Introduction to the TORBED Technology and its role in Process Intensification

Daniel Groszek, Torftech Group
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INTRODUCTION

A Well-Tested Technology

- 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

The TORBED® Energy Technologies are covered by numerous patents.

The trademark TORBED® is registered in all major industrial countries.
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
- Fly ash treatment and recycling
- Waste bitumen disposal
- Paper sludge drying
- Gas scrubbing
- Food processing
- Catalyst regeneration
- Vermiculite manufacture
- Pot liner disposal
- Clay calcination: paint whitener
- Catalyst development

Clients include:
- ELF
- Total
- Marathon
- British Gas
- bp
- LAFARGE
- Heijmans
- sappi
- Rio Tinto
- SAINT-GOBAIN
- Promat
- BP
- British Gypsum
- COMALCO
- Kellogg’s
- Kraft
- Rhodia
- SASOL
- IMERYS
- Nestlé
- Pepsico

Torftech Energy
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
Compact Bed Reactors (CBRs)
THE TECHNOLOGY

Expanded Bed Reactors (EBRs)
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
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 $\approx$ Particle velocity

Slip Velocity $\approx 0$

Stable boundary around particles lead to slow reaction rates.

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With a TORBED

Gas velocity $>>$ Particle velocity

Slip Velocity $\approx$ 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.
WHY THE TECHNOLOGY WORKS

Processor Slip Velocity Comparisons

- TORBED CBR
- TORBED EBR
- Transport Reactor
- Circulating Fluid Bed
- Fluid Bed Reactor

Velocity
**WHY THE TECHNOLOGY WORKS**

Heat Transfer in a TORBED

Measured at $8\text{kW/m}^2\text{C}$ in a vermiculite exfoliation process but...

This number is dangerous!
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**

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**Torftech**
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

**Torrefaction**

- 250 – 350°C
- Atmospheric Pressure
- Inert Environment

- Pulverized, Torrefied Wood

- Torrefied Wood
  “Bio-Coal” Pellets
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

Temperature during torrefaction process

- Traditional Technology
- Topell Torrefaction System (TTS)
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
-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.
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
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 CO₂
- Production of carbon nanotubes and other nano materials
- Advanced gasification using gas injection
Thank you!

Any Questions?

Please also send an email queries to dan.groszek@torftech.com