A BETTER BURN

Alex Wagner, Unitherm Cemcom, and Vyacheslav Borsch and Roman Titei, Asia Cement LLC, discuss the operation of the M.A.S/SG burner.

Introduction

Asia Cement LLC operates a dry kiln with a production capacity of 5000 tpd and 1.86 million tpy. The plant is located in Ust-Inza in the Nikolskiy district. Operation of the burner started in October 2013 and on 27 November 2013 the first tonne of cement was produced. The main fuel for the clinker production is natural gas.

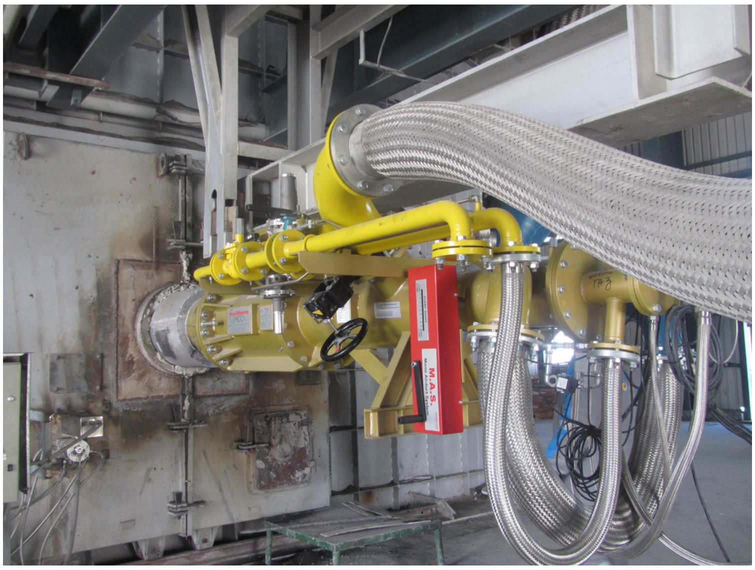

Figure 1. New M.A.S./SG burner.

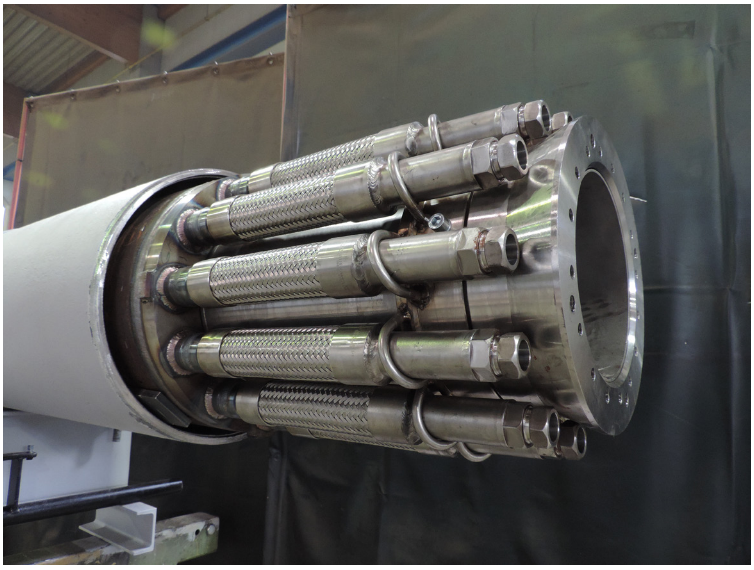

Figure 2. Flexible burner nozzles in axial position.

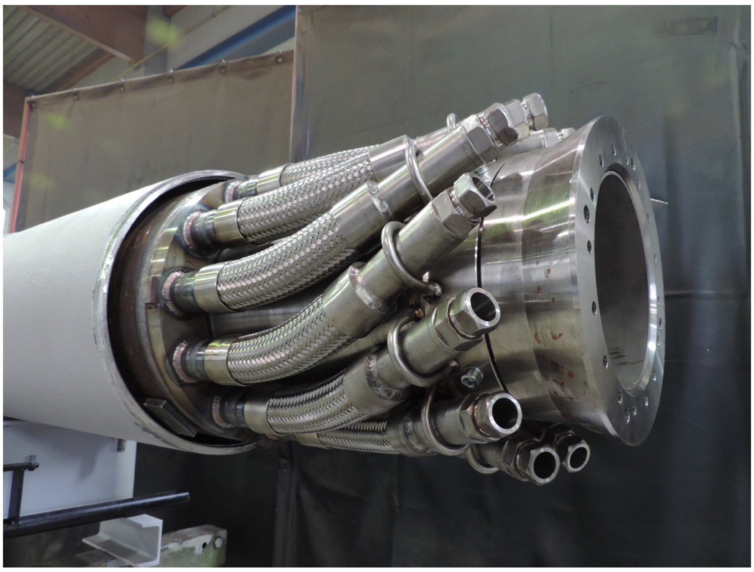

Figure 3. Flexible burner nozzles fully deflected.

The plant was supplied from China, with key components coming from European suppliers. The plant operates a rotary kiln with a diameter of 4.8 m and a length of 72 m. The preheater consists of three stages with two strings and a CDC-type calciner. Cooling is completed by a grate cooler with 15 fans and a 1300 mm x 3000 mm hammer crusher. All equipment is designed for a clinker capacity of 208 tph.

At the heart of the burning process, a combined rotary kiln burner for pulverised coal and natural gas was initially installed. The capacity of the burner was designed to be 101 MW.

During the operation of the original burner between October 2013 and April 2017, the following problems occurred:

- Complete nozzle damage every three months. Even a replacement of the nozzle with higher-grade steel brought no improvement.
- The complete destruction of the baffle plate and the central guiding tube was registered during the winter of 2016/17.
- Refractory damage at the front of the burner jacket tube due to insufficient cooling. The burner jacket tube was strongly deformed, which made an adjustment of the axial air impossible.
- According to the recommendation of the burner manufacturer, a primary air pressure of 200 mbar had to be maintained to form a stable flame. A roots blower was supplied for the primary air, which was constantly operated at maximum speed and load. This resulted in increased wear and frequent blower emergency stops.
- From October 2013, the flame sensor at the supplied ignition burner did not work. The igniter itself could only be started in manual mode and would not work for more than 120 sec.

Due to the above-mentioned problems, the plant decided to replace the existing burner. In April 2017 a new M.A.S./SG burner with a nominal gas consumption of 9 000 Nm^3/hour at 1 bar pressure was delivered (Figure 1). To ensure safe operation of the new burner and the burning process, a new igniter and flame monitoring system were also delivered.

Design features of the M.A.S./SG burner

The most important advantage of the M.A.S./SG burner lies in the fact that the

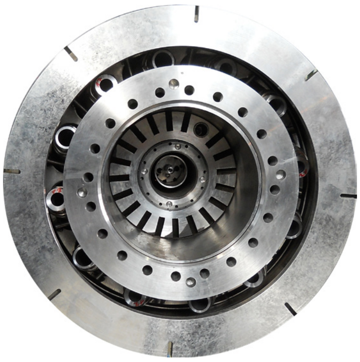

Figure 4.Burner face of M.A.S./SG burner.

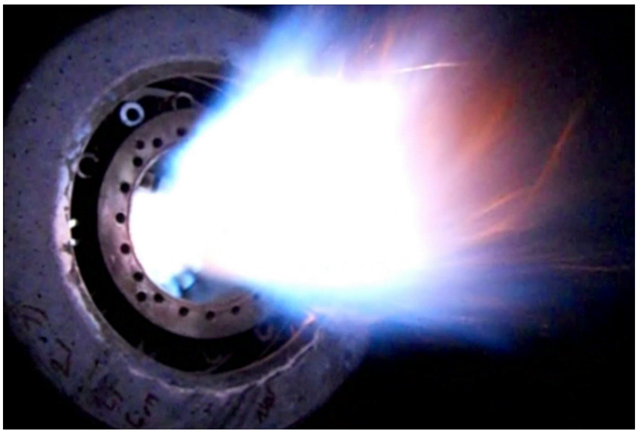

Figure 5. Thermo-carbolysator in operation.

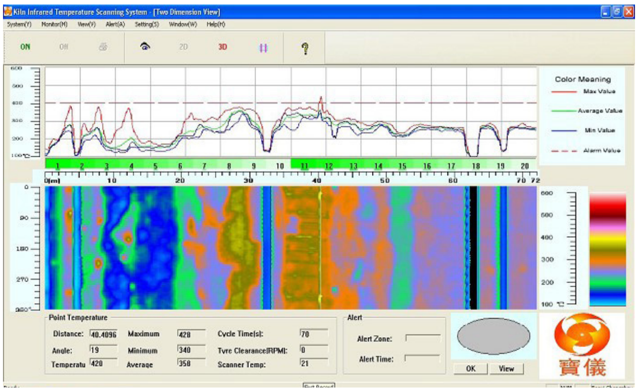

Figure 6. Kiln temperature profile with old burner.

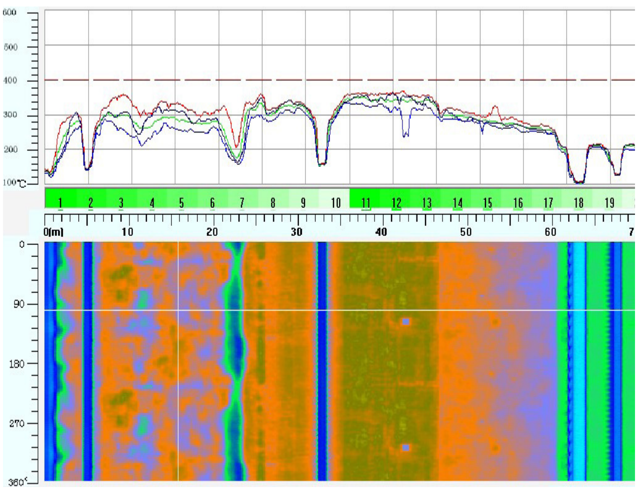

Figure 7. Kiln temperature profile with M.A.S./SG burner.

flame pattern formation depends on the angle and speed of the natural gas injection from the flexible burner nozzles at constant gas pressure (Figures 2 and 3).

The burner features two natural gas channels. A central channel of approximately 2% – 5% of the total gas flow, which is used to stabilise the flame. The main gas channel, with a system of flexible hoses, comes from the traditional M.A.S. burner (Figure 4).

The low-pressure primary air in the kiln burner is only used for cooling purposes, because the gas velocity is higher than the primary air velocity at the injection point. This provides effective management of the flame shape by using the natural gas, instead of primary air.

The adjustment of the natural gas jets via the flame setting device is continuous from 0˚ – 40°. This ensures an easy and accurate adjustment of the flame shape for optimum process conditions during clinker production. The natural gas is injected in single jets into the kiln, which leads to an intense flame. The operating pressure of the natural gas in nominal condition exceeds the critical value (0.75 g bar). At these supercritical pressure values, the injection speed of the natural gas is 408 m/sec. and remains constant, independent of the gas pressure level.

The M.A.S./SG burner is also equipped with a 'thermo-carbolysator', which is built into the burner's central channel. The thermo-carbolysator speeds up the process of the gaseous fuel heating until the gas is mixed with the secondary air. It provides continuous combustion without flame detachment during the heating up phase. The thermo-carbolysator is equipped with a separate natural gas and air supply to maintain the stoichiometric gas-to-air ratio.

The natural gas is mixed with low-pressure air inside the burner, is ignited and forms a flame with the root located inside the burner (Figure 5). It provides an exceptionally stable satellite flame, since the ignition point of this flame is located not inside the kiln area, but inside the burner. The main gas flow is heated by the satellite flame to over 1000°C under the shortage of oxygen near the burner nozzles.

At such conditions the main flame starts to glow, thus the thermal radiation affecting the clinker intensifies. The main disadvantage of natural gas burning is the low level of thermal radiation provided by the flame in comparison to coal. As a result, a cooling zone emerges, which results in a degradation of the kiln stability and a decreased clinker quality. The positive effect of the high flame stability and high thermal flame radiation on the sintering zone and transition zones can be seen in the kiln shell temperature profiles shown in Figure 6, the old burner, and Figure 7, the M.A.S./SG burner.

It is commonly known that the correct positioning of the burner in the kiln is very important. Unfortunately, many suppliers of burner equipment only recommend the installation of the burner along the kiln axis. This universal approach, where the type of fuel, the kiln, the kiln head geometry, and the raw meal composition are discounted, appears to be superficial for many cases. Every rotary kiln is unique and the optimum position has to be selected individually. In the case of Asia Cement, the burner tip has been pushed 200 mm inside the kiln, placed 150 mm downward, and 65 mm towards the material relative to the kiln axis for optimum results.

Results with the M.A.S./SG burner

Natural gas consumption

The savings in natural gas consumption amount to 1.5 million Nm^3/year. These savings are achieved due to the higher efficiency of the burning process, better coating stability, and the reduction in primary air consumption.

Power consumption

The primary air blower has an installed power of 132 kW. The old burner was operating at 200 mbar pressure, whereas the M.A.S./SG burner is operating at 110 mbar at the burner. Since the installation of the new burner, the blower speed could be decreased by 30%. This results in a saving of about 294 600 kW/year. Additional to the power savings, the reliability of the blower has greatly improved. Since the installation of the new burner, not a single emergency stop has been registered.

Spare parts

During the operation of any equipment, the spare part costs are an important factor. The costs for the nozzles at the M.A.S./SG burner are roughly four to five times lower than with the previous burner. Additionally, the burner nozzles of the M.A.S. burner are equipped with a threaded connection, which makes the replacement much less cost and labour intensive.

Conclusion

The high combustion efficiency, operational reliability, and easy handling of the M.A.S./SG burner, combined with the service and ease of maintenance, makes it a suitable tool for any natural gas fired rotary kiln.

About the authors

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