"TRUE BLUE" – a Synonym for Perfect Firing

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A new generation of burners closes a gap in the market and promises high potential energy savings.

Obviously, the firing process remains a focus of interest when it comes to cutting rejects, improving quality, and especially with regard to saving energy in the manufacture of ceramics. After long years of effort and progress by the suppliers and operators of industrial kilns and furnaces, you might wonder what more can be done in this stage of the manufacturing process and where the limits are in terms of financial and technical outlay.

Growing Demands on Intermittent Firing Systems

Without doubt, the firing process in periodic/intermittently operated kilns or furnace requires other assessment criteria than those for continuous firing processes, which usually demonstrate lower specific energy consumption. For a growing number of innovative ceramic products, however, continuous firing systems offer no real alternative. These products need firing systems that reliably and reproducibly ensure the debinding process in the temperature range from 60 to 300 °C, and enable subsequent heating up to 1600 °C. Highly dynamic firings, with precision control of a wide range of atmospheres as well as heating and cooling rates from 0 to 1000 K/h are expected of these firing systems. These requirements can be much more efficiently met in an intermittently operated kiln than in continuous kilns.

It was the repeated desire from customers and our experience with commercially available burners that inspired us to develop new multi-functional burner systems that can meet complex requirements and also considerably improve the energy balance of intermittent kilns and furnaces.

What Happens when Secondary/Diffusion Air Eats up Energy

It is a physical fact that at low temperatures heat is transferred to the ware based on convective mechanism. And above 600 °C heat transfer by radiation becomes more dominant. Therefore, high flow rates and selective turbulence in the firing atmosphere favour heat transfer by convection at low temperatures and ensure better temperature distribution.

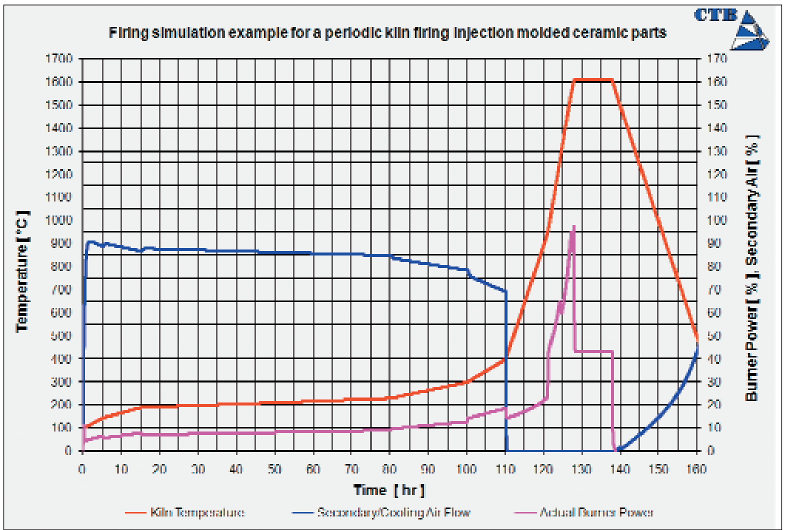


Fig. 1 For a defined optimum firing curve (red line), the energy requirement of the burner is well below 10 % in the first 80 hours of the firing cycle. To enable control of the process, however, it has to be operated at this output level. The volume of secondary air shown here (blue line) is necessary for temperature uniformity as well as for the firing atmos-phere. Burners that do not cover the lower control range are not suitable for this model process

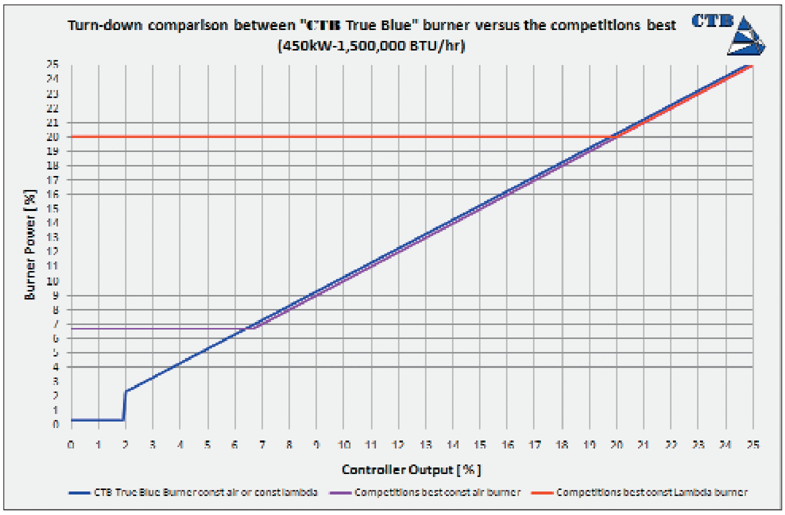
Current Situation

In intermittently operated kilns and furnaces, the problem is that only a very low quantity of energy is needed during the debinding process, but the burners themselves have to be designed to ensure the required output at maximum firing temperature or maximum heating rates. At low burner outputs, the velocity and the volume of the air/gas mixture are, however, too low to generate the necessary turbulence in the firing atmosphere.

In addition, all burners and control equipment available on the market cannot operate under these conditions. Generally, the burner output can be controlled in the range from 10 – 100 % of the nominal capacity. Below 10 %, severe operating problems occur resulting in flame outs of the burners.

To solve these problems, the burners must operate above their minimum outputs at low temperatures. To compensate the high heat input from the burners excessive amounts of secondary/diffusion air is required to maintain the temperature. This has its price and is waste of energy as the high amount of exhaust gases from the kiln must be also treated with a considerable amount of energy in the Catalytic or Thermal Oxidizer to comply with environmental regulations. In addition, high flow rates of the burners can potentially cause cracks on the surface of the product around the ware stack due to excessive heat transfer to the product and the kiln atmosphere might be too rich in oxygen for the debinding process. Fig. 1 illustrates a perfect firing with high convection and good temperature uniformity with a reasonable amount of secondary/diffusion air.

Fig. 2
Turn-down range of a "TRUE BLUE" burner compared to the best burners currently available on the market



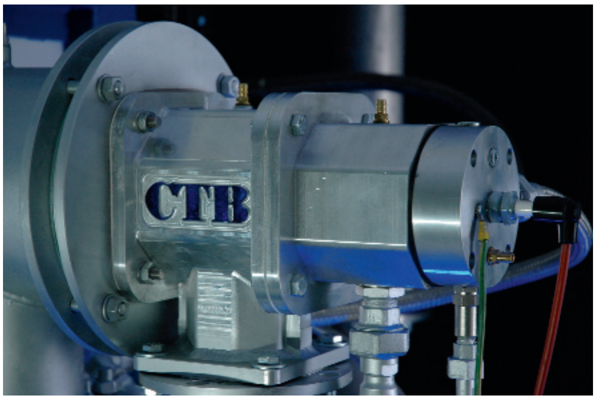


Fig. 3 "TRUE BLUE" burner installed

Fig. 4
"TRUE BLUE" burner flame

Summary

If conventional burner systems can only be operated with an extremely high percentage of secondary/diffusion air at low temperatures, then apart from the problems described above stems represent a completely unsatisfactory solution for intermittent kilns and furnaces.

Pulsed Burner Technology – One Option, but not Always Feasible

One firing alternative which does not require secondary/diffusion air are pulse fired burners. The product of combustion from the burner is introduced into the firing chamber in pulses at high speed and can therefore ensure the necessary flow pattern to permit convective heat transfer. The flow pattern can be influenced and controlled with a permanently set or regulated pulse algorithm.
The energy supply necessary to maintain the defined firing curve is regulated on the basis of the pulse frequency and pulse duration. Kiln atmosphere settings are also possible.
However, for certain firing processes, in particular technical ceramics or products containing high amount of binders, has proven that pulse firing is not possible as the maximum permissible concentrations of combustibles in the firing atmosphere (lower explosive limit) can be easily exceeded as a result of the evaporation or debinding of organic binders or additives in the wares.

"TRUE BLUE" Burners – "Unlimited" Control to Fully Utilize Potential

The development of the new CTB burner provides an extremely energy-efficient solution to the problems explained above. These burners operate below 10% of the nominal capacity to form a stable and blue soot-free flame. The control range is extended to 2 to 100 % (turn down ratio of 1:50) of the nominal capacity at constant lambda and to 0,7 to 100 % (1:100) at constant air volume: The "TRUE BLUE" burners have therefore closed a gap on the international market for industrial burners.
Fig. 2 illustrates the difference in the regulation and control of a "TRUE BLUE" burner compared to the best burners currently available on the market for ceramic kiln and furnace construction.
The name "TRUE BLUE" was specifically chosen for the new burner generation with allusion to the blue colour of a gas flame during stoichiometrically optimal combustion.

Design Details and Services

Numerous types of gas burners in different capacity classes are available on the market. With its unique design (Fig. 3 and Table) available in three sizes, the new CTB burner meets all generally acknowledged requirements for ceramic firing systems.
The basic burner set-up is identical for all three capacity classes:
(1) Pilot housing with integrated pilot burner
(2) Gas housing with flame cell
(3) Combustion air housing for preheated combustion air to 350 °C
(4) Burner nozzle available in different grades depending on the firing temperature
(5) Secondary/diffusion air housing (optional)
(6) Secondary/diffusion air burner nozzle available in different grades depending on the firing tem- perature (optional).
The optimum burner size is determined at CTB as standard with the help of simulation software for a defined firing cycle. In this process, the necessary volumes of secondary/diffusion air are calculated to ensure optimal temperature distribution and to comply with requirements for the concentration of combustibles in the firing atmosphere specified in the European standard EN1539 and the American standard NFPA 86-2003 respectively. Through the secondary/diffusion air connection, however, low oxygen or any other process gas can be supplied and mixed with the burner jet. This can be necessary, for example, to have a better control of the debinding process, while maintaining the set oxygen concentration of the product of combustion.

The Optimum S-olution - "TRUE BLUE" Burners in Combination with CTB Firing Technology

The burner is a very important component for the firing process. But all

Burner size	Application	Capacity range kW (BTU/hr)	
1	Continuous firing units, small intermittent firing units	15-100	(50 000 – 340 000)
2	Medium-sized intermittent firing units	100-300	(340 000 – 1 000 000)
3	Intermittently operated large-volume firing units	300-600	(1 000 000 – 2 000 000)

Tab. 1 Available burner sizes

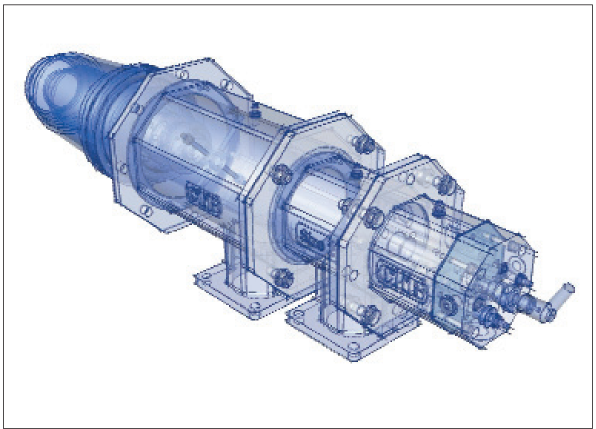


Fig. 5 Schema of the burner design

options for an optimal process can only be achieved with precise control equipment and smart controls.
CTB firing technology is based on temperature- and pressure-compensated gas and air volume flow measurements with simultaneous measurement of the ambient conditions such as barometric pressure, air humidity and temperature. With this system, the required gas or air mass flow can be automatically and precisely fed to every single burner. Even when the ambient conditions vary (winter/summer), manual adjustments to the burner or resetting are unnecessary.

Recommendations and Prospects

For gas-fired kilns and furnaces, the new burner complements the multifunctional CTB firing technology, which can be used to engineer energy-efficient solutions for practically all sophisticated industrial firing processes in the ceramics industry.
"TRUE BLUE" burners can enhance intermittent kilns and furnaces in particular with completely new properties and possibilities, making this type of firing system much more attractive. Considerable quality improvements and energy savings are possible even for installed systems. The first conversion of a firing system led to around 10-% energy savings solely as a result of the retrofitting of the new burners. Retrofitting the entire CTB firing technology upped the saving to almost 25 %. This energy-saving potential certainly makes you sit up and think against the background of the recent energy cost explosions.
One special feature of the system is the option for switching from modulating to pulse fired operation. The entire cooling phase can also be operated in pulse or modulating mode. Similar to the heating-up at low temperatures, reasonable amount of turbulence is required for cooling the ware with a good temperature uniformity. With regard to firing considerations, the new CTB burner is ideal for products requiring low heating rates in the lower temperature range, i.e. oversized products or products containing organic binders. But it is also beneficial for ware with discontinuous and tricky heating and cooling phases, e.g. for firing and anneal glass or ceramic foam products.
Tests with the new "TRUE BLUE" burners can be conducted at the CTB Testing Centre in Berlin. At Ceramitec, Hall A5 215/316, CTB is presenting a chamber kiln for 1600 °C, equipped with the new "TRUE BLUE" burners.
Tomorrows kiln technology today!