Introduction
to the
TORBED Technology
and its role in
Process Intensification

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June 2016

INTRODUCTION

A Well-Tested Technology

The TORBED® Energy Technologies are covered by numerous patents.

The trademark TORBED® is registered in all major industrial countries

- Invention of the TORBED®* process in 1981
- Installation of the first commercial prototype in 1985
- £60m has been invested in the technology
- More than 160 plants around the world
- ~ 5 million reactor hours
- Well known in the process industries

INTRODUCTION

Proven Technology with Multiple Applications and Global Clients

The technology has a rich industrial heritage with an extensive and successful track record of application in new contexts for processes where close control is required

Oil well waste treatment

elf

British Gas

bp

TOTAL

MARATHON

Fly ash treatment and recycling

LAFARGE

Waste bitumen disposal

heijmans

Paper sludge drying

sappi

Gas scrubbing

RioTinto

Catalyst regeneration

Vermiculite manufacture

SAINT-GOBAIN

Promat
High Performance Insulation

BPB BritishGypsum

Pot liner disposal

COMALCO

Food processing

Kellogg's

Kraft

PEPSICO

Nestlé

Clay calcination: paint whitener

IMERYS
TRANSFORM TO PERFORM

Catalyst development

Rhodia

sasol
reaching new frontiers

Torftech Energy

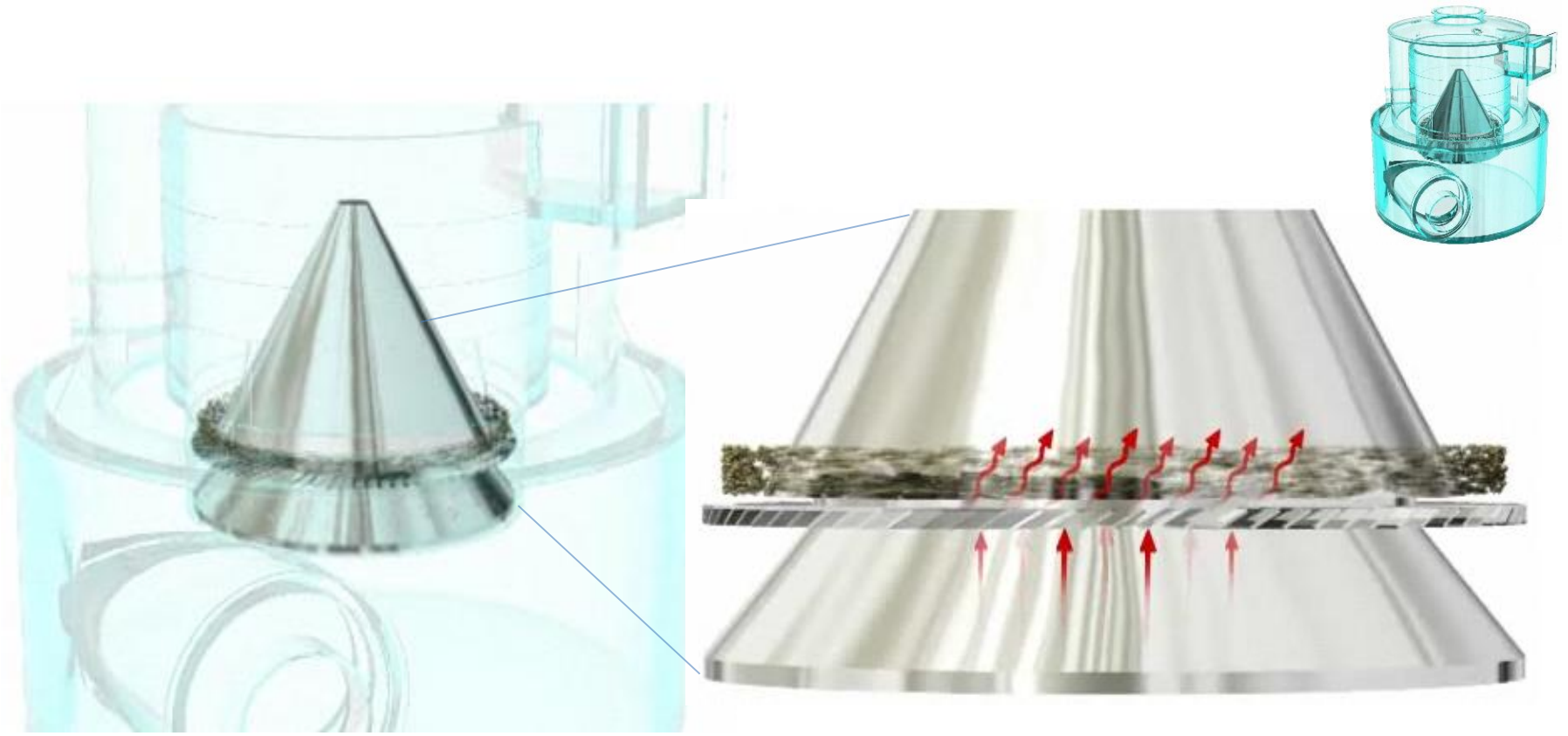
THE TECHNOLOGY

TORBED Reactors

- 2 main reactor families
- Compact Bed Reactors (CBR) typically used in solids processing or low attrition processes
- Expanded Bed Reactor (EBR) typically used for gas processing
- Sliding scale and design to suit for a wide range of applications

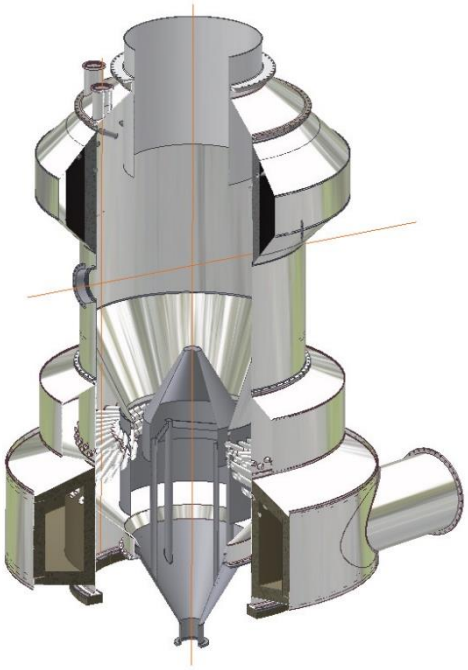
THE TECHNOLOGY

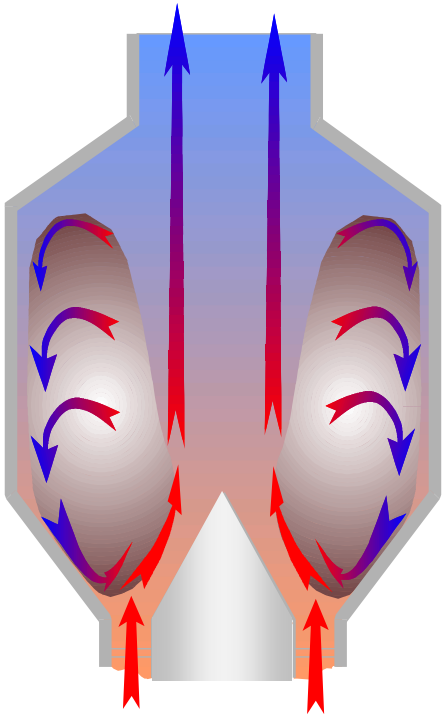
Compact Bed Reactors (CBRs)



THE TECHNOLOGY

Expanded Bed Reactors (EBRs)





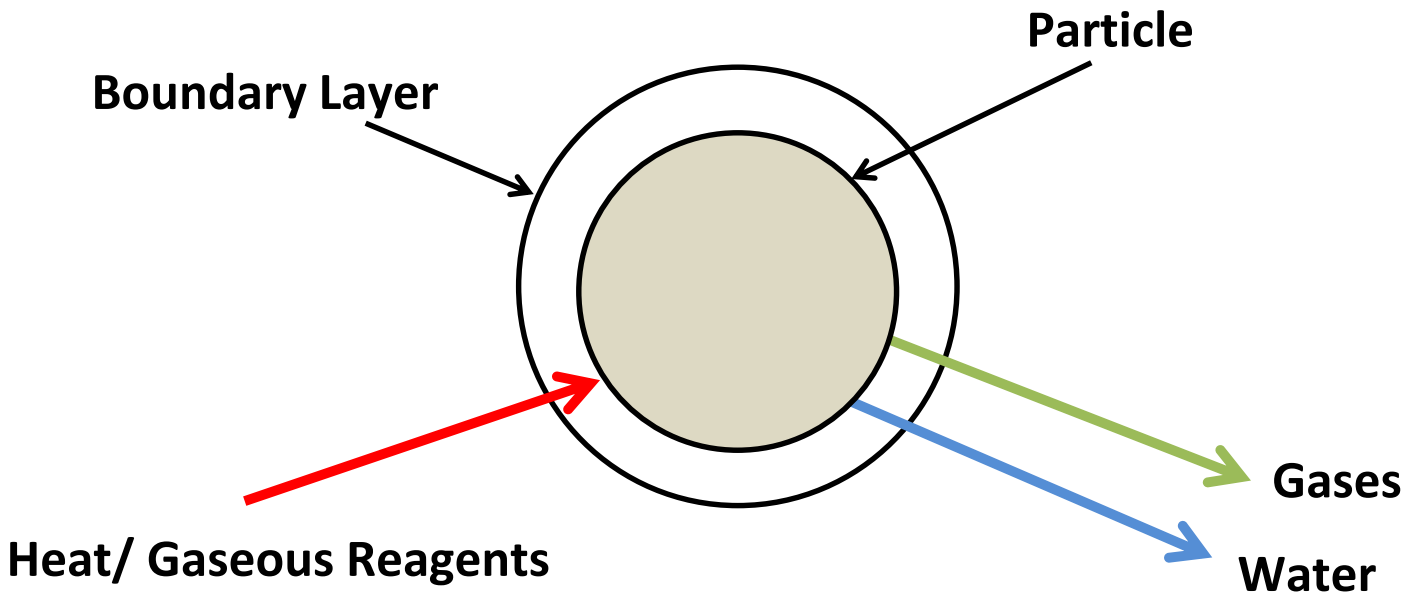
THE TECHNOLOGY

Why Use a TORBED?

- High heat transfer rates = > smaller unit => lower CAPEX
- Handles widely graded and irregularly shaped feed
- Low pressure drop = > easy process gas recirculation => high turndown ratio
- Very rapid start-up
- Simple to operate and automate => real time control => avoid slagging even with high alkali metal content feeds
- No moving parts
- No sand bed
- Multi fuel capability

WHY THE TECHNOLOGY WORKS

Boundary Layers

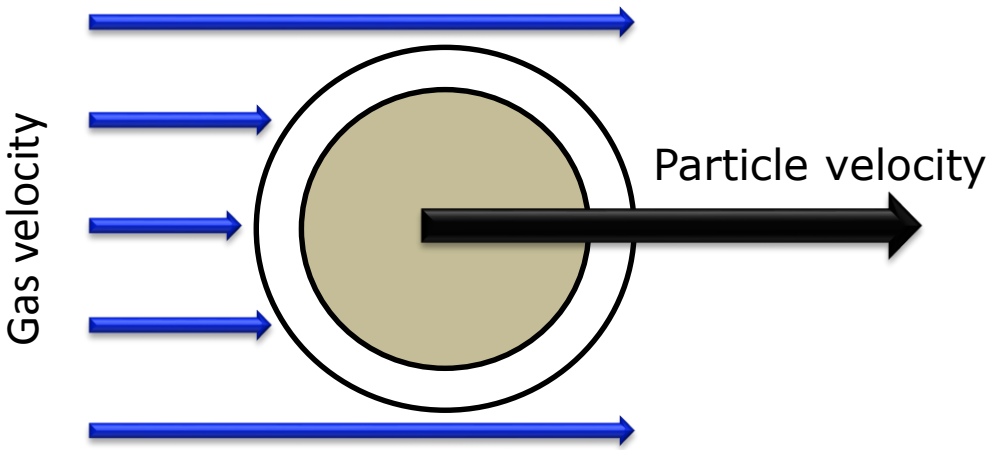


The boundary layer must be penetrated for the reaction to take place.

A thick boundary layer inhibits reaction rate whereas a thin layer facilitates fast reaction rates.

WHY THE TECHNOLOGY WORKS

Slip Velocity



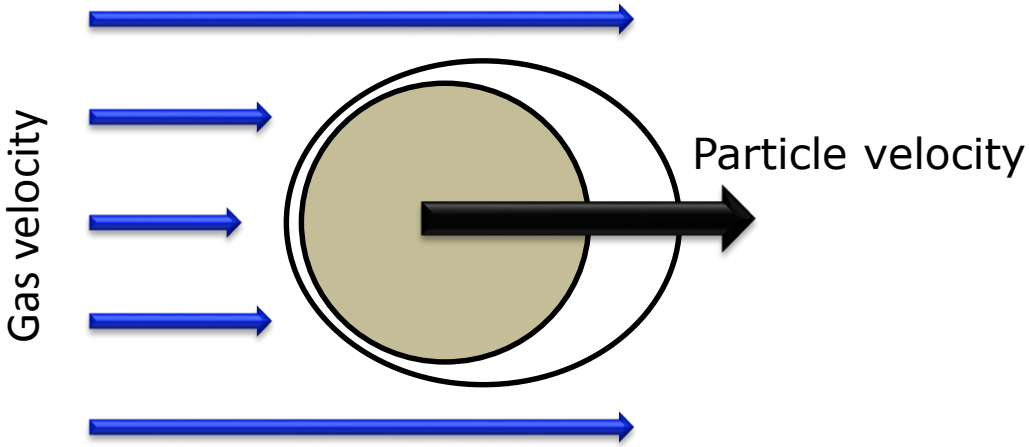
Gas velocity ≈ Particle velocity

↓

Slip Velocity ≈ 0

↓

Stable boundary around particles lead to slow reaction rates.



With a TORBED

Gas velocity >> Particle velocity

↓

Slip Velocity ≈ Gas velocity

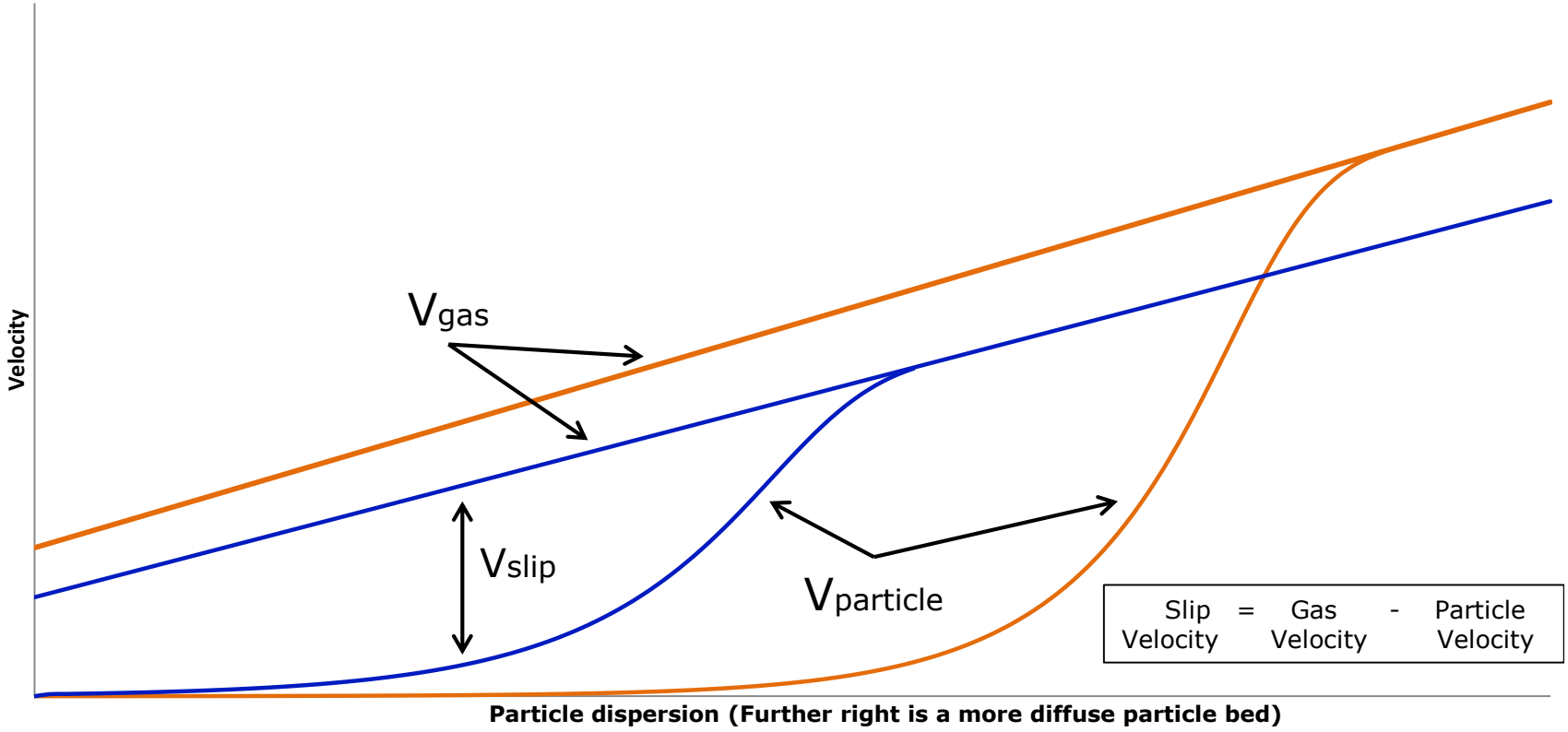
↓

Boundary layer stripped from particle leading to fast reaction rates

WHY THE TECHNOLOGY WORKS

Higher Slip Velocity

Blue lines indicate conventional technology with particle entrainment at lower speeds.
Orange lines indicate TORBED technology, where very high slip velocity is achieved.



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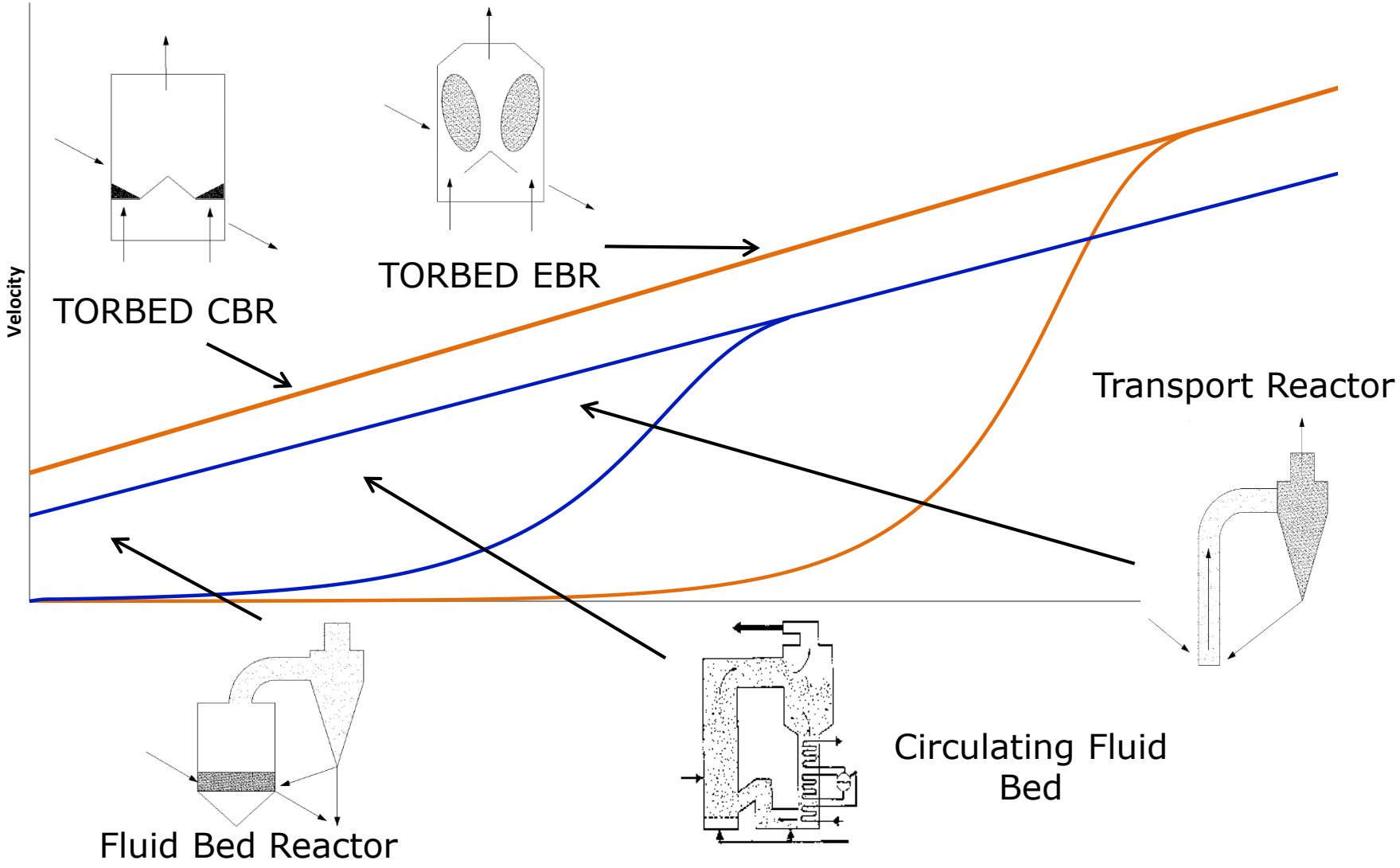
WHY THE TECHNOLOGY WORKS

Processor Slip Velocity Comparisons



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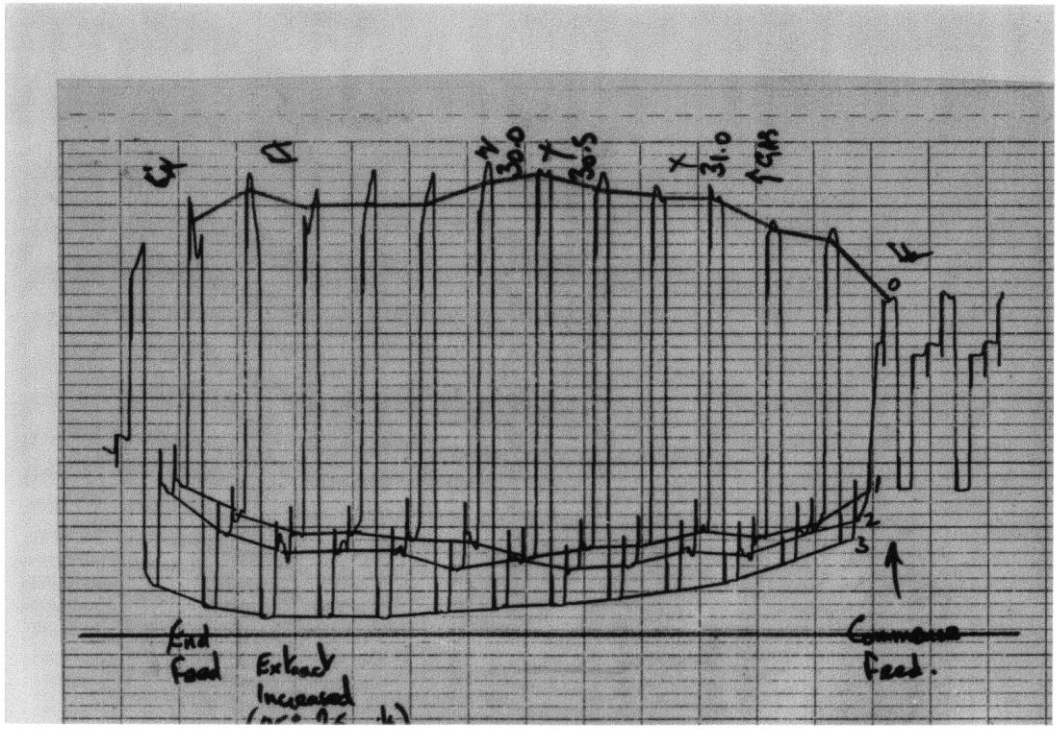
WHY THE TECHNOLOGY WORKS

Heat Transfer in a TORBED

Measured at 8kW/m^2.C in a vermiculite exfoliation process but…



This number is dangerous!

WHY THE TECHNOLOGY WORKS

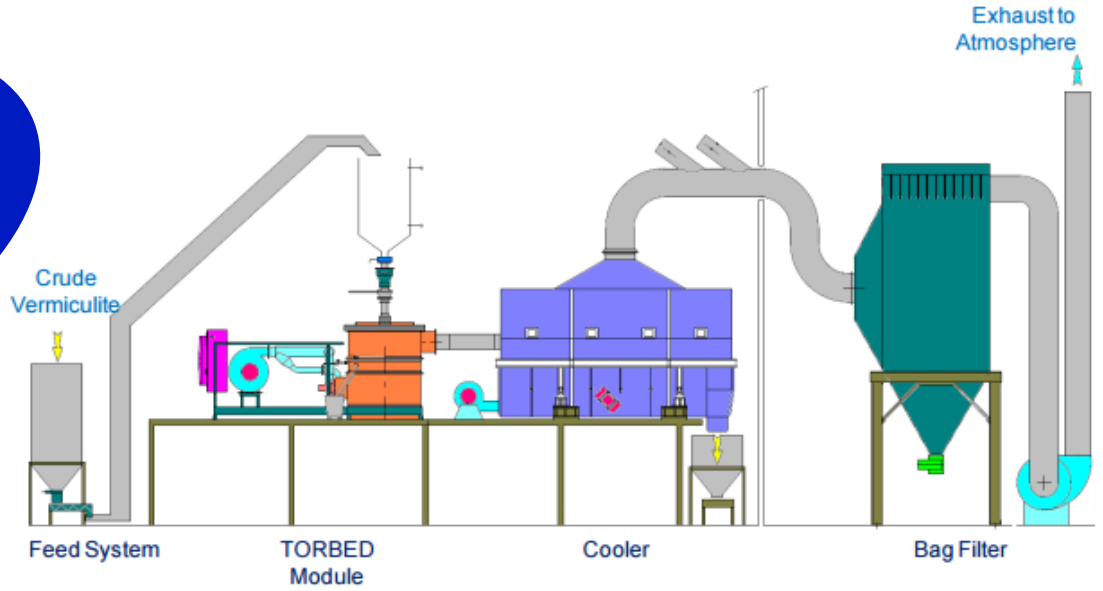
More than Intensification

- Increased process control opens more possibilities than just more intense processes
- Hand in hand they can unlock ‘problem’ processes
- High throughput through intense processes leads to lower CAPEX
- Cross-discipline experience and implementation of technology

CASE STUDIES

Mineral Processing

High temperature, high precision processing



- High Temperature exfoliation
- Replaces traditional furnaces greatly reducing size requirements while giving consistent processing
- Gateway into calcination and other flash processing of minerals

CASE STUDIES

Mineral Processing

- Flash processing of <5 micron particulate
- Gas injection for temperatures of 1300 °C

- Calcination carried out at 1600 °C
- Used for the formation of lightweight prills

CASE STUDIES

Torrefaction

- Tower of 4 TORBEDs processing wood into 'biocoal'

- Wood Chips
- Grass
- Straw

250 – 350°C

Torrefaction

Atmospheric Pressure
Inert Environment

Pulverized,
Torrefied Wood

Torrefied Wood
"Bio-Coal" Pellets

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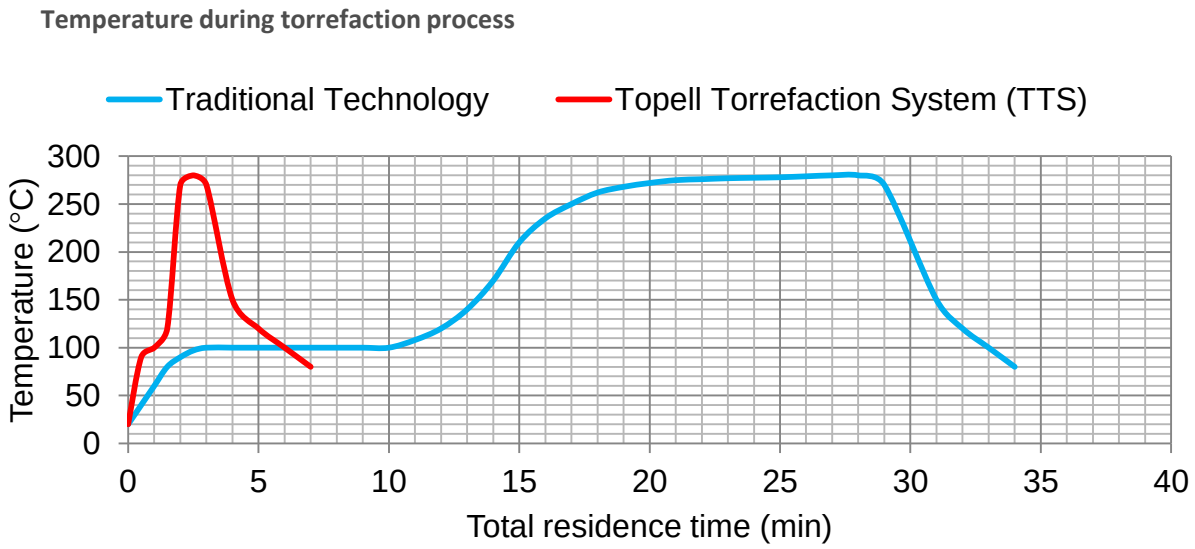
CASE STUDIES

Torrefaction

- Successful pilot trials led to full size (80,000 tpa) plant construction in 2011
- High throughput and process control compared to conventional technology
- Successful co-firing trials



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CASE STUDIES

Carbon Processing

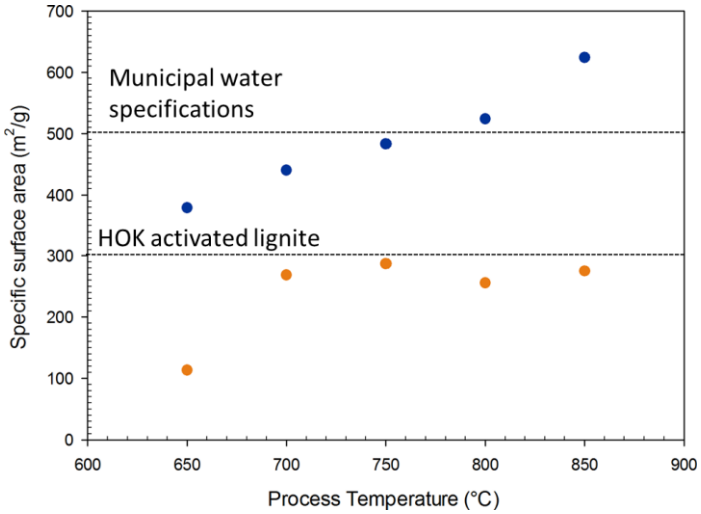
- Includes combustion, drying and upgrading.
- Fine particulate drying in South Africa
- Drying of low grade coals for export purposes
- Combustion of dross coals as waste abatement

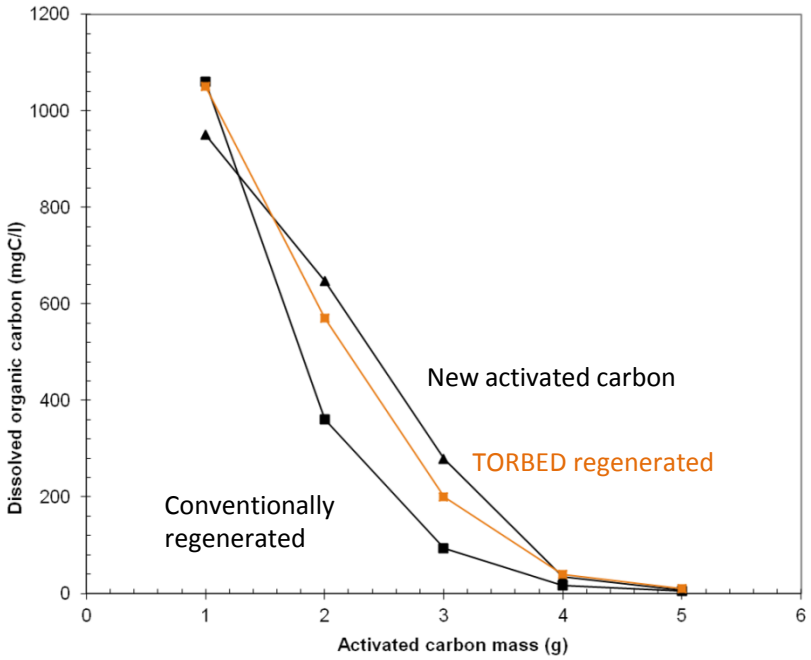
- Upgrading of low quality coals into PCI substitutes
- Creation of high surface area material such as activated carbon
- Regeneration of activated carbon

CASE STUDIES

Carbon Processing

- Processing of Victorian brown coal
- The coarse and fine particulates demonstrate high surface areas achieved on the Torftech pilot facility





- Regeneration of activated carbon
- Demonstrates reversal close to new activated carbon without the carbon burnout or loss of surface area in other methods.

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Pilot Trials

- 2 pilot facilities, a mobile plant currently in Poland and a Plant in Canada
- Can carry out a wide range of tests using both CBRs and EBRs
- Feed rates of up to 100 kg/hr
- Have produced a number of reports and results for publication

Research and Development

Technology Development

- Ongoing iterative in house design work
- Hybrid and novel reactor designs
- Design to the process – a philosophy of adaptation to specific process requirements

Process Development

- Using 'old' processes as the base point for new processes
- History of working with industry to develop from pilot stage through demonstration to commercial readiness
- A process team that develops models and carries out empirical research for understanding process chemistry

RESEARCH AND DEVELOPMENT

Current Areas of Interest

- Activated carbon and biochar– creation of high surface area material from coal and biomass for a wide variety of applications
- Catalyst manufacture and regeneration
- Rice husk combustion and amorphous silica ash generation and properties
- Multi-pollutant adsorption – including CO_2
- Production of carbon nanotubes and other nano materials
- Advanced gasification using gas injection

Thank you!

Any Questions?

Please also send an email queries to
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