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energy

OxyCoal™ Burner Technology Development

The 13th Annual APGTF Workshop:

'Carbon Capture & Storage – a Showcase of UK Research and Development'

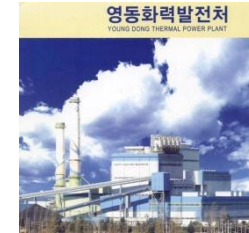
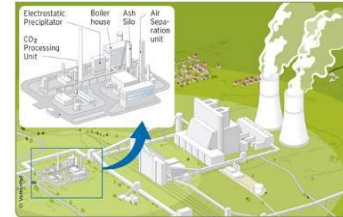
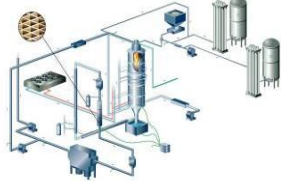


Doosan Power Systems

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OxyCoal™ Research, Development and Demonstration Projects

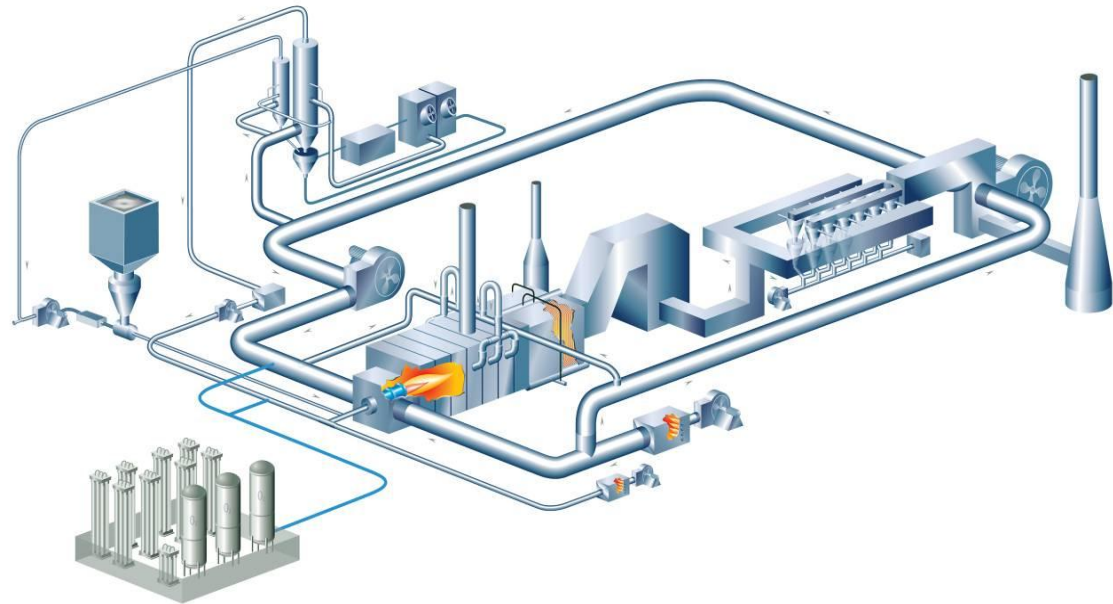
For over 20 years, Doosan Power Systems has been a leading player in the development of oxyfuel technology, starting with the demonstration of the process in 1995.



- OxyCoal-UK: Phase 1 Fundamentals and Underpinning Technologies (2007 – 2009)
 - Develop a competitive oxyfuel firing process, based on integration of well proven and innovative power plant design components.
- OxyCoal 2 Demonstration of an Oxyfuel Combustion System (2008 – 2010)
 - Design an OxyCoal™ burner of a type and size applicable to new build and retrofit coal-fired boilers and demonstrate its performance.
- Oxyfuel Pilot Plant Project Schwarze Pumpe (2010 – 2012)
 - Jointly develop oxyfuel combustion technology towards commercially viable application in later large-scale power plants.
- Young Dong 100MW_e Oxyfuel Technology Demonstration (FEED Study 2011-2012)
 - Convert anthracite-fired boiler to bituminous coal firing and demonstrate oxyfuel technology.

OxyCoal 2 Demonstration of an Oxyfuel Combustion System

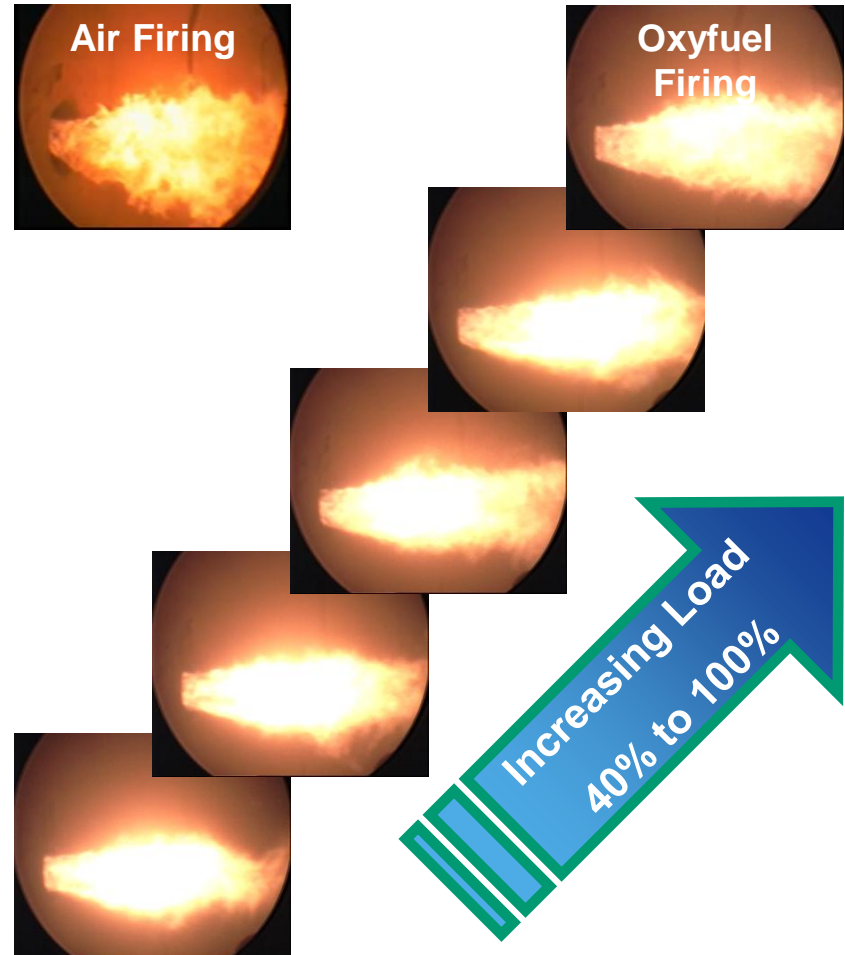
Design an OxyCoal™ burner of a type and size (40MW_{th}) applicable to new build and retrofit coal-fired boilers and demonstrate its performance.



OxyCoal 2 Demonstration of an Oxyfuel Combustion System

The results from testing demonstrate Doosan Power Systems' pioneering expertise in the carbon capture field and mark a major step towards making full-scale carbon capture a reality.

- A full scale 40MW_{th} OxyCoal™ burner was successfully demonstrated on air and oxyfuel firing, achieving safe and stable operation across a wide operational envelope.
- Oxyfuel flame stability and flame shape was comparable to air firing experience.
- Safe and smooth transitions between air and oxyfuel operation were demonstrated.
- Realistic CO₂ levels were achieved (in excess of 75% v/v dry, and up to 85% v/v dry).
- 40MW_{th} OxyCoal™ burner turndown proven from 100% load to 40% load – a comparable turndown to Doosan Power Systems' commercially available air firing low NO_x axial swirl burners.
- NO_x and SO₂ expressed as mg/MJ is significantly lower under oxyfuel firing than air firing.
- Combustion efficiency under air and oxyfuel conditions, as expressed by CIA, unburnt loss, and CO, is comparable.



Oxyfuel Pilot Plant Project Schwarze Pumpe

The Oxyfuel Pilot Plant (OxPP) tests intend to improve the oxyfuel combustion process as well as establish a better understanding of the behaviour of individual components within the process chain.

- Doosan Power Systems has joined the Technology Partnership for the Oxyfuel Pilot Plant (OxPP) project
 - Agreement signed between Vattenfall Europe Technology Research GmbH and Doosan Power Systems in December 2010
- Doosan Power Systems was responsible for providing an alternative burner (30MW_{th} OxyCoal™ burner) for testing on the 30MW_{th} pilot plant in Schwarze Pumpe, Germany.



- The purpose of the pilot plant is to validate engineering work, to learn and better understand the dynamics of oxyfuel combustion and to demonstrate the capture technology

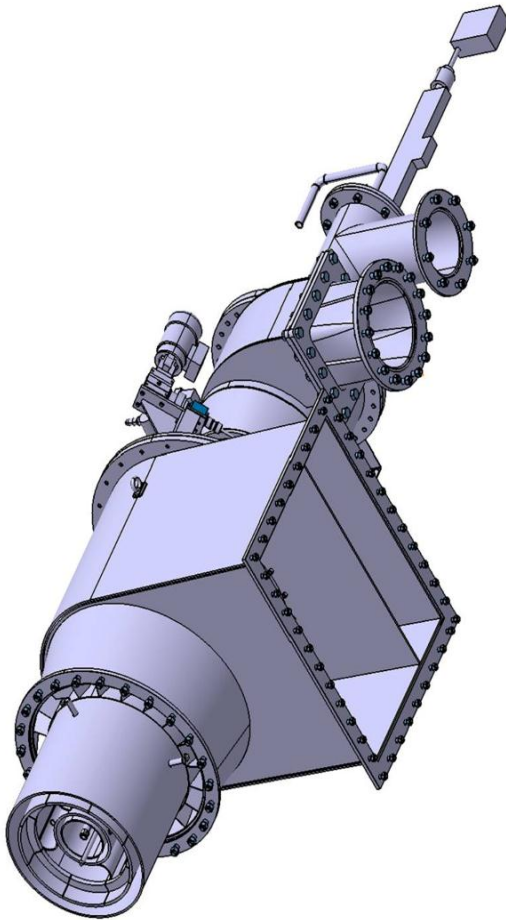
Oxyfuel Pilot Plant Project Schwarze Pumpe

Doosan Power Systems OxyCoal™ burner design is based on our existing knowledge, experience and expertise of low NO_x air-fired burner technology.

- Doosan Power Systems 40 MW_{th} OxyCoal™ Burner for Clean Combustion Test Facility (CCTF), Renfrew, Scotland
 - Multi-fuel Burner Test Facility
 - Intermittent operation
 - Igniters Combustion Engineering pre-mixed gas flame system
 - Heavy fuel oil light-up burner
 - Pulverised fuel
 - » Kellingley (UK bituminous coal)
 - » El Cerrejón (Columbian bituminous coal)
 - Common windbox
 - » Secondary oxidant
 - » Tertiary oxidant
 - Manual adjustment swirlers
 - National Instruments Supervisory Control and Data Analysis (SCADA) system
- Doosan Power Systems 30MW_{th} OxyCoal™ Burner for Oxyfuel Pilot Plant (OxPP), Schwarze Pumpe, Germany
 - Pilot Plant
 - Continuous operation
 - DURAG high energy spark igniter
 - Gas light-up burner
 - Pulverised fuel
 - » BKS (German lignite coal)
 - Individual ducts
 - » Secondary oxidant
 - » Tertiary oxidant
 - Automatic actuated swirlers
 - Siemens Power Plant Automation T3000 (SPPA-T3000) web-based instrumentation & control (I&C) system

Oxyfuel Pilot Plant Project Schwarze Pumpe

Operation of the Doosan Power Systems' 30MW_{th} OxyCoal™ burner in the Oxyfuel Pilot Plant (OxPP) for close to 2800 hours during the testing in 2011 and in 2012.



Air Firing

Oxy Firing

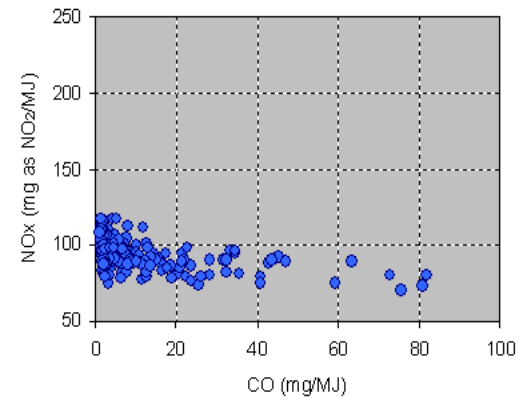
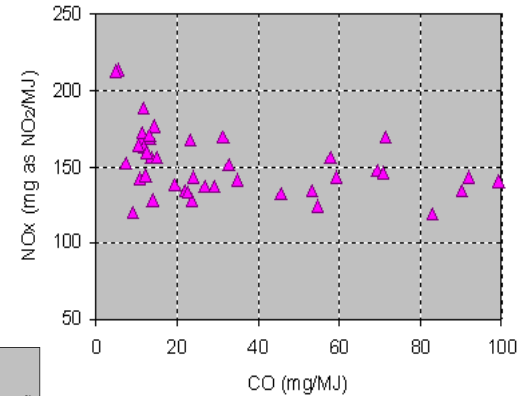
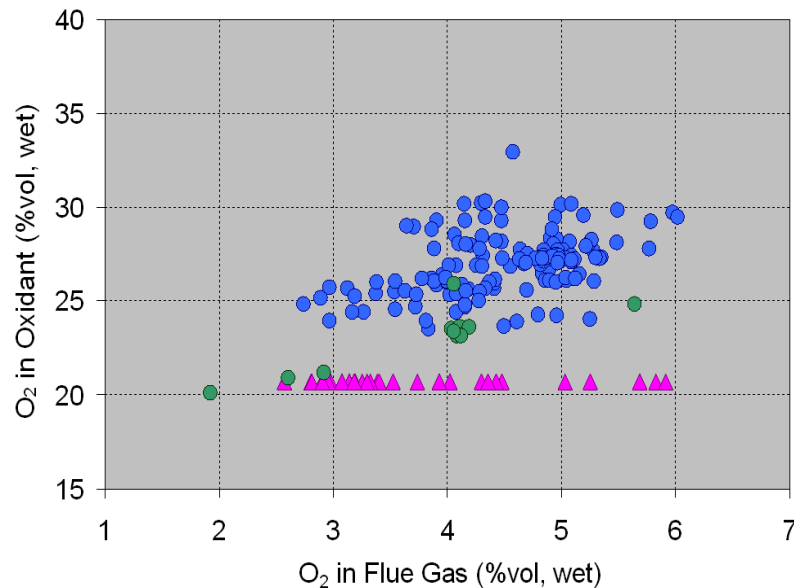
- Automatic control modified to demonstrate safe and smooth transitions between air and oxy firing, and vice versa.
- 300 hours operation of the 30MW_{th} OxyCoal™ burner on air firing.
- 2500 hours operation of the 30MW_{th} OxyCoal™ burner on oxy firing.
- Steady oxy firing operation for extended periods - a requirement for parallel test measurements.

Oxyfuel Pilot Plant Project Schwarze Pumpe

The 30MW_{th} OxyCoal™ burner demonstrated good flame stability over a wide range of operating conditions, while maintaining low levels of NO_x and CO.

■ Combustion performance optimised to achieve set targets.

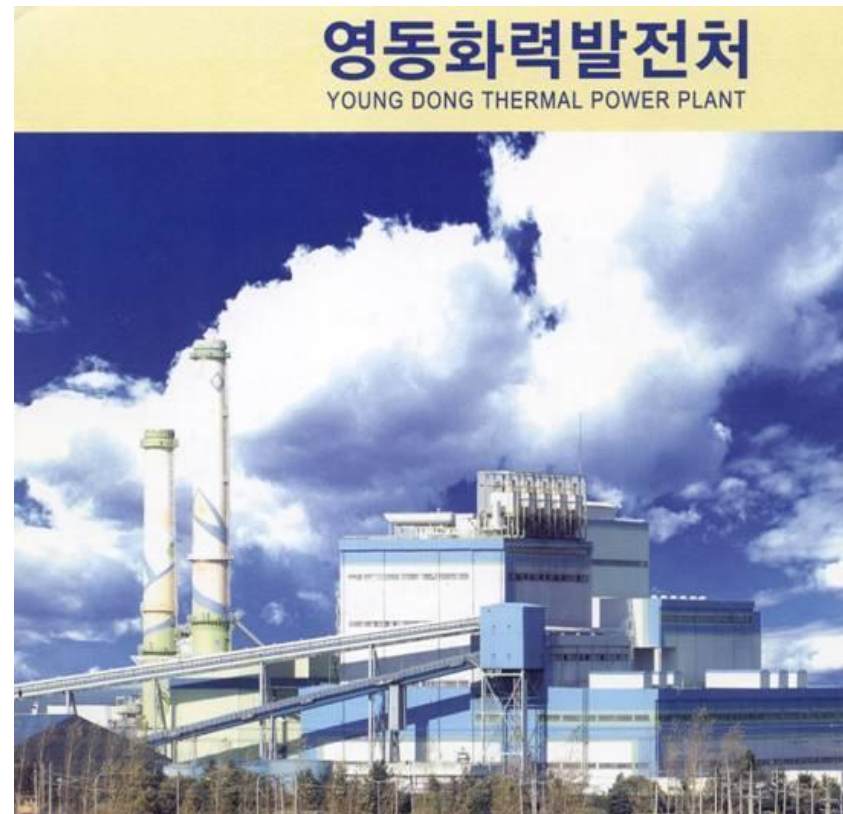
- O₂ < 3 vol% (wet)
- NO_x < 250 mg/Nm³ (air) < 800 mg/Nm³ (oxy)
- CO < 50 ma/Nm³ (air) < 100 ma/Nm³



Young Dong 100MW_e Oxyfuel Technology Demonstration

KOSEP's Young Dong Power Station has been selected to host a 100MW_e oxyfuel demonstration

- Unit #1, 125MW_e
- Downshot boiler firing domestic anthracite and heavy fuel oil
- In-service 1973
- OEM was Babcock Hitachi KK, built under licence from Doosan
- Change of fuel from domestically sourced low volatile anthracite to world-traded high volatile bituminous coal for long term operation
- Retrofit of oxyfuel firing system for demonstration
- Front End Engineering Design Study successfully completed.



Contact Details

Doosan Power Systems is committed to delivering unique and advanced carbon capture solutions to create a low carbon future.

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