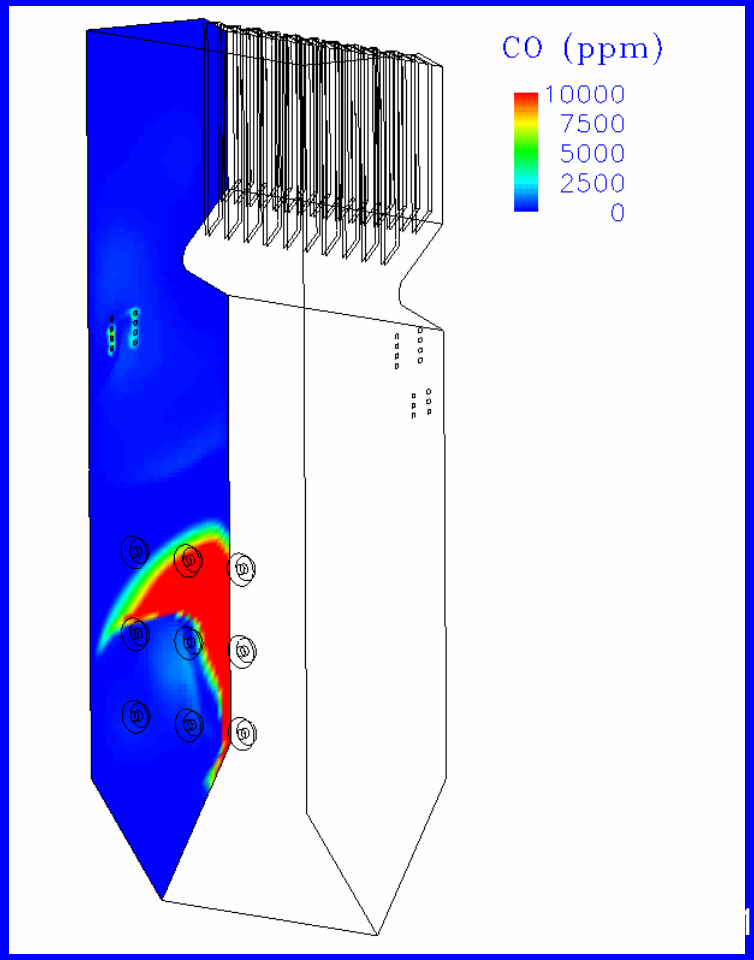


CO分布

Without ROFA
无ROFA

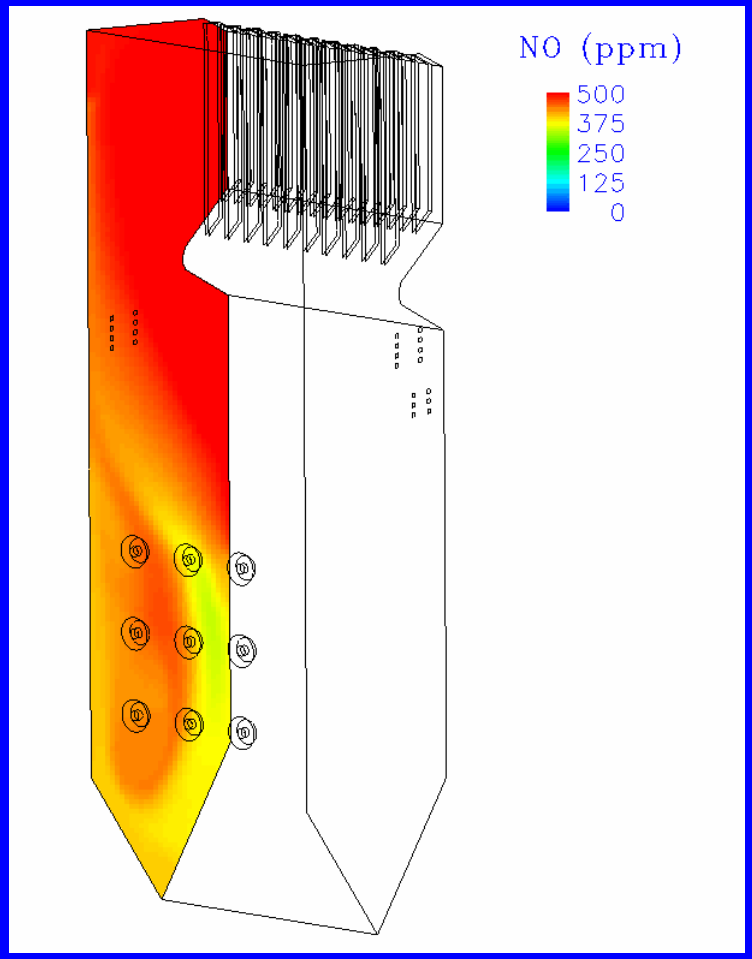


With ROFA
有ROFA

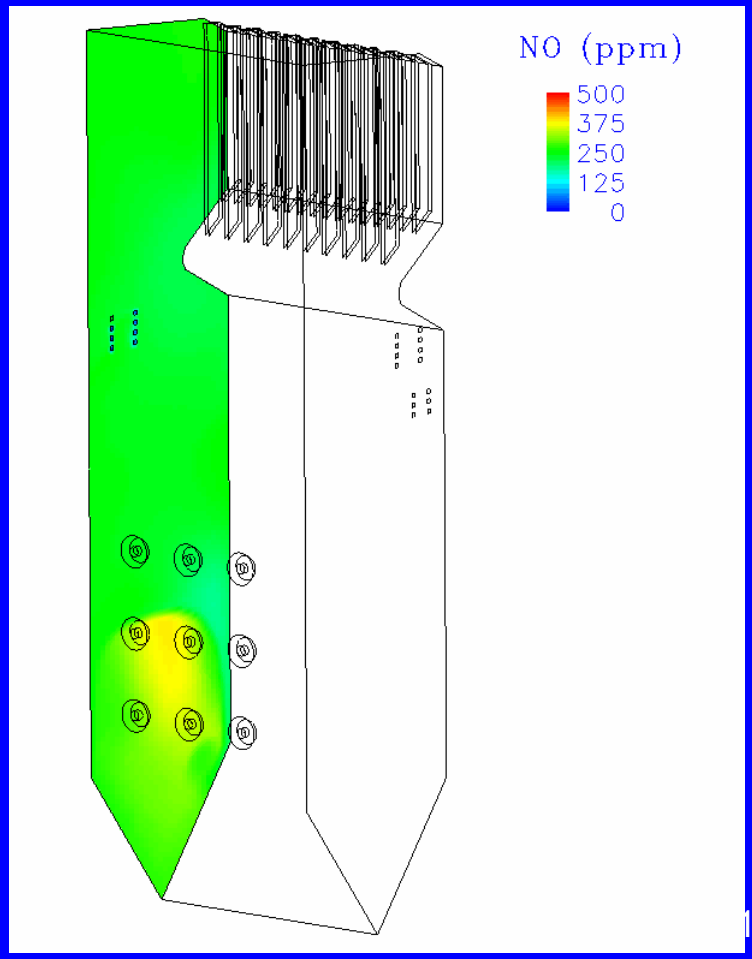


NOx分布

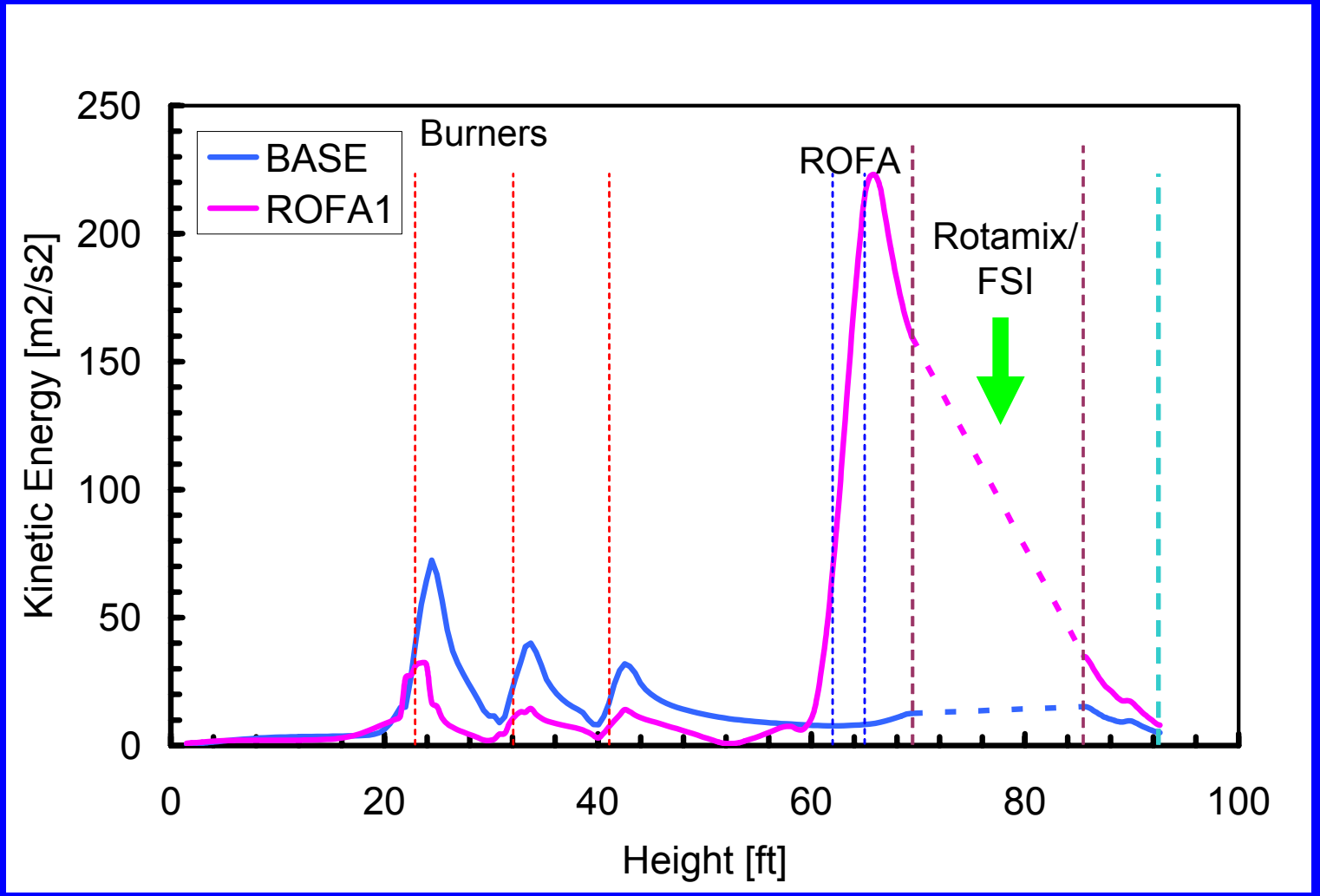
Without ROFA
无ROFA



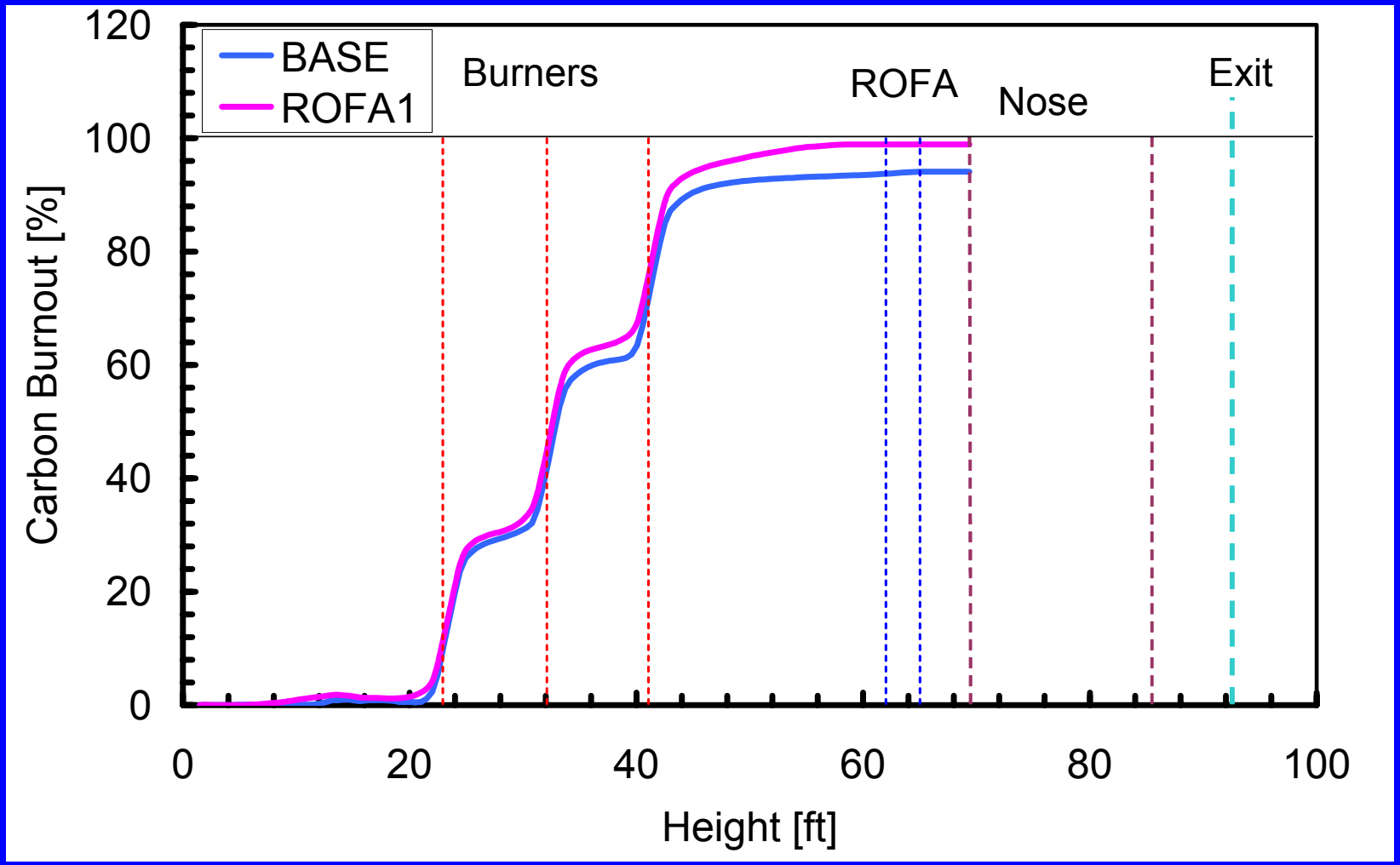
With ROFA
有ROFA



High Turbulence – 强湍流



Better Combustion – 燃烧改进
Carbon Burnout – 碳燃烬高



SOx Reduction – 脱硫技术

- ROFA-FSI
  - Limestone Injection
  - Intense turbulent mixing
  - 60% - 90% SOx reduction
  - Metal (Hg) capture

- ROFA-FSI(炉内喷吸附剂)
  - 喷入石灰石
  - 炉膛强烈混合
  - 60%-90% 脱硫效率
  - 吸附重金属（如汞等）

ROFA-FSI vs. Traditional FSI
ROFA-FSI与传统FSI的比较

- Traditional FSI
  - 30% to 40% SOx Reduction
- ROFA-FSI
  - 60% to 90% SOx Reduction

- 传统FSI
  - 脱硫效率30-40%
- ROFA-FSI
  - 脱硫效率60-90%

De-SOx CFD Results on 580 MW Unit

- Inlet SOx
  - 1700 ppm
  - 2.5 kg/s
- Exit SOx
  - 475 ppm
  - 0.70 kg/s
- SOx Reduction
  - 72%

- 入口SOx
  - 1700 ppm
  - 2.5 kg/s
- 出口SOx
  - 475 ppm
  - 0.70 kg/s
- SOx降低效率
  - 72%

Installed References

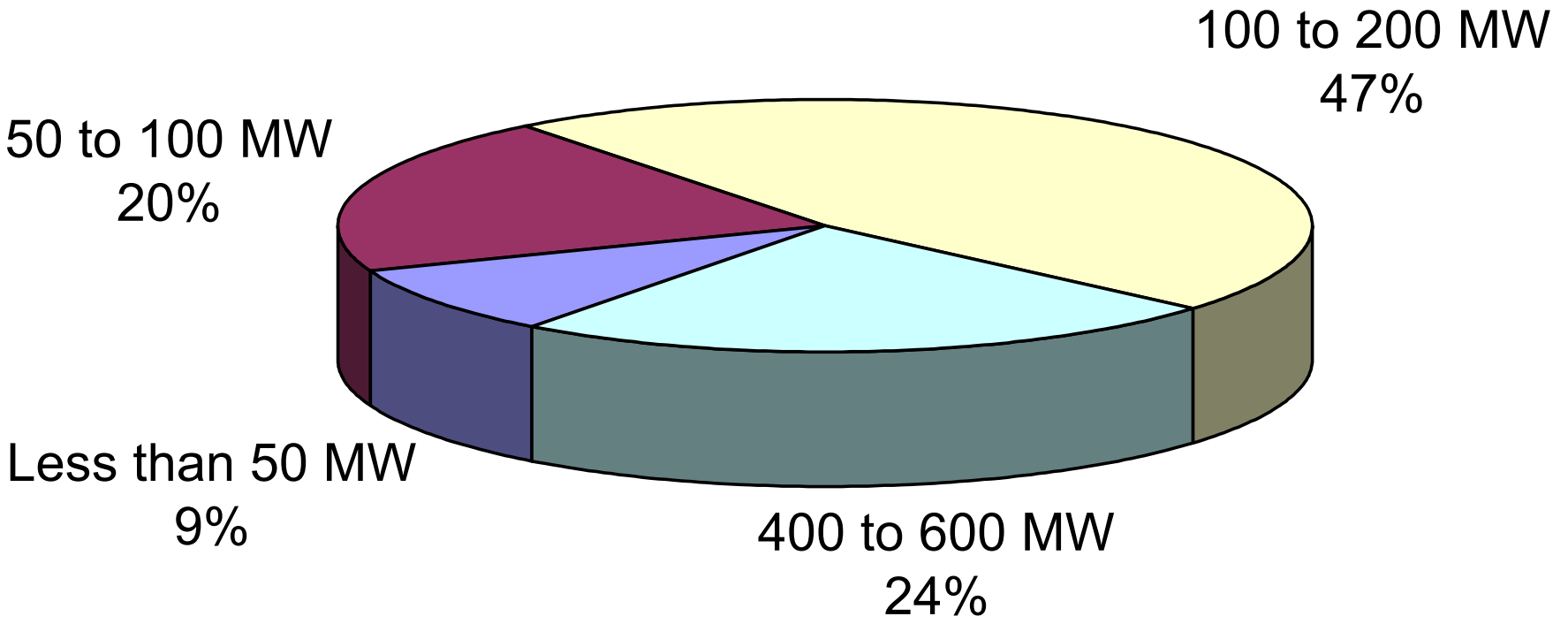
安装实例

Mobotec USA History (Mobotec USA 历史)

- Sweden (1992)
  - 17 Units
- USA (1999)
  - 27 Units
- PRC (2005)

- 瑞典 (1992)
  - 17 台机组
- 美国 (1999)
  - 27 台机组
- 中国 (2005)

Installed Capacity By Load [MW]
安装机组负荷分布



Cape Fear 5 & 6

Cape Fear 5

- Operator: Progress Energy

- Capacity: 154 MW
- Type: T-Fired
- Fuel: Pulverized Coal

FSI and Rotamix System

Cape Fear 5
NOx Reduction

- Baseline NOx 0.62 lb/MMBtu
- NOx after ROFA 0.27 lb/MMBtu
- NOx after Rotamix 0.10 lb/MMBtu

- NOx Reduction (urea) 84%

* 1.0 lb/MMBtu ≅ 1200 mg/Nm^3

Cape Fear 5
ROFA-FSI: SOx Reduction %

Pollutant	Limestone	Trona
SO2	64	69
SO3	90	90
HCl	0	75
Hg	89	67
NOx	4	11
PM	18	80
Opacity	No Change	No Change

Cape Fear 6
NOx Reduction Project

- Baseline NOx 0.63 lb/MMBtu
- NOx after ROFA 0.28 lb/MMBtu
- NOx after Rotamix 0.13 lb/MMBtu

- NOx Reduction (urea) 79%

* 1.0 lb/MMBtu ≅ 1200 mg/Nm^3

Vermilion 1
NOx Reduction Project

- Operator: Dynegy

- Capacity: 77 MW
- Type: T-Fired
- Fuel: Pulverized Coal

Vermilion 1
NOx Reduction Project

- Baseline NOx 0.58 lb/MMBtu
- NOx after ROFA 0.22 lb/MMBtu
- NOx after Rotamix 0.10 lb/MMBtu

- NOx Reduction (urea) 83%

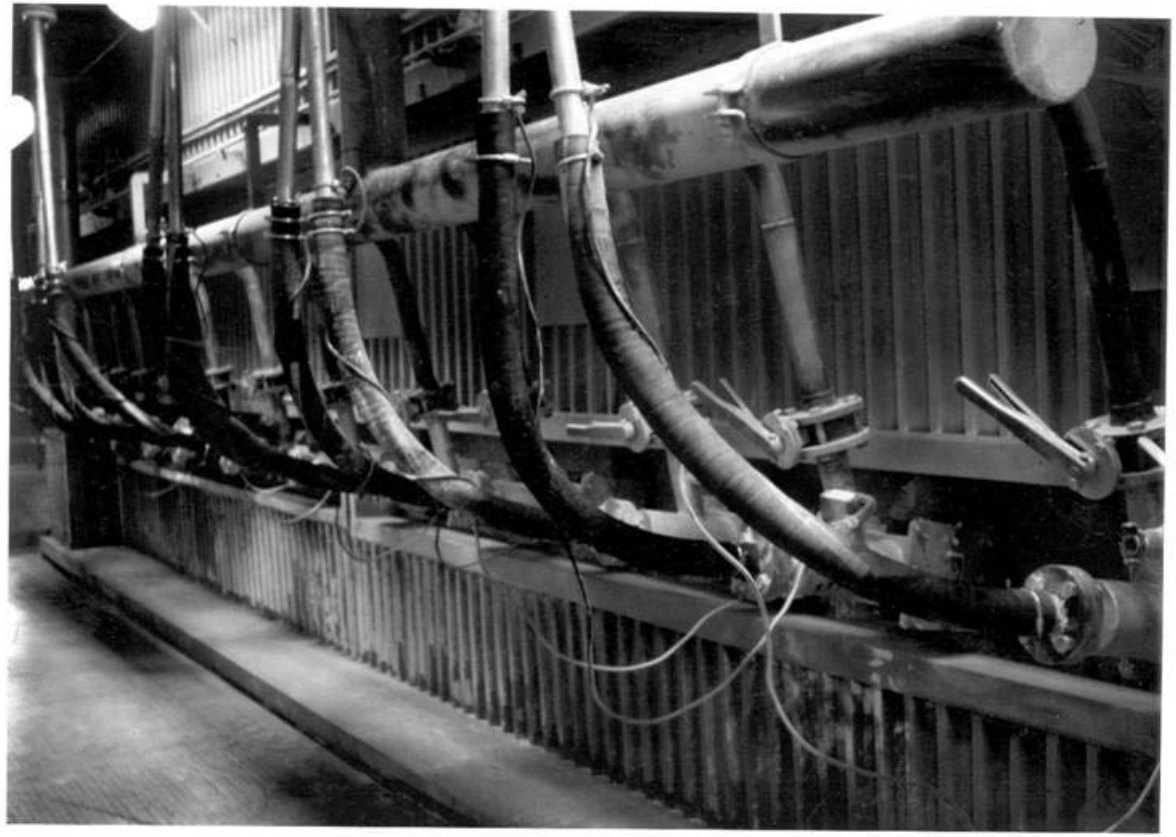
* 1.0 lb/MMBtu ≅ 1200 mg/Nm^3

Jordberga Data

- Commissioned in 1989
- Generates steam for the production of sugar
- Operates from September to January
- 78.4 MW thermal output
- 880 psi/900 deg.F steam
- Uses a speaderstocker to burn coal
- Coal contains <0.60% sulfur

- 投建于1989 年
- 为造糖产生蒸汽
- 运行其间为9月至下年1月
- 7.8万千瓦热输出
- 63个大气压/482 deg.C
- 燃煤窑炉
- 煤含硫量 <0.60%

Previous Jordberga de-SOx System



New ROFA-FSI System

Jordberga Results

	SO_2 Emission [lb/MMBtu]	SO_2 Reduction [%]
No Control	0.392	
Jordberga System	0.16	60
ROFA with Jordberga System	0.08	80
ROFA-FSI Only	0.039	90

Summary
总结

- Combustion Improvements with ROFA
- NOx reduction with ROFA, Rotamix, and in-duct Catalyst
- SOx reduction with FSI
- Phased approach

- ROFA改进燃烧
- 三阶段ROFA, Rotamix 和烟道内催化来脱硝
- 炉内喷吸附剂并用脱硫
- 与一次性SCR和FGD相比,阶段性技术投资可大大节省开支

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Thank You

谢谢！