Reinhard Ringdorfer, Unitherm, Austria, describes the innovation of the M.A.S. burner since its development 20 years ago.

EVOLUTION THROUGH EXPERIENCE

Introduction

2015 marks the 70th anniversary of the foundation of Unitherm and the 20th birthday of the M.A.S. burner. Since the innovation of the M.A.S. burner numerous modifications and adjustments have been made to the nozzle head. This article will explain and highlight some of the major modifications that make the M.A.S. burner so well suited to the rotary kiln process. The aforementioned changes were derived from experience with existing burners and implemented using CFD modelling. The biggest innovations were made at the primary air injection and the solid secondary fuel injection of the burner.

The primary air system

When it comes to primary air, most people think of burner momentum. The common rule is that the higher the burner momentum, the better the combustion. The burner momentum became more and more important when cement plants were looking for cheaper fuels. First came the use of petcoke, followed by the utilisation of solid secondary fuels. Nowadays the industry is looking at ways to fire 100% solid secondary fuels.

Burner momentum is defined by the mass of primary air multiplied by its injection speed. When divided by the thermal capacity of the burner we get the specific primary air momentum in N/MW. However, it is only possible to measure the installed primary air momentum and not the effective momentum available for flame shaping. The installed momentum is defined by the primary air fan or blower installed. If the momentum should be increased, the amount or pressure of the primary air has to be increased.

With the M.A.S. burner, Unitherm Cemcon took a different approach to the momentum topic. Instead of increasing the installed momentum, Unitherm is optimising the effective momentum by reducing the losses inside and outside of the burner. This means it is not necessary to install a bigger fan or a blower to achieve a higher effective momentum.

With one primary air channel and therefore no mixing losses at the burner tip, the pressure drop through the burner was already lower than with traditional burners. In the last few years, the internals and especially the nozzle head have been modified to optimise burner efficiency. The main modifications were:

- Lower distance of the flexible hoses and M.A.S. nozzles to the burner mouth.
- Wider air nozzle opening.
- Inclination of the flexible hoses.

These modifications had the following effect on the burner operation (see Figures 1 and 2 – before and after modification). The unobstructed injection of the single air jets allows a much better mixing of the secondary air into the flame. This leads to a more stable combustion and excellent control of the flame shape. The inclination of the flexible hoses allows an even bigger adjustment range than before. The kiln operators are able to adjust the flame to any requirement of the kiln in a matter of moments by adjusting the flame setting and the primary air pressure only.

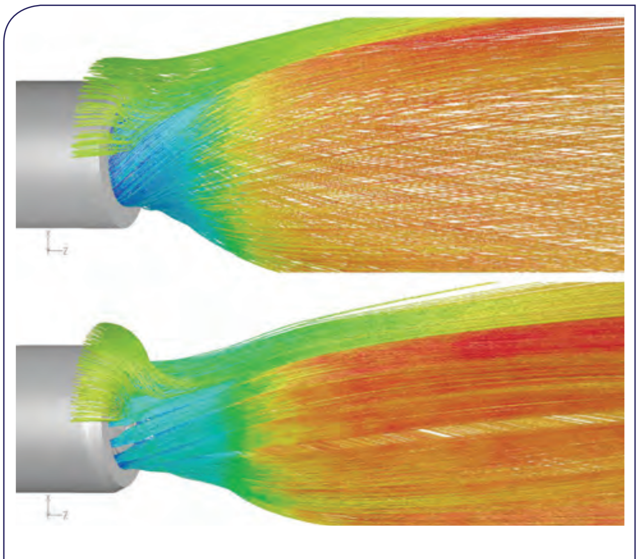

Figure 1. Slimmer flame geometry.

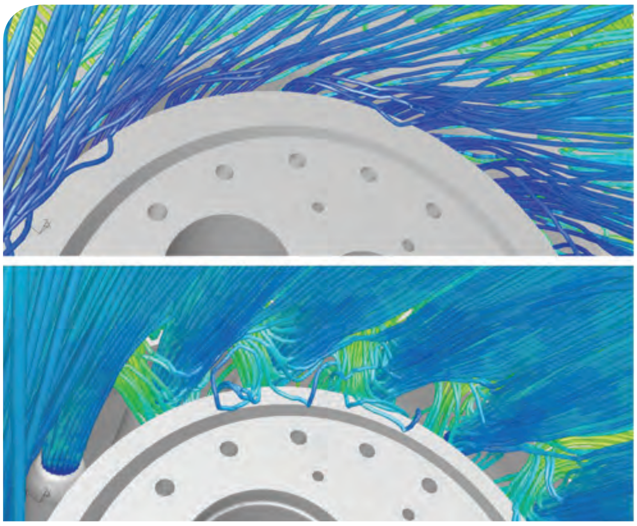

Figure 2. Increased mixing.

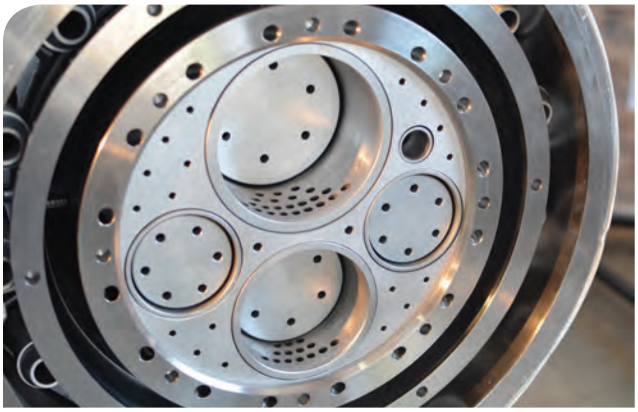

Figure 3. SSF channels with Pneumo-Deflector.

Case study 1

The efficiency of this new nozzle head can be seen in a simple case study. Unitherm Cemcon was approached to deliver a burner to fire 100% petcoke. The M.A.S. burner replaced a two-channel burner that was equipped with a blower and a fan for axial and radial air supply.

After installing the M.A.S. burner and a new fan for the primary air supply, the client summarised the results as follows:

- Ability to fire 100% petcoke.
- Decrease in specific power consumption of primary air supply (-72%).
- Better control of burner alignment and flame shape.

Due to the success of the project, the main burners in three more plants were changed with very similar results to the complete satisfaction of customers.

Case study 2

In 2004 Unitherm was approached to design a burner to maximise the solid secondary fuel substitution rate. After commissioning and optimisation of the burner operation a substitution rate of approximately 55% was reached.

To further increase the amount of solid secondary fuel, the central channel was equipped with bigger feeding pipes and oxygen enrichment. With these new modifications the plant was able to boost the substitution rate to approximately 80%.

In 2011 the nozzle head of the M.A.S. burner was modified to the latest design. The results after

Tradition and quality 'Made in Austria'

Every single M.A.S. burner that is designed in Unitherm's head office in Vienna is manufactured in the company's workshop located in Styria, where it has been manufacturing burners for the last 20 years. All welders and fitters have worked on at least 100 rotary kiln burners and know it inside out. Before dispatch, every burner is personally inspected by the head of the design department and checked for mechanical and operational functionality.

The head office in Vienna mainly consists of engineering, sales and administration. A dedicated team of service and commissioning engineers completes the team. Besides support of erection, installation and startup, this team is responsible for the optimum performance of all installed burners. Unitherm supports its clients with frequent visits even when there is no commissioning scheduled.

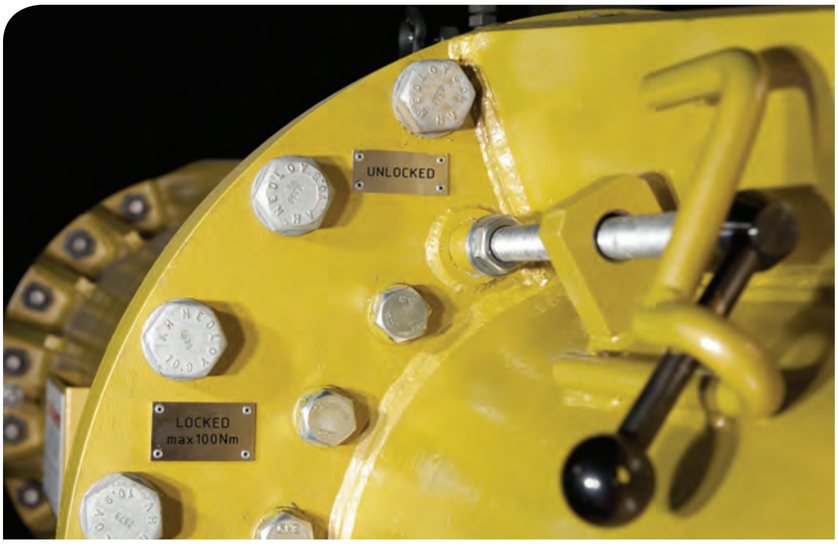

Figure 4. Locking mechanism of divisible jacket tube.

Figure 5. Removing the front jacket tube.

optimisation can be summarised as follows:

- Substitution rate was increased to 85%.
- Oxygen enrichment was not necessary anymore and could be stopped.
- Control and setting of the flame was greatly improved.
- More compact and stable flame and therefore much better heat transfer to the material.
- Better mixing of secondary air into the flame root and higher flame core temperature.
- Higher C_3S generation at higher SSF rates.

Complete compatibility

Another advantage of the new nozzle head is the complete compatibility of the new injection system with the old one. Instead of a cost-intensive modification, the new nozzle parts necessary can be supplied for the same price as normal spare parts. In addition to the normal spare parts, only new flexible hoses with inclination have to be installed. The installation can be carried out during a short kiln stop and without the necessity of a supervisor.

Solid secondary fuel injection

Beside a superior primary air system for optimum fuel ignition and flame shaping, the way the solid secondary fuel is injected into the kiln plays an essential role in the substitution rate. The M.A.S. burner is operating in several plants with 100% secondary fuel, some only solid, some a mixture of liquid and solid fuels.

For the last two decades Unitherm has implemented several tools in the burner to influence the distribution of solid recovered fuel (SRF) particles in the flame. To utilise the combustion energy of the SRF where it is needed, namely in the flame, the residence time of the particles in the flame has to be maximised.

This cannot be achieved by increasing the velocity of the SRF, but only by changing the injection angle. According to the experience gathered from numerous Mono Airduct System (M.A.S.) burner installations, an increase of the injection speed will not increase the retention time, whereas a change of the injection angle by 5° will alter the trajectory of the particles and increases the available time for combustion in the flame by approximately 60%. Due to the abrasive nature of most solid recovered fuels, a mechanical deflection of the particles is difficult to implement.

Unitherm Cemcon therefore invented the Pneumo-Deflector (PD). As the name suggests, the deflection of the particles is done pneumatically. For this purpose, a certain amount of primary air is led to the business end of the fuel pipe, where the PD-nozzle is installed (Figure 3). This allows the deflection of the solid particles in an unprecedented way.

The combination of variable exit speed and angle allows any setting for optimum operation with alternative fuels. The operation of the PD can be adjusted for varying fuel qualities.

Results of installations with PD show an essential increase in the thermal substitution rate (TSR) with constant clinker quality.

The PD can be found in all new M.A.S. burners. Existing burners for alternative fuels can also be retrofitted with this patented system.

Additional burner features

The M.A.S. burner has a service-friendly and low maintenance design. Several features reduce maintenance time and manpower. One of the most important features is the divisible burner jacket tube, which has also been greatly improved over the years.

As the damage to the refractory of the burner jacket tube occurs normally around the burner tip, it makes sense to have the possibility to change only a part of the lining. While renewing the refractory of the complete jacket tube is a big task, a jacket tube in two parts simplifies this task.

The jacket tube of the M.A.S. burner is divided into two parts (Figures 4 and 5): the front part, which is 1200 mm long, and the rear part. During normal maintenance, the front part can be removed separately from the burner. It can be easily replaced by a spare part. If no spare part is available, the low dimensions compared to the complete jacket tube make it very easy to apply the refractory.

Conclusion

The results from both new and modified burners show that the modification of the nozzle head in combination with the Pneumo-Deflector greatly improves the handling of the burner. While other companies are working on new designs to reach a substitution rate of 100% through the kiln burner, the M.A.S. burner has already achieved this goal in several plants.

The reduced power consumption of the primary air system and the high solid secondary fuel rates, as well as more than 400 successful installations, convince more and more customers to decide in favour of Unitherm Cemcon for a new kiln burner.