FCT COMBUSTION
Delivering Performance

TURBU-FLEX™ BURNER

A world first. Effortlessly adapt to different fuels with one burner.

The world of pyro-processing fuel is constantly changing. Now it's no big deal.

One of the biggest headaches for pyro-processing plants when fuels and other inputs are varying, is finding a single burner with the flexibility to deliver optimum combustion performance. Alternative Fuels (AF) are attractive as cost effective sources of fuel, but they pose significant challenges for kiln operators. FCT Combustion spoke with global customers to develop a deep understanding about their requirements and key issues, such as how to:

- Maintain quality when switching to different fuels can change heat transfer
- Ensure fuel savings aren't negated by lower production outputs
- Minimize NOx emissions.

To address these challenges we developed the Turbu-Flex burner, the next evolution of FCT Combustion's successful Turbu-Jet™ burner, which has delivered exceptional value for many years across hundreds of global installations. The new Turbu-Flex burner has the flexibility to fire both 100% conventional fuel and very high levels of varying alternative fuels, while maintaining production output, quality and low NOx emissions under all circumstances, to truly realize the value of fuel cost reduction. In short – realize the profitability of AF, without compromising on plant operations.

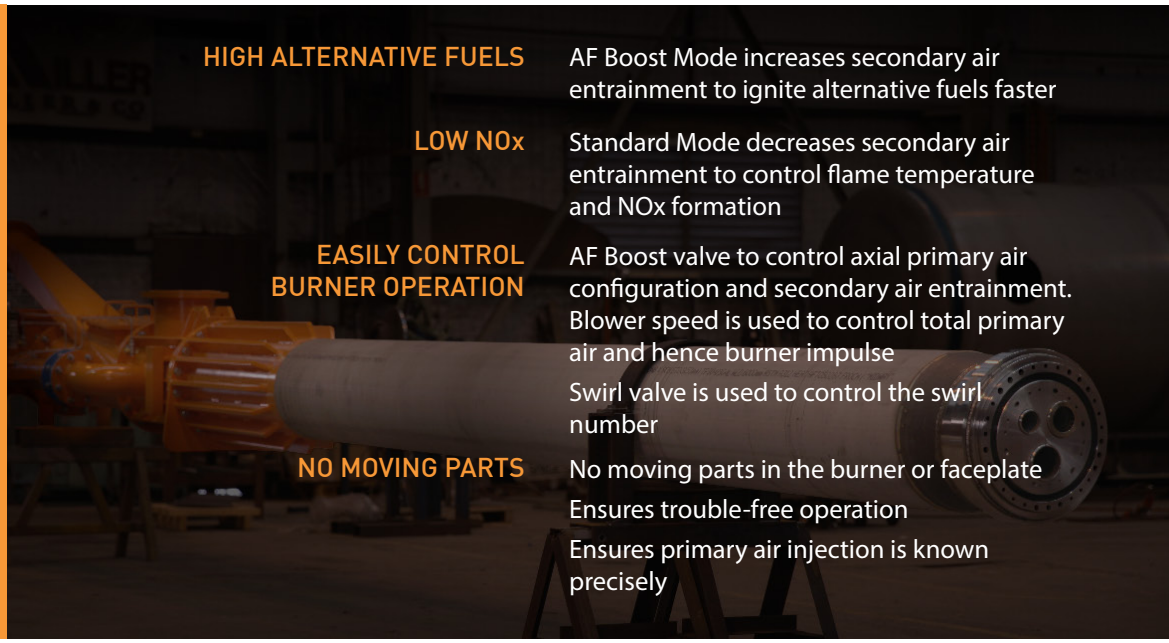
LOWER FUEL COSTS

IMPROVE KILN PERFORMANCE

FIRE VERY HIGH LEVELS OF ALTERNATIVE FUELS

CHANGE FUELS EASILY

NO COMPROMISE ON PLANT OPERATIONS



HIGH ALTERNATIVE FUELS	AF Boost Mode increases secondary air entrainment to ignite alternative fuels faster
LOW NOx	Standard Mode decreases secondary air entrainment to control flame temperature and NOx formation
EASILY CONTROL BURNER OPERATION	AF Boost valve to control axial primary air configuration and secondary air entrainment. Blower speed is used to control total primary air and hence burner impulse
	Swirl valve is used to control the swirl number
NO MOVING PARTS	No moving parts in the burner or faceplate
	Ensures trouble-free operation
	Ensures primary air injection is known precisely

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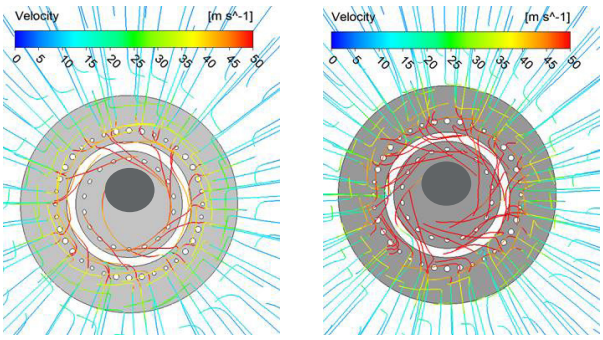
The key feature of the Turbu-Flex burner is that the primary air axial holes are in two groups, each with a separate air supply. With the turn of a single valve the burner changes from:

- **Standard Mode:** operating with many evenly distributed holes all at the same pressure, which restricts secondary air entrainment and peak flame temperature
- **AF Boost Mode:** operating with a small number of holes at high pressure grouped together, which increases secondary air entrainment into the core of the fuel stream and peak flame temperature

Further innovations in the swirled primary air hole design have also been devised to enhance the control of mixing and hence combustion.

The benefits to plant managers are clear – with the flexibility to effortlessly switch between fuels, the new Turbu-Flex burner ensures lowest fuel costs and highest kiln performance. With the Turbu-Flex burner, changes in fuel can be done easily and with certainty.

Secondary air flow lines 2x burner diameters down stream of the burner tip. Lines coloured by velocity.



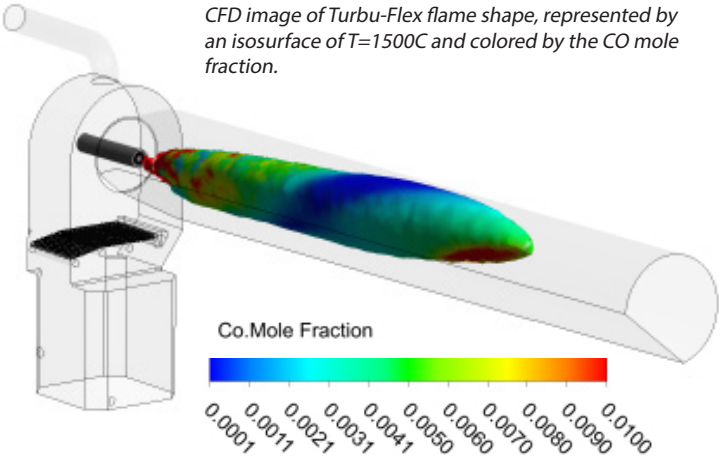
STANDARD MODE AF BOOST MODE

Burner design based on proven and scientifically validated techniques.

FCT Combustion has been employing a variety of modeling techniques to develop burner designs since its inception in 1984.

We have created a world leading capability with Computational Fluid Dynamics (CFD) to compare the performance of different burner designs in rotary kilns.

In order to develop the Turbu-Flex, we conducted an extensive CFD investigation that assessed the effect of the number, distribution and arrangement of axial and swirl primary air holes. These are the key design variables that control axial and swirl momentum and hence burner impulse, secondary air entrainment, mixing and flame shape.



CFD image of Turbu-Flex flame shape, represented by an isosurface of T=1500C and colored by the CO mole fraction.

INDUSTRY APPLICATION	Rotary kiln for all industries
PRIMARY FUEL TYPE	Coal, petcoke, gas or liquid
MULTI-FUEL CAPABILITY	In combination with gas, liquid and alternative fuels
OUTPUT	Customizable from 1-150MW
PRIMARY AIR DATA	Approximately 7%
INCLUDES	Optional ceramic coating for protection of faceplates
ACCESSORIES	Integral automatic pilot ignitor In-burner flame sensor

FIELD TESTED. FIRST DEPLOYMENT IS FIRING VERY HIGH LEVELS OF VARYING ALTERNATIVE FUELS.

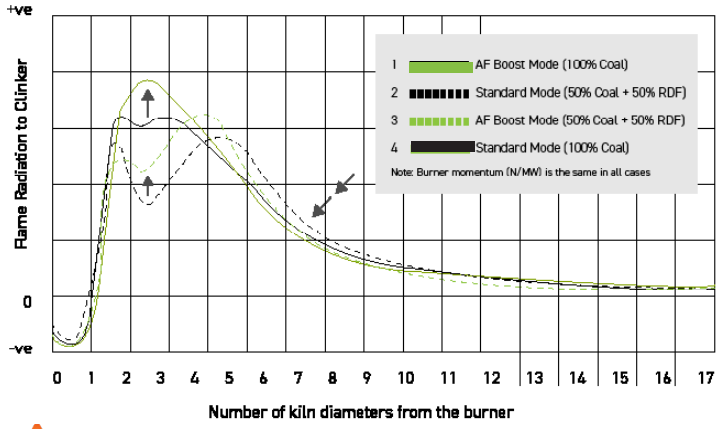
Building upon the proven, industry-leading technologies of the Turbu-Jet burner, the first Turbu-Flex has been in operation since August 2017.

We found that grouping axial primary air holes close together changes the secondary air entrainment and hence flame temperature and NOx. For example, halving the number of axial air holes results in a 7% increase in peak radiation and NOx and a combined 14% increase when the holes are grouped together.

A burner that has the flexibility of adjusting axial primary air configuration can hence optimize combustion depending on fuel and emissions requirements, i.e. a high number of axial holes can help suppress NOx formation, while a small number of holes grouped together is ideal for co-firing AF.

The graph demonstrates the effect of the AF Boost on flame radiation to clinker (kW/m^2) for 100% coal and co-firing of 50% coal and 50% RDF. All of these cases have the same specific burner momentum (N/MW). [1] shows 100% coal firing in Standard Mode and provides a very good radiation profile for high quality clinker production. [2] at 50% RDF co-firing in Standard Mode, the peak heat flux drops and more heat is transferred to the clinker further up the kiln. [3] In AF Boost Mode there is a 5% increase in radiation in the first 5 kiln diameters. [4] AF Boost Mode also significantly increases the peak radiation for 100% coal. All of the improvement in AF Boost Mode is a result of changing the air flow pattern at the burner tip.

Flame Radiation to Clinker for Coal and RDF



Setting global performance benchmarks in pyro-processing.

FCT Combustion is the world leader in optimizing high-temperature processing plants to realize new levels of performance for productivity, emission control, fuel efficiency and flexibility to meet ever-changing requirements.

Our pyro-processing products and expertise are all based on proven and scientifically validated techniques, helping our global customers be competitive as their needs and industry conditions change. Our designs, engineering and product range are used in the world's most competitive mineral processing plants.

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