SATELLITE SUCCESS

Reinhard Ringdorfer, Unitherm Cemcon, explains how the development of new satellite burner systems has allowed cement plants to push the limits of AF utilisation.

The usage of alternative fuels in liquid and solid form is an integral part of every cement process. Initially the cement kiln was used as an incinerator. Since landfilling was no longer allowed, other methods of waste disposal had to be found. The cement kiln with its high temperatures was a perfect candidate, and cement plants were paid to dispose of the waste.

Over the years the incentive has changed, but alternative fuels are still used in the kiln and calciner to a high extent. Since secondary fuels are nowadays considered CO_2 neutral, the use of these fuels reduces production costs and helps cement producers to decarbonise their production.

Ever since cement plants started using alternative fuels, Unitherm has been a disruptive pioneer in the market, introducing new technologies to push the limits of AF utilisation.

While liquid secondary fuels are rather easy to burn with the right equipment, solid secondary fuels haven proven more difficult. In 2001, with the introduction of the Pneumo-Swirl (PS), the first attempt was made to influence the flight behaviour of the fuel particles. This device, located at the exit of the solid secondary fuel channel causes the fuel particles to a swirl and mixes them with the primary fuel (Figure 1).

In 2007 the PS was supported by the Pneumo-Injector (PI), which gave the operator the ability to accelerate the particle exit velocity

and therefore affect the throwing length of the particles. Bigger particles especially could be thrown farther into the kiln, avoiding reducing conditions in the sintering zone.

Both devices were used in numerous burners, ensuring a successful operation with the combustion of solid secondary fuels.

The latest development was the introduction of the Pneumo-Deflector© in 2011 (patent no. E 2 633 235 B1). Solid secondary fuel particles can be deflected above the kiln axis via bores in the outlet nozzle of the fuel, the required air is supplied by the primary air fan and the intensity can be adjusted via valve. Since then, this innovative solution has been further optimised using CFD and has proven to be most successful, enabling the operator to increase the amount of secondary fuel of the same quality while maintaining a high clinker quality. Figure 2 shows the CFD simulation of solid secondary fuel firing with and without Pneumo-Deflector (parameters 200 mbar PD air pressure, injection velocity of particles 30 m/s).

Where to fire secondary fuels

Generally there are three parameters for classifying solid secondary fuels to determine where they can be utilised in the cement process (Figure 3):

- Particle size
- Moisture content
- Ratio of 3D to 2D particles

Depending on the available residence time where the material is brought in, the fuel has to be prepared accordingly.

The highest residence time is available at pre-calciner combustion, where bulky material is burned until it can be fed into the calciner.

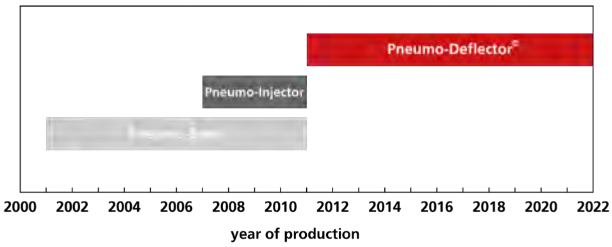

Figure 1. The Pneumo-Swirl (PS) was first introduced in 2001, followed by the Pneumo-Injector (PI) and Pneumo-Deflector.

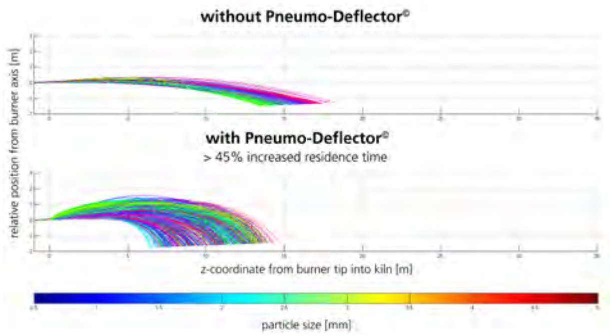

Figure 2. Alternative fuel trajectories inside a rotary kiln.

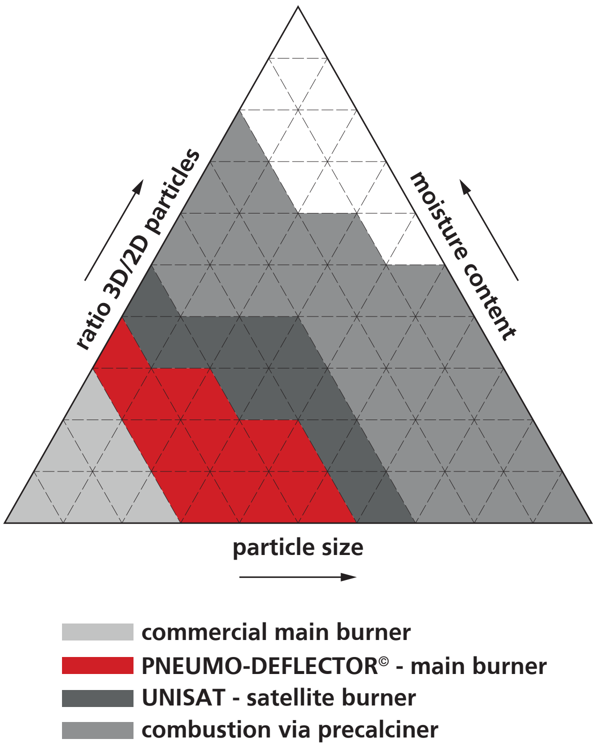

Figure 3. Generally, there are three parameters used to classify solid secondary fuels: particle size, moisture content, and ratio of 3D to 2D particles.

Modern calciners, with or without a combustion chamber, usually have a residence time of up to 10 sec., which allows the firing of bigger particles with high 3D content.

When it comes to firing in the rotary kiln, the particles have to be much finer and have a lower moisture content due to the low residence time.

While the implementation of technologies, such as Pneumo-Swirl, -Injector and -Deflector had a positive influence on the combustion, there is still room for improvement.

Satellite burners

Several years ago Unitherm resurrected the concept of the satellite burner to increase the amount of solid secondary fuel fired in the kiln. Initially invented in the 1980s as a simple static pipe, Unitherm was among the first to adapt this technology to the new millennium.

The operation of the UNISAT satellite burner brings the following advantages:

- The material is introduced in a high temperature area above the main burner, ideal for drying and the release of the volatile matter.
- Unlike injection of the fuel inside the kiln burner, the oxygen content above the main burner is at the highest level, allowing an ignition of the volatile matter.
- Usually the injection point of the satellite burner is a certain distance above and behind the main burner nozzle. This increases the residence time of the particles and allows for complete combustion.
- Since the secondary fuel channel is located outside, the main burner can be designed with a smaller diameter and less weight.
- Mixing of the secondary fuel with the primary fuel reduces the risk of a double flame formation.

To achieve the optimum combustion with a satellite burner, there are two important factors to be considered.

Firstly, the satellite burner has to be designed as an actual burner, not just a pipe. The Unitherm satellite burner consists of a solid secondary fuel channel surrounded by a cooling air channel with a heat resistant air nozzle. Adjustment possibilities in every direction are necessary to adjust the burner for optimum mixing of the material into the main flame. Therefore, Unitherm supplies the satellite burner with a separate burner trolley for axial, vertical and horizontal adjustment.

To ensure the efficient mixing of the secondary fuel into the main flame, the satellite burner has to be paired with a high momentum burner with strong mixing capabilities. Typically, Unitherm satellite burners are delivered together with the M.A.S. burner. Due to the unique primary air system with strong primary air jets with high momentum, the burner is well suited for the use with a satellite burner.

If these conditions are not met, the set-up with the satellite burner will not operate efficiently.

All satellite burners are tailor-made solutions, fitting exactly to the existing kiln and main burner. During the engineering phase all relevant data for the design of the satellite burner is collected. The final design and the positioning of the burner is then determined using the know-how gained from previous installations as well as the operational experience of commissioning engineers.

Case study – Austria

The plant in question is using an M.A.S. burner delivered in 2003. The burner is designed for the firing of coal, fluff and natural gas for start-up with a thermal capacity of 40 MW. Solid secondary fuels have been used at a high percentage for many years through the main burner. The goal of the satellite burner installation in 2020 was the optimisation of the operation in terms of ignition behaviour of the particles and process stability.

Due to the lack of space above the main burner, the satellite burner had to be installed on a monorail beside the main burner, roughly at the 2 O'clock position (Figure 4).

Result: due to the pre-drying, the material ignites earlier and the operation is more stable. The burner is currently operating at >90% substitution rate.

Case study – Hungary

The goal of the project was to increase the substitution rate at the main burner. The existing burner, an M.A.S. burner has been operation for more than 10 years, operating on petcoke, heavy fuel oil, liquid and solid secondary fuels.

During the modernisation project, the 50 MW main burner was upgraded to the latest nozzle head, the M.A.S.DT system. For the secondary fuel firing, a satellite burner DN 150 was installed (Figure 5).

After successful commissioning, the burner is now operating with solid secondary fuels through both the main burner and satellite burner. The main burner is fired with approximately 2.5 tph of industrial plastic and a maximum of 1.5 tph of petcoke, while the satellite burner uses between 4 and 5 tph of fine RDF.

With a substitution rate of 83% the client is fully satisfied with this successful project.

Conclusion

While the combustion of solid secondary fuel through the main burner works well with the latest generation of primary air injection and Pneumo-Deflector, the advantages of the satellite burner technology are obvious when it comes to increasing the total amount or reducing the quality (particle size, moisture content, 3D/2D ratio) of the solid secondary fuel.

Looking at the references and the latest orders, there is a clear tendency in the direction of the UNISAT satellite burner technology. The numbers of orders for a satellite burner have been constantly increasing over the last years and account for approximately 70% of the orders involving solid secondary fuel firing. ■

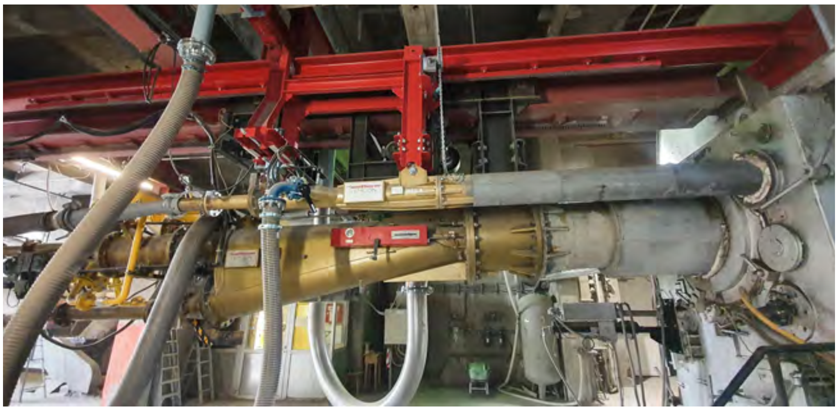

Figure 4. The satellite burner was installed on a monorail beside the main burner.

Figure 5. For the secondary fuel firing, a satellite burner DN 150 was installed.