



Energy and Environmental Engineering Research Group

Department of Chemical and Process Engineering, The University of Sheffield

Background / Introduction

The Combustion and Incineration Group has a worldwide reputation for its broad range of innovative process research particularly that into combustion of fossil fuels (coal, gas and oil), energy utilisation and associated power generation and CHP systems. The Group also specialises in several major areas of environmental concern, including flue gas clean-up systems, corrosion/erosion in heat recovery systems, slag build-up in furnaces, emission monitoring and diagnostics, instrumentations and pollution control.

In the related field of development of Combined Heat and Power (CHP) Systems for cities, the Group played a key role in developing one of the UK's first and still the largest district heating system with 150MWh currently connected. The Group has been also in charge of running many collaborative research projects with the UK/EU Power Industry at the Department's Buxton research laboratory/site. These programmes have included; Fire safety, explosions, CO₂ mitigation, CFD modelling, pulverised coal, limestone/gypsum spray characterisation, long distance slurry pumping, fluidic flow control, and characterisation of cyclone demisters. Extensive laboratories are available and equipped with fuel supplies, flues and diagnostic facilities for combustion and explosion research.

Expertise / Skills

- Combustion of fossil fuels
- Combined Heat and Power(CHP)
- Fires and explosions
- CFD modelling
- Heat Recovery Systems
- Diagnostics and Instrumentation
- Pollution Control
- Renewable Energies
- Power Generation Systems

Some Recent Industrial Partners

- Shell / BP / Esso
- Health & Safety Executive (HSE)
- PowerGen
- British Gas
- Rolls Royce
- BNFL
- Foster Wheeler
- AEA Technology
- LAND Combustion, etc.

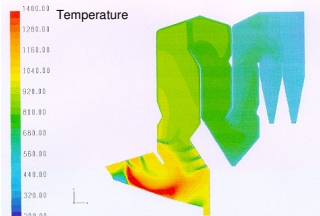
Research Track Record

Sheffield District Heating System - Combined Heat and Power

- The Network is supported by back-up facilities, with 3 pre-heated stand-by/peaking boiler plants
- Providing Heat & Electricity to more than 5000 residential homes, schools, businesses, 5 hospitals and 2 universities in Sheffield
- Green Heat: For every 100,000 MWh of useful energy delivered, 145,000 MWh of fossil fuel energy is replaced, saving 34,000 tonnes of CO₂ from being released into the atmosphere



FLUENT – CFD Code



Malvern - Particle Sizing Instrument



Harpur Hill Research Facility

- Unique 60 hectare research facility with 14 laboratories
- Supplied with services and a comprehensive mechanical workshop
- Research work is being carried out in the fields of combustion, incineration, fires/explosions, fluidics, multiphase flows & instrumentations (Collaborators: Shell, BP, HSE, AEA etc)



• Oxy-Fuel Combustion: 1 MW capacity furnace

• Confined Explosion Test Rig

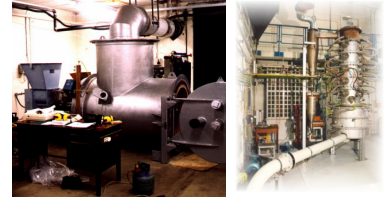


Some Research Facilities/Projects

Ultra Superheated Steam Gasifier



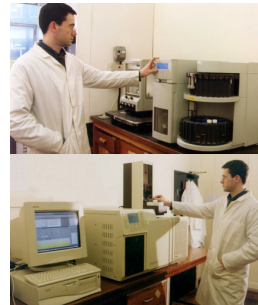
Novel Rotating Fluidised Bed Unit



- Combustion of Refuse Derived Fuels in a Fluidised Bed
- The Stability of Turbulent Hydrogen Flames in the Presence of CO₂ and C₃H₈
- Hydrogen Production From Solar Energy
- Development of Hot Flue Gas Clean-up Systems

Analytical Facilities

Dioxins/Furans Measurement



Heavy Metal measurement

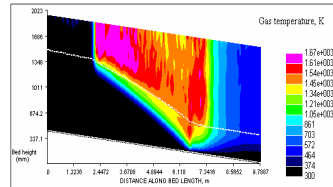
- Mobile laboratory containing the latest state of the art ICP/OES instrument, has a flexible heated sampling probe (40m long) and can measure concentrations of 70 species



Computational Fluid Dynamic Modelling

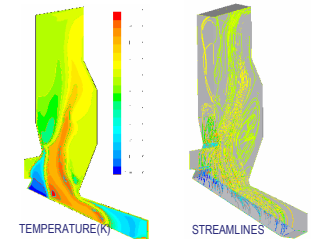
FLIC

- CFD Code developed by CIG/SUWIC for the simulation of solid-gas phase reacting bed



FLIC Simulation Results for Waste Bed in a Incinerator

FLUENT



FLUENT Simulation Results for a Waste Incinerator

Sheffield University waste Incineration Centre (SUWIC)



- SUWIC, which is an established key-centre associated to CIG, is the leading international research centre for the thermal treatment of wastes. The Centre has a world-wide reputation for innovative investigations into combustion, gasification and pyrolysis of biomass/waste and the associated electrical power generation systems.
- SUWIC specialises in several major areas of environmental concern, including waste management, flue gas clean up systems, recycle/reuse of ash residuals and the eventual disposal of sludges.

International and National Awards

- The Queens Anniversary Award (Environmental Outreach) 2002
- The Queens Anniversary Award for Exports (Malvern Instrument) 1988
- The Walter Ahlstrom Award - 2002 (Presented by Prime Minister of Finland pictured left with Prof. Swithenbank at the ceremony)
- Weinberg Award : Institute of Physics
- Redland Magnesium Award, Roscoe Prize, Institute of Energy
- Foxwell Memorial Awards, Institute of Energy
- James MacEntee Award: Combustion Institute
- EPSRC Research Event: Environment Category first prize
- IChemE Research Event : Clean Technology Category Award
- ExxonMobil Engineering Teaching Fellowships (Y Wu, N Russell)



CIG/SUWIC Future Research Directions

- Development of Integrated Power and Waste Management Systems
- Clean Hydrogen Fuel Generation and its Safety
- Combined Heat and Power (CHP) Networks
- Clean Coal Technologies
- Direct CO₂ Photo-reduction and Electro-reduction using Semi-conductor Nano-particles and Photovoltaics
- Emission Control by Flameless Combustion