RING OF FIRE

Reinhard Ringdorfer, Unitherm Cemcon, discusses a new burner design.

Unitherm Cemcon is an Austrian company with more than 70 years of combustion expertise. Founded in 1945 as a company producing heating systems for households, in 1953 the first burner for a rotary kiln was developed and installed. By the beginning of the 1990s, approximately 300 traditional three-channel rotary kiln burners were installed worldwide.

In 1992, Heinz Lederer invented the M.A.S. burner. This was the first burner to have only one primary air channel with a unique internal flame setting device. Instead of using two static channels (axial and radial air) to influence the flame shape, this new burner could deflect the primary air into any desired swirl (Figure 1).

This concept of a dynamic burner revolutionised the industry. While during the 1990s the focus for rotary kiln burner was low NO_x emissions, in the 2000s cement plants looked for ways to reduce production costs. On the firing side, this was realised by using alternative fuels in solid and liquid forms. To achieve this goal, a high-efficiency burner with a high degree of adjustment possibilities, such as the M.A.S. burner, was required.

Evolution

Since its introduction, the M.A.S. burner has been installed almost 500 times around the world. Installed burners give feedback to Unitherm's commissioning engineers and technical staff for further improvement. Over more than two decades of service, the company has implemented four big modifications to the M.A.S. burner's primary air system. All of these changes directly impacted the efficiency of this system. Each modification resulted in better combustion and control of the flame, without changing the primary air input.

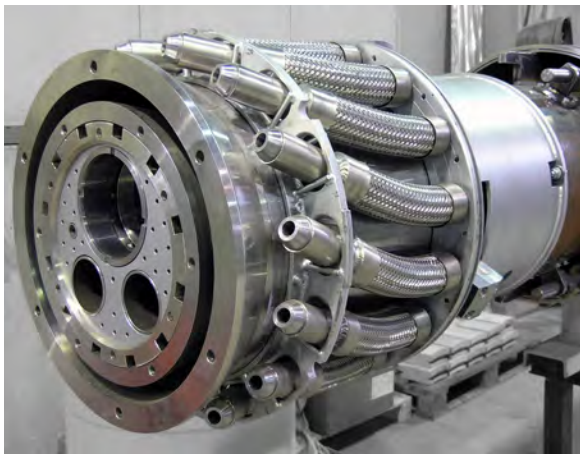

Figure 1. The M.A.S system.

Figure 2. Low swirl, long flame.

Figure 3. High swirl, short flame.

The development of the disc burner was the next natural step in optimising the burner's performance (Figures 2 and 3). Placing the adjustable primary air openings directly at the burner mouth leads to the unobstructed injection of the air jets into the kiln. Without any losses at the air nozzle, the entrainment of the secondary air is improved by approximately 15% at the same primary air pressure. This improves the ignition and combustion of the fuels and increases flame control and stability.

The disc system gives the designer of the nozzle head the advantage of complete freedom with regard to the number and shape of primary air nozzles. This means the primary air system can be designed for specific kiln parameters and fuels. Parameters such as the type of cooler (secondary air temperature), kiln hood design and size, kiln dimensions, etc. influence the design of the burner, especially for the primary air system.

The cooling of the outer jacket tube with the M.A.S. system (hose and disc design) is superior to that of other rotary kiln burners. As 100% of the primary air can be used for cooling, all test burners showed improved lifetime for the refractory lining at the burner. On average, the lifetime of the refractory at the burner is extended by approximately 20%. Particularly for kilns in which the refractory service life is below one kiln campaign, the new design could be beneficial.

The new primary air system – with discs instead of flexible hoses – also requires less space inside the primary air channel. Even though the simple adjustment of the flame setting device remains the same, the burner will be smaller in diameter and therefore lighter in weight.

The advantages of the new system can be summarised as follows:

- Higher flexibility in the number and geometry of the primary air openings.
- More efficient primary air injection, resulting in higher effective momentum.
- A slimmer flame.
- Better cooling.
- A smaller burner diameter.
- Lower maintenance costs.
- Downward compatibility to existing M.A.S. burners.

Modification of existing burners

One of the most important features of the new primary air system is its downward compatibility to the M.A.S. system. As it was possible with old burners to upgrade to the latest nozzle head execution (generation five), it is also possible to equip existing M.A.S. burners with the latest – so called M.A.S.^{DT} (disc technology) – primary air injection system.

This modification can be done onsite by the client themselves, without the help of a specialist from Unitherm's workshop. It usually takes two skilled metalworkers approximately two days to dismantle the flexible hoses and the guiding ring, adapt the motion converter to the new setting device, and install the disc holder and the disc package (Figures 4 and 5). After the final movement test of the new system through the full flame setting range, the burner jacket tube can be installed and the burner can be put into operation.

Applications

Several years ago, the new burner system was designed and manufactured as part of a research project for the development of a new flame setting device. The first burner was installed in a cement plant in Austria. Even though the basic principle was clear from the beginning, the mechanical realisation was more complicated. Optimised cooling and the avoidance of abrasion posed additional problems.

Figure 4. Before modification.

Figure 5. After modification.

Figure 6. Test burner in Germany.

All of these challenges were addressed by using computational fluid dynamics modelling, combined with real world testing on the trial burner. After testing several different designs, the final execution delivered convincing results in terms of performance and equipment lifetime.

During the trials with the first burner, the new system was also installed on a spare burner for a cement plant in Germany. This burner is installed in a preheater kiln without a calciner, which operates with a high substitution rate of solid secondary fuels (Figure 6).

The results of this second burner, which is installed in a much larger kiln, provided additional data for the development of the final design. As with the first trial burner, the plant personnel worked in close cooperation with Unitherm technical staff.

Over the last years, the disc system has been installed in three more burners of different sizes, with similar good results to the first two burners.

In January 2019, one spare burner in a cement plant in Germany was modified as the latest trial before the official presentation of the new burner generation. Up to now there have been no final results, but the client's first impression is promising.

Conclusion

With the development of the M.A.S. disc system burner, Unitherm's rotary kiln burners are prepared for all technical challenges in future.

The high flexibility of the primary air injection system, with its simple adjustment and smaller burner diameter, makes the burner suitable for various kinds of processes with different kinds of fuels. Lower maintenance costs and optimised cooling are additional benefits in terms of cost effectiveness.

This newly developed M.A.S. disc system combines the aforementioned improvements with the reliable advantages of the M.A.S. hose system. ■

About the author

Reinhard Ringdorfer has a master's degree in chemical engineering from the Technical University in Graz. He started working with ATEC after his graduation and then started at Unitherm, where he has worked for the last 16 years. His position at Unitherm is Sales Manager for North and Middle America and Western Europe.