# IGNITING INVESTMENT

**Tom Howard and Stephen Kearsey, Hope Cement, UK, and Reinhard Ringdorfer, Unitherm Cemcon, Austria, illustrate how major investment at Hope Cement's works in Derbyshire led to cooperation with Unitherm to upgrade the kiln firing system.**

## Introduction

UK based cement producer Hope Cement (a Breedon Group company) has recently teamed up with Unitherm Cemcon to complete a £1.4 million project to completely upgrade the kiln firing systems at its Cement Works in Hope, Derbyshire. The installation on each kiln system was successfully completed in January and April 2016, 10 months from the project's inception.

**Figure 1. M.A.S./6/KO.SO.X in the Unitherm workshop before refractory installation.**

**Figure 2. Air film pads for transportation of burner.**

**Figure 3. Hope and Unitherm engineering team during installation.**

Hope Cement Works has been operational for the past 87 years, and is a major contributor in the UK market, producing 1.4 million tpy of cement. The production facility is currently undergoing a capacity increase project, which will see major modifications to each of the kiln systems to increase total output to 1.6 million tpy. Hope Cement Works has two independent dry process kiln lines, each with a four stage suspension preheater and grate cooler. The modifications for the capacity increase followed a debottlenecking study and will include completely new kiln feed systems, replacement of the kiln inlet chambers, associated seals, riser sections and modifications to upper stage cyclones. The first area highlighted for development was to uprate the existing kiln firing systems.

In 2007, Hope completed the installation of multi-channel burners as part of a firing system upgrade, when the plant progressed from direct fired to indirect fired. These multichannel burners were rated to 88 MW and were able to fire a variety of fossil and waste fuels but had inherent limitations due to the size of internal channels and the reliability of the ignition system. It would have become a major bottleneck with the capacity increase and also halted Hope's desire to increase their waste derived fuel (WDF) usage.

At present, the majority of the fuel mix remains as coal with a thermal substitution rate (TSR) of 40% via WDF. The current WDF portfolio for front-end firing includes solid waste fuel (SWF), meat and bone meal (MBM) and a plastic based fuel. Complementing this range, chipped tyres provide approximately 20% of the total heat requirement at the back-end of the kiln via the riser.

**Project requirements**

The existing burners were rated to 88 MW and, to fit in with Hope's ambition to increase plant capacity to 1.6 million tpy, they needed to be upgraded to over 100 MW in order to provide the required heat input for clinker manufacture and also to optimise combustion of Hope's waste derived fuel portfolio.

When specifying the project, Hope required an upgrade to the kiln burner ignition system with the aim of simplifying and improving reliability during kiln light up. New kiln pyrometers were also included within the project scope since they would allow easier optimisation of the burner and integration into the high-level control system. Overall, the project was required to deliver a more reliable, flexible and safer kiln ignition and firing system, adhering to ATEX and DSEAR requirements. As part of the development of the design process, a full HAZOP study and LOPA study were performed.

The project included Computational Fluid Dynamic modelling of the burner, rotary kiln and will later extend to modelling of the new kiln inlet section and preheater waste derived fuel combustion. This work was performed in conjunction with Cinar, who

have been helping with Hope Cement's combustion modelling.

After a full tendering and technical evaluation process, Unitherm were chosen as Hope Cement's preferred supplier for the burner. This decision was made based on the proven reliability and ingenuity of the MAS burner design, which included a divisible refractory jacket tube, removable waste fuel pipe inside the burner and Pneumo-Deflector system for optimising waste fuel combustion. Unitherm's experience within the industry and their willingness to work with the client to develop their product were major factors in the decision-making process. The project needed to be delivered with the end user in mind, allowing for full operability during each step of the capacity increase project and accommodate the evolving WDF portfolio. Hope were keen to ensure that, in the addition to this cutting-edge burner technology, the system would be even more accessible to site personnel in terms of user transparency and ease of maintenance.

**Scope of supply**

To meet the requirements of Hope Cement, the scope of supply consisted of the main burners with moving support trolley, primary air system and kiln ignition system for the handling of gas and fuel oil.

For the design of the burner the following had to be considered:

- The burner should be able to operate between 72 and 101 MW for different kiln capacities.
- Facilitating the optimised combustion of Hope Cement WDF portfolio.
- Hope Cement required three burners in total: one for each kiln and a common spare. The Hope kilns rotate in opposite directions and, therefore, the design of the burners needed to be adapted to allow for each burner to be used on either kiln line, giving full flexibility.

The main burner was designed as an M.A.S./6/KO.SO.X with a maximum thermal capacity of 101.5 MW (see Figure 1). The central channels contain one solid secondary fuel channel DN125 with Pneumo-Deflector for up to 5 tph SWF, two guiding tubes for the fuel oil lance and the gas ignition lance and one guiding tube for the fibre optic flame monitoring system.

The coal channel is designed for the co-firing of coal, MBM and a plastic based fuel. Due to the abrasive nature of this fuel mix, the inlet part of the channel is lined with ceramic tiles for wear protection. The connection between the burner and the fuel conveying pipe is done using a telescopic pipe to allow adjustments to the burner position during operation.

The M.A.S. system had to be designed for different thermal capacities as well as different rotation directions for both kilns. To operate the burnersat the optimum operational point for actual and future kiln capacity, it was therefore supplied with three different sizes of M.A.S. nozzles. These nozzles correspond to the primary air quantity necessary for a certain thermal capacity and can be easily changed when the burner is outside the kiln.

To adapt the burner to the rotation direction of kiln 1 or 2, the motion converter of the flame setting device was designed with two guide slots for clockwise or counterclockwise deflection of the M.A.S. hoses. Therefore, the direction of deflection of the M.A.S. hoses can be adapted within a few hours.

The new burner moving support trolleys are designed to fit the existing suspended rails, the static calculation of the rails and support structure was done by Hope Cement.

To support the complete optimisation of the burner a fully automated system was delivered, which included the flame setting device and primary air control valves. These were equipped with electric drives and positional feedback, the primary air channels are equipped with pressure transmitters to allow burner adjustment from the control room.

The primary air is supplied to the burner via a single stage radial fan with variable speed drive. The fan is capable of generating a maximum pressure increase of 315 mbar to ensure high momentum for the combustion of the Hope WDF portfolio and is designed for 12% primary air ratio at the maximum thermal capacity of the burner. The system also included an emergency cooling air fan is designed to protect the burner in case of power failure and is connected to an emergency generator.

The fuel oil supply system includes a double pump station, a fully automatic burner valve train, a UNIGRESS DDM-XL lance and the burner management system. The double filter/pump station delivers a maximum of approximately 3000 kg/h fuel oil (currently kerosene) at 6 bar to the burner valve train. The valve train controls the flow of kerosene and compressed air to the lance to achieve optimum atomisation of the fuel. The burner valve train is controlled by a Mitsubishi burner management system, consisting of a control cabinet with CPU and junction boxes on the valve train and burner. The hardware was delivered by Unitherm, the software was programmed by the Hope Cement system engineers according Unitherm logic diagrams.

**Installation and start-up**

The installation of both burners was scheduled to take place during the annual major repair of each kiln line, Kiln 2 in January 2016, Kiln 1 in April 2016.

The Unitherm logic was supplied to Hope Cement personnel and after the software was programmed it was taken to the Unitherm workshop in Austria and then installed on to the burner management system. Hope and Unitherm then worked together to fully

**Figure 4. Hope and Unitherm engineers during installation.**

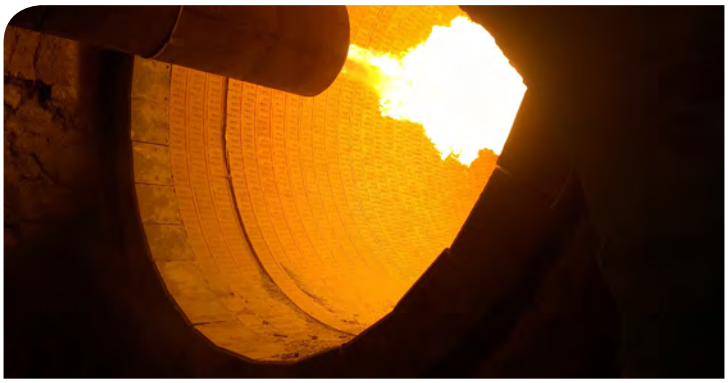

**Figure 5. Oil established. Successful commissioning of the first Unitherm burner at Hope.**

test the functionality of the system with regards to the normal operation and also the safety systems.

Due to the time constraints of installing the full burner system within the allocated window in the major repair a large amount of pre-engineering was done before the major repair. This pre-engineering included the structural modifications to the support steelwork and the installation of the primary air fan, the pump station and valve trains, control cabinets and junction boxes were all started while kiln 2 was still in operation.

During the design procedure it was highlighted that the Unitherm burner would weigh an additional 5 t. This meant that the existing system for transportation on the burner platform would be unusable both due to floor loading capabilities and maneuverability. Based on these calculations an air film lifting solution was selected as this would resolve both of these issues. This can be seen in Figure 2.

Unitherm commissioning and electrical engineers arrived for the final stages of the installation of the burner equipment. Once complete, the primary air fan, kiln ignition system and burner management system were fully tested.

The successful hot commissioning of the burning system was completed at the end of January 2016, which led directly into the restart of the kiln line according to schedule. The kiln reached full production within three days of the completion of the hot commissioning.

During the kiln warm up procedures, the Unitherm supervisor completed additional commissioning and performance checking of the system whilst also providing the Hope personnel with full hands-on training.

**Results and benefits**

"The main burner has been very well engineered and has provided a large amount of flexibility to aid the combustion of the WDF portfolio here at Hope. The Pneumo-Deflector offers optimisation of the variable SWF at the main burner to ensure that the material is kept within the flame. Due to this we have seen no reducing conditions in the clinker with increase substitution rates of up to 20% SWF at the front end.

We have also seen the benefit of the improvements to the gas ignition and oil warm up system with the modified gas ignition lance. The new system has proved to be a much more reliable technology, which has meant that the system lights first time, every time, reducing downtime and costs on kiln warm-up. The simplification of the system and clarity of the plant layout, coupled with the installation of a fully functional Mitsubishi GOT screen on the main PLC, allows a field operator to see the progress of a light-up sequence and diagnose any faults with the fully interactive touch screen display," explains Steve Kearsey, Senior Process Engineer.

"During the commissioning stage, the Hope projects team experienced a complementary working relationship with the Unitherm commissioning engineers to ensure success, with Unitherm providing very knowledgeable and personable commissioning engineers. The cross functional team delivered the project on time which is an impressive achievement on reflection; given the complexity of the project, the additional work to achieve a more bespoke solution for Hope and the timescale of the project from its inception.

Hope sees the Unitherm MAS burner as enabling technology and has already observed increased production rates on one kiln line, in association with a kiln back end upgrade that is all part of the overall uprating plan," says Tom Howard, Senior Project Engineer.