



TECHNISCHE UNIVERSITÄT  
BERGAKADEMIE FREIBERG  
Die Ressourcenuniversität. Seit 1765.




## Customized Solutions for the Gasification Sector

### 气化单元定制解决方案








5<sup>th</sup> OMB Conference, 07/11/2016, Nanjing, China


**Prof. Dr.-Ing. Bernd Meyer**  
 Institute for Energy Process Engineering & Chemical Engineering (IEC)  
 TU Bergakademie Freiberg

迈尔  
 能源化学所 (IEC)  
 弗莱贝格工业大学




弗莱贝格能源及燃料研究








**Prof. Rammler**  
BHT coke (BHT 焦炭)



**Prof. Dr.-Ing. Bernd Meyer**  
(迈尔教授)



Chief Consultant,  
Schwarze Pumpe  
(黑水泵化工厂首席顾问)



1950's

1960's

1994

2003 2010 2013

Current (现今)

1918

1960's – 1980's

Saxony State Lignite Research Foundation  
(萨克森州褐煤研究基金会)

DBI (德国燃料研究所)


SIEMENS

CHOREN

First R&D gasification plant  
(首台气化测试装置)


Large scale test plants at IEC  
(大型试验装置)


2




### Objectives

目标







Efficiency (效率)




Productivity (产率)



Environmental Impact (环境影响)




Costs (成本)




**Technology Innovations & Optimization**  
 (技术创新与优化)



3



### Research Groups

研究小组



~100 full-time scientific & technical staff  
(近百人的科研和技术团队)

**Feedstock & Conversion**  
 (原料和转换)

- Mineral Matter (矿物质)
- Thermochemical Conversion (热化学转化)

**Process & Components**  
 (过程和部件)

- CFD Modeling (CFD建模)
- Plant Operation (装置操作)

**Systems**  
 (系统)

- Process Chain Development (流程链开发)
- Technology Assessment (技术评估)

**Technologies**  
 (技术)

- Syngas Technologies (合成气技术)
- Solid Fuels Gasification (固体燃料气化)

**Worldwide Industry Partners**  
全球工业合作伙伴

**Europe (欧洲)**

**North America (北美)**

**Asia Pacific (亚太地区)**

**Africa (非洲)**

Logos include: AIR LIQUIDE, ENVIRO THERM, THE LINDE GROUP, VATTENFALL, e.on, Lurgi, RWE, Uhde, CHOREN, SIEMENS, ALSTOM, C A C, ARAL, bp, TOTAL, NETL, EERC, GE, ConocoPhillips, gti, TAMPA ELECTRIC, AN EMERA COMPANY, SYN FUELS CHINA, SEDIN, ICLAS, CSIRO, VINACOLIN, JINDAL STEEL & POWER, Reliance Industries Limited, posco, CRIEPI.


**Our Strategy**  
我们的战略

**Experimental Procedures**  
(Laboratory & Large Scale)  
试验过程  
(试验装置, 大型装置)



**Modeling**  
(Flow-sheet & CFD)  
建模  
(流程和计算流体力学)

**Customized Industrial Solutions**  
定制工业解决方案

**Validation for Large-Scale Application**  
验证以应用于大型装置



**BGL Slag-Bath Test Gasifier at IEC**  
英国天然气/鲁奇 (BGL) 渣池气化炉

**OBJECTIVES (目标)**

**1) Deeper understanding to optimize slag behavior**  
更深入的了解，以优化熔渣的特性

**2) Faster start-up procedure**  
更快的启动程序



**BGL Slag-Bath Test Gasifier at IEC**  
英国天然气/鲁奇 (BGL) 渣池气化炉




**Experiments & Validation (实验和验证)**



**BGL gasifier (BGL 气化炉)**  
(1.4 t/d, 40 bar)



**Mechanical & optical access to slag flow**  
熔渣取样和视窗

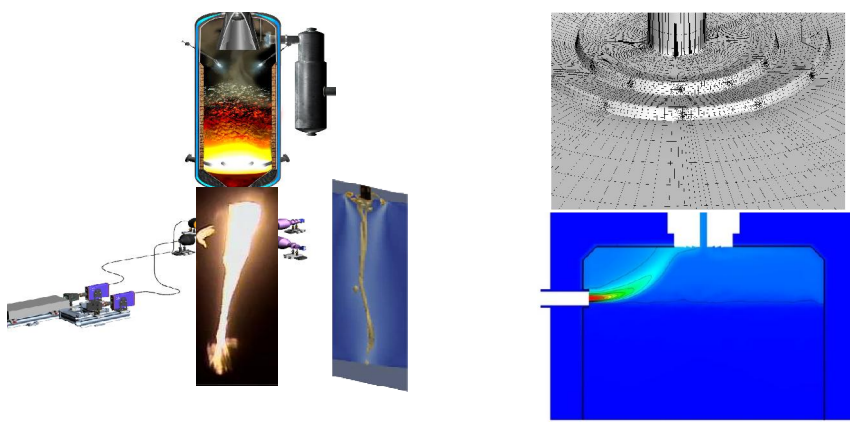




**Slag viscosity measurement**  
熔渣黏度测量

**BGL Slag-Bath Test Gasifier at IEC**  
英国天然气/鲁奇 (BGL) 渣池气化炉

**Simulations (模拟)**




**Real Slag Flow & CFD**  
熔渣流动观测和CFD模拟

**CFD Pilot Burner**  
点火装置CFD模拟



**BGL Slag-Bath Test Gasifier at IEC**  
英国天然气/鲁奇 (BGL) 渣池气化炉

**RESULTS ACHIEVED (取得的结果)**

- 1) **Achieve wider feedstock variability & extended database for slag behavior under high pressure**  
能使用更广泛的进料；扩展了在高压下熔渣特性的数据库
- 2) **Ignition at 40 bar; reduction in costs through lower consumption and outage time**  
可在40 bar点火；通过降低原料消耗和停运时间降低成本




**Entrained-Flow Gasifier**  
气流床气化炉






**OBJECTIVES (目标)**

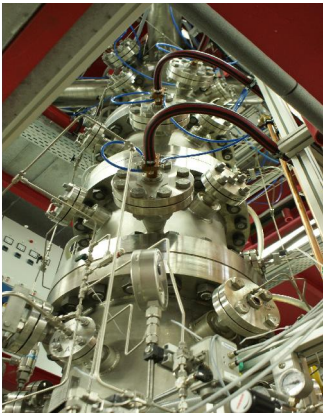
- 1) **Improve process performance and efficiency**  
改善工艺性能和效率
- 1) **Improve reactor design**  
改进气化炉设计
- 2) **Reduce fine dust formation**  
降低粉尘的形成
- 3) **Complete immobilization of trace elements in slag**  
完全固定熔渣中的微量元素

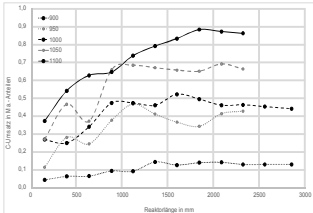


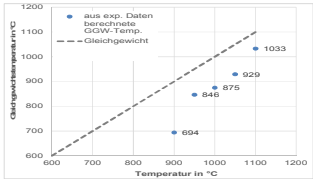
**Entrained-Flow Gasifier**  
气流床气化炉

**Experiments & Validation (实验和验证)**





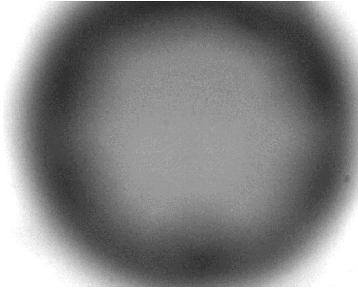


**Coal kinetics at up to 100 bar**  
高达100bar时的煤炭动力学

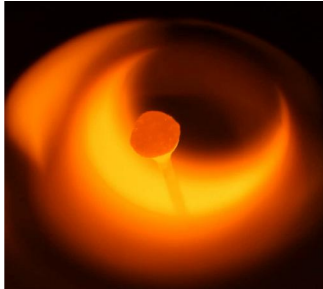
**Entrained-Flow Gasifier**  
气流床气化炉

TU BERGAKADEMIE FREIBERG IEC EVT

**Experiments & Validation (实验和验证)**



**Particle Fragmentation**  
煤颗粒破碎过程



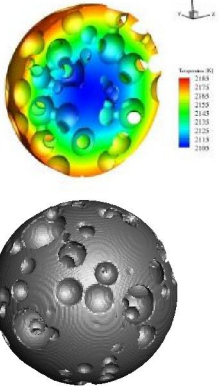
**Particle Conversion**  
颗粒转化过程

**Entrained-Flow Gasifier**  
气流床气化炉

TU BERGAKADEMIE FREIBERG IEC EVT

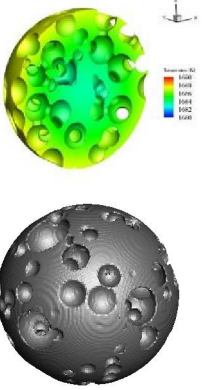
**Simulations (模拟)**

diffusion limited (扩散控制)

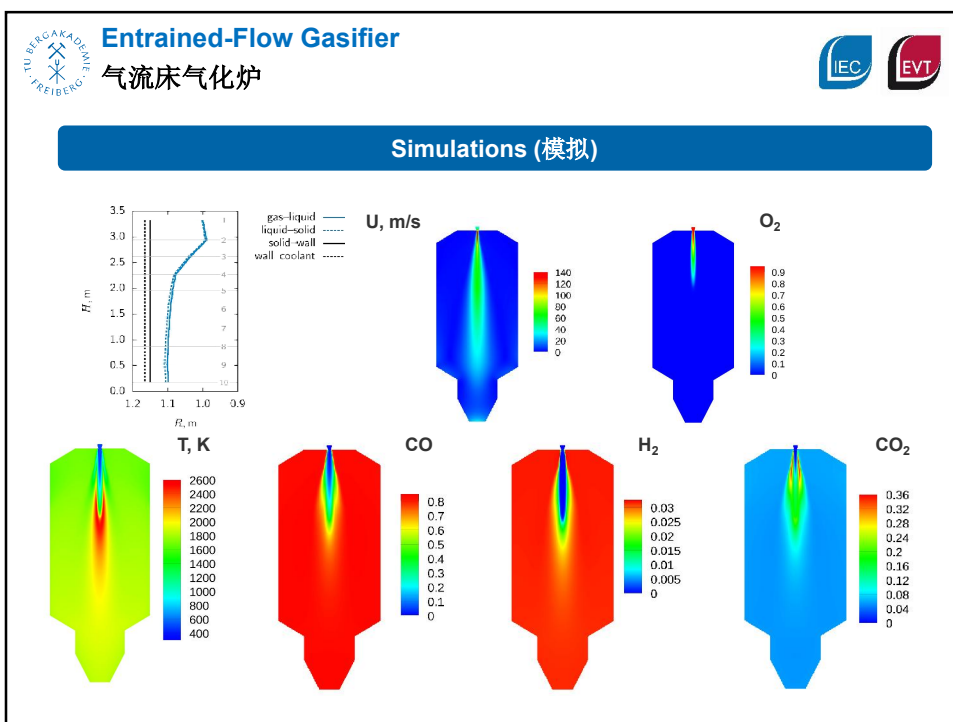
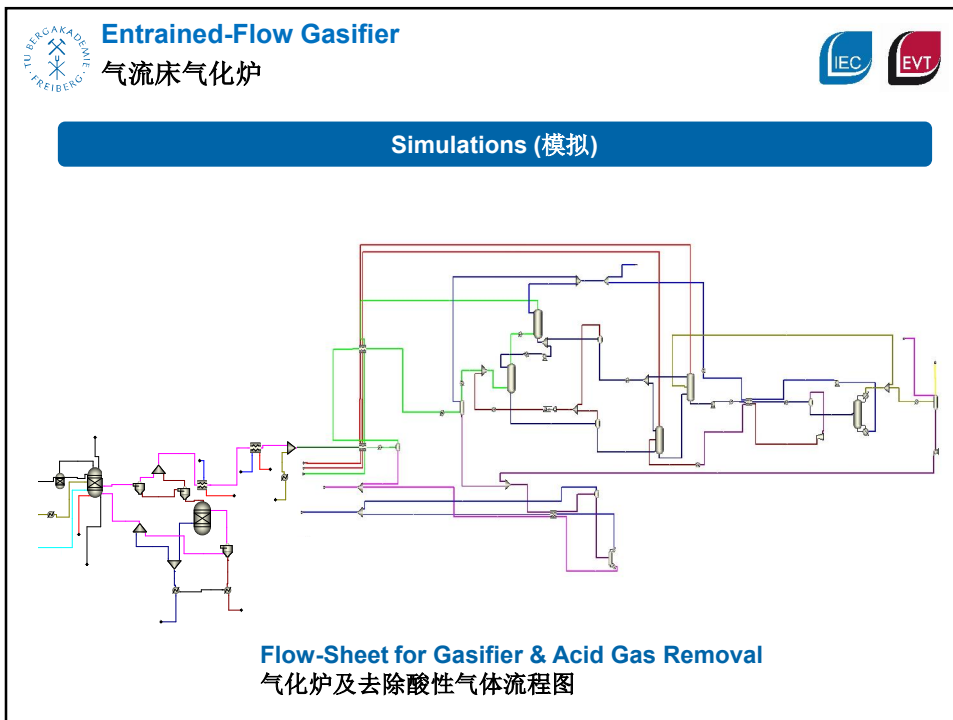


**Typical for Entrained Flow**  
典型气流床过程




Kinetically limited (动力学控制)



**Typical for Fluidized Bed**  
典型流化床过程









**Entrained-Flow Gasifier**  
 气流床气化炉
 





**RESULTS ACHIEVED (取得的结果)**

- 1) **Improved reactor performance & efficiency through customized burner and gasifier designs**  
通过定制烧嘴和气化炉设计提升反应器性能和效率
- 2) **Reduction of carbon losses and fine dust through complete carbon conversion and ash melting**  
通过碳素的完全转化和灰的完全溶解降低残碳和粉尘
- 3) **Immobilization of trace elements in glassy slag lead to reduced environmental impact**  
通过将微量元素固定在玻璃化的渣中，可降低环境影响


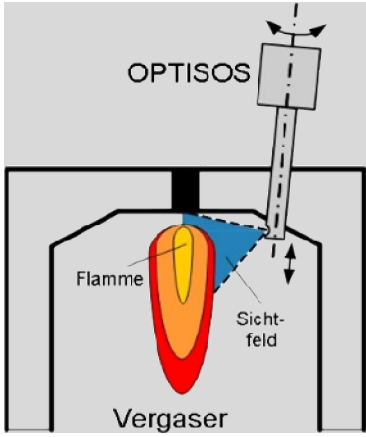

**High Pressure, Partial Oxidation (HP-POX) Plant at IEC**  
 高压，部分氧化（HP-POX）试验装置
 


**OBJECTIVES (目标)**




- 1) **Reduce CAPEX for (mega) plants**  
为大型装置降低资本支出
- 2) **Reduce OPEX for existing and future plants**  
为已有和待建装置降低运营成本


**High Pressure, Partial Oxidation (HP-POX) Plant at IEC**  
 高压，部分氧化（HP-POX）试验装置
 


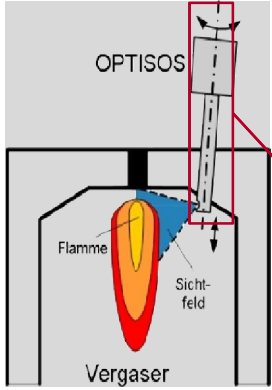

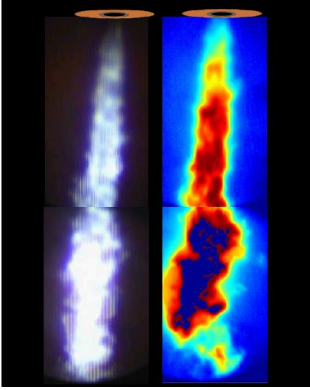
Experiments & Validation (实验和验证)

**HP-POX plant (500 m<sup>3</sup>(STP)/h, 100 bar)**  
 高温部分氧化装置


**High Pressure, Partial Oxidation (HP-POX) Plant at IEC**  
 高压，部分氧化（HP-POX）试验装置
 


Experiments & Validation (实验和验证)

**Optical access to flame**  
 火焰视窗

**High Pressure, Partial Oxidation (HP-POX) Plant at IEC**  
 高压，部分氧化（HP-POX）试验装置

**Simulations (模拟)**

1475 1510 1545 1580 1615 1650 1685 1720 1755 1790 1825 1860 1895 1930 1965 2000

**Gas POX**  
 气体部分氧化




**Oil POX (non-reactive)**  
 油料部分氧—冷态

**High Pressure, Partial Oxidation (HP-POX) Plant at IEC**  
 高压，部分氧化（HP-POX）试验厂

**Simulations (模拟)**



**Conventional burner with axial flame**  
 传统烧嘴—轴向火焰



**IEC experimental burners with shorter radial flames**  
 IEC实验烧嘴—短径向火焰


**High Pressure, Partial Oxidation (HP-POX) Plant at IEC**  
 高压，部分氧化（HP-POX）试验装置
 


**RESULTS ACHIEVED (取得的结果)**

- 1) **Reduce reactor sizes or increase capacity**  
降低反应器尺寸或增加容量
- 2) **New high capacity burner designs with longer life-span**  
新型高容量长寿命烧嘴


**Industry Collaboration ( )**



- 
**Scientific and technological consulting**  
 科技咨询
- 
**Lab analyses at high pressure/high temperature**  
 高压/高温实验分析
- 
**Evaluation of fuel conversion processes & process chains**  
 燃料转化和流程链的评估
- 
**CFD -based development and optimization**  
 基于CFD的技术开发和优化
- 
**Pilot scale experiments**  
 中试实验

**DBI-Virtuhcon GmbH** your partner for *contract research*



**International Freiberg Conference**  
弗莱贝格国际会议






**7th International Freiberg/Mongolia Conference**  
Coal Conversion and Syngas  
7-11 June 2015  
Hohhot, Inner Mongolia, China



**8th International Freiberg Conference**  
Innovative Coal Value Chains  
12-16 June 2016  
Cologne, Germany

**9th International Freiberg Conference**  
on IGCC & XtL Technologies  
Sector Integration: Challenges & Opportunities  
**2018**  
Berlin, Germany







**(Tailored) Courses**  
(量身定制) 课程






- **Short courses (2-3 days) on gasification, syngas generation and IGCC technologies** (气  
化, 合成气生成以及IGCC技术相关短期课程 (2-3天))
- **20 courses since 2006** (从2006年起已20期)
- **Participants: Industrial global players (engineering & technical personnel)** (参与者:  
工程和技术人员)





**THANK YOU FOR YOUR ATTENTION!  
I LOOK FORWARD TO YOUR VISIT IN FREIBERG!**

感谢您的关注! 欢迎到弗莱贝格!

**GLÜCK AUF!**

Prof. Dr.-Ing. Bernd Meyer  
IEC, TU Bergakademie Freiberg  
Email: [bernd.meyer@iec.tu-freiberg.de](mailto:bernd.meyer@iec.tu-freiberg.de)  
Tel: 0049 3731 39 4511