

# Experience Gained in Pilot Scale and Bench Scale Fluidised Bed Processing

TD HADLEY<sup>1</sup> AND BC NORTH<sup>2</sup>

<sup>1,2</sup>CSIR Materials Science and Manufacturing, PO Box 395, Pretoria 0001  
<sup>1</sup>thadley@csir.co.za

## ABSTRACT

The CSIR has had a strong drive in fluidised bed technology for over two decades. During this period collaboration has been fostered with numerous partners and clients. By being able to draw on their resources, skills, test and other facilities, considerable progress has been made. The earliest developments were in coal combustion. Work has been done on in-bed sulphur capture to reduce the sulphur dioxide off-gas content. Expertise in the design and commissioning of industrial-scale plants has led to the supply (through licensees) of a biomass sludge incinerator/boiler generating 26t/h steam, a 20 MW high-sulphur pitch incinerator and a 12 MW fluidised bed deodoriser. In the late 1990s the Fluidised Bed Centre of Excellence was formed to combine the expertise and facilities of the CSIR and Kumba Resources, particularly in the field of combustion and minerals beneficiation.



1984: National Fluidised Bed Combustion Boiler

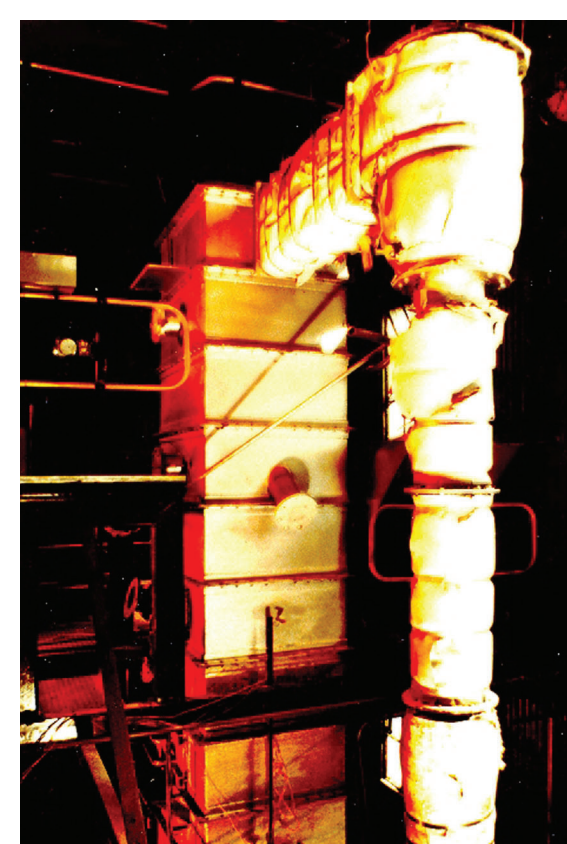
## INITIAL RESEARCH – LOW GRADE COAL COMBUSTION

Research in fluidised bed technology was formalised at the CSIR in the early 1980s when investigation was initiated into the use of discard and duff coals by means of Fluidised Bed Combustion (FBC) technology. This work was funded by the Department of Minerals and Energy Affairs (DMEA) and resulted in the establishment of the National Fluidised Bed Combustion (NFBC) boiler in 1984.

The facility was primarily used for thermal and combustion efficiency trials where the effects of load, grit re-firing and bed temperature on the thermal and combustion efficiencies were investigated.

Sulphur reduction trials were conducted with the aim of determining the ability of South African sorbents to reduce sulphur dioxide emissions.

## DEVELOPMENT AND EXPERIMENTATION



1992: Multi-Purpose Fluidised Bed Combustor

### Multi-Purpose Fluidised Bed Combustor

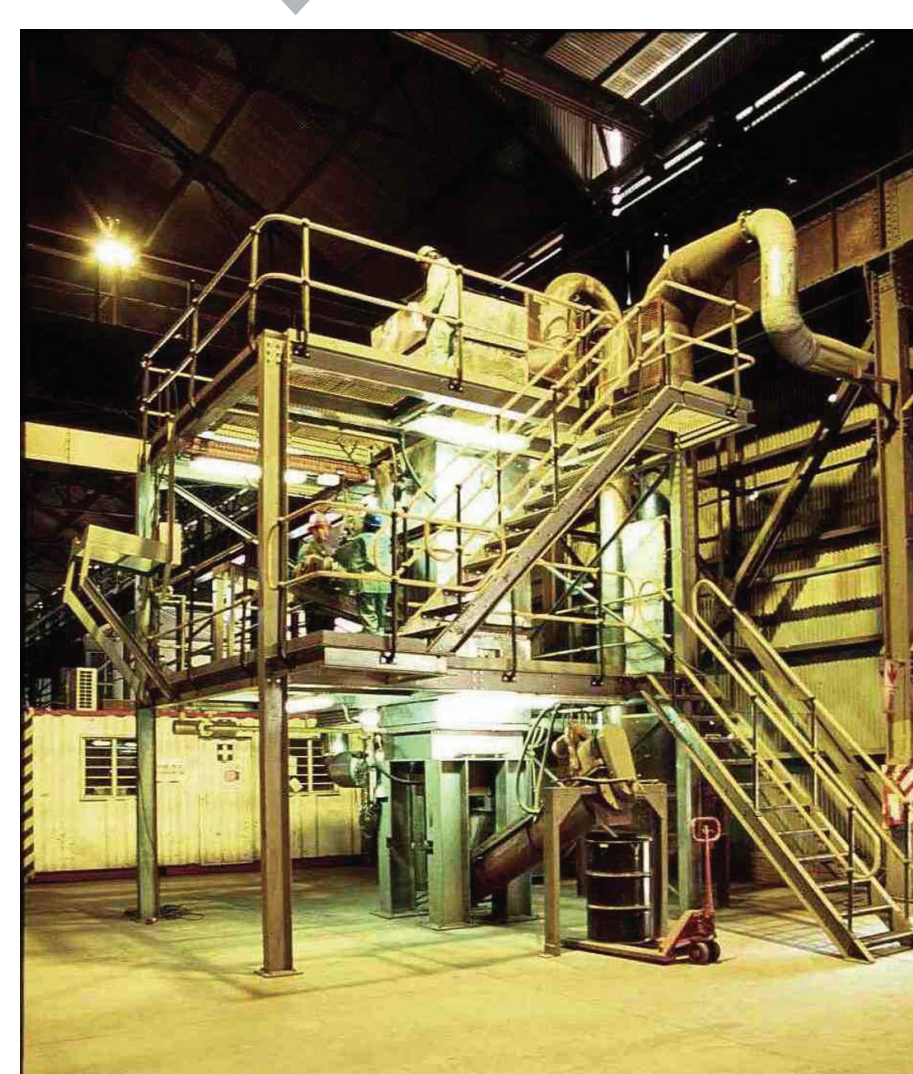
- Built as a mimic of the larger NFBC. Allows quicker turn-around
- Development of specialised LPG nozzles
- Sulphide-bearing ore investigations

### Calcination Rig

- Smaller, flexible rig for calcination of calcium carbonate and magnesium oxide work
- Now modified for clean coal technology thrust



1994: Calcination Rig



2000: Multi-Purpose Fluidised Bed at FBCOE

### Bench Scale Test Rigs

- One and two inch bench scale rigs for high value material testing

### Fluidised Bed Centre of Excellence

- Fluidised Bed Centre of Excellence (FBCOE) formed
- Ilmenite beneficiation by effecting magnetic susceptibility



1998: Bench Scale Test Rigs

## COMMISSIONED PLANTS

### Slagment Hot Gas Generator

Client : Slagment  
 Bed area : 25 m<sup>2</sup>  
 Plant purpose : A 10 MW plant for the combustion of duff coal at greater than 98% burnout to provide hot gases for the drying of slag. Subsequently also used for organic waste incineration.

Project duration : 1988 – 1989  
 Current status : Operating successfully  
 Awards : South African Institution of Mechanical Engineers Projects and Systems Award 1990



Slagment Hot Gas Generator

### Biomass Sludge Boiler

Client : A multinational food producer based in Estcourt, KwaZulu Natal.  
 Bed area : 27 m<sup>2</sup>  
 Plant purpose : A 20 MW plant for the incineration of a stream of 12 tons/hr coffee grounds (85% water) while raising 26 tons of process steam with the off-gases.

Project duration : 1992 - 1994  
 Current status : Operating successfully  
 Awards : South African Institution of Chemical Engineers Innovation Award 1994



Biomass Sludge Boiler

### High Sulphur Pitch Incinerator

Client : SASOL  
 Bed area : 21 m<sup>2</sup>  
 Plant purpose : Incineration of 2500 kg/hr of high sulphur pitch and 2000 kg/hr of phenolic effluent. The plant is designed for 85% sulphur capture by the addition of limestone. Potential use for thermal soil remediation.

Project duration : 1995 - 1997  
 Current status : Operating successfully



High Sulphur Pitch Incinerator

### African Products Deodoriser

Client : African Products  
 Bed area : 16 m<sup>2</sup>  
 Plant purpose : To deodorise a stream of gas from dryers, while generating hot gases and ultimately process steam. This plant is part of the 'Greenfields' development projects, which has been in operation since late 1997.

Project duration : 1996 - 1997  
 Current status : Operating successfully



African Products Deodoriser

### FBC Hot Gas Generators

Client : Palabora Mining Company  
 Bed area : 10 m<sup>2</sup>  
 Plant purpose : Two 8.5 MW fluidised bed coal combustors used to provide hot gas to dry vermiculite.

Project duration : 1995 - 1996  
 Current status : Operating successfully



Hot Gas Generators

## Other applications

- Recovery of precious metals through incineration of wood chips
- Chemical vapour deposition onto valuable substrates

## CONCLUDING REMARKS

- Fluidised bed technology is robust with unique characteristics, rendering it suitable to a host of different applications;
- Despite the advances made in modelling and simulation, in this kind of investigative work, there are always surprises necessitating test work;
- There are great advantages to having access to a range of versatile test facilities, skills and expertise; and
- Partnership with industry is essential to solve real problems and for building greater knowledge and expertise in the field.