CUSTOMISED ENGINEERING AND CLINKER COOLING

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Changes in the structure and the focus of cement producers inevitably lead to changing requirements on the cooler suppliers. If the focus yesterday was on new plants or on big plants, tomorrow's demand may easily be the modernisation or the extension of existing production lines. In that case brownfield instead of greenfield is required. Thus time inevitably becomes a crucial factor and the logistic requirements increase significantly. Such requirements demand a cooler concept that is mechanically flexible and highly efficient with regard to process. The realisation of such concepts necessitates target-oriented, software-based planning and engineering. The planning and conversion required will be demonstrated using an example cooler modification where a modern clinker cooler has been replaced by a fifth generation of cooler: the ETA cooler.

Figure 1. Engineering of cooling air blowers.

Figure 2. Positioning of the side aeration.

Figure 3. Prepared air chambers.

Quality requirements on the cooler planning and the engineering

Databank-based working and cross-linking of the planning tools of CAD, PDM and ERP systems are the basis for state-of-the-art cooler planning. As CAE software for the process and the electro-technical planning and documentation Engineering Base of AUCOTEC is used. As an example Figure 1 shows the planning of a cooling air blower with Engineering Base as a section of a cooler P&I flow sheet.

The shortened equipment list on the right side of Figure 1 indicates the allocation of the single components of the flow sheet. All changes that occur during one of the project phases are centrally recorded and are instantly known to all departments involved. Supplementary requests from the customer regarding measuring technology or capacity adjustments, as well as modifications required by the civil engineering, are promptly processed. This way the people responsible for budget and processes as well as the construction, electric and automation engineers, always have the same up-to-date knowledge. Multiple collection of data is omitted. This accelerates the process as a whole and avoids possible sources of error. Comfortable handling allows for the processing of data in accordance with the customer's nomenclature. Integrated dictionaries adapt the documentation to the local language with a simple switchover.

Modification project TCC Chongqing kiln line 1 in China

To date 26 ETA coolers are already in operation in China alone. Their operating reliability and low operating costs convinced Taiwan Cement Corporation (TCC) to replace a relatively young clinker cooler with a fifth generation of cooler: the ETA cooler. TCC has a total capacity of approximately 55 million tpy of clinker in nineteen plants. The kiln lines are equipped with different clinker coolers. In 2014 TCC decided to replace the cooler of kiln line no. 1 in Chongqing plant with a CP ETA cooler. Due to the space situation at the site and the required capacity of 5500 tpd, a cooler type ETA 1078 S was delivered. This is ETA cooler with a static inlet of 10 rows and a width of 7 lanes, which convey the clinker via 8 chambers to the cooler outlet. The letter S stands for semi-modular and points out the high degree of modularity of the ETA cooler required for this type of modification.

Assembly of the new cooler lower part

The replacement of a cooler in a given plant structure is always a logistic challenge of engineering. For TCC Chongqing plant the following applied:

- The cooler upper part was supposed to stay unchanged, if possible.
- The new cooler was supposed to be integrated into the existing side wall structure of the lower part.
- The existing inclination of the lower part of 5˚ was to be maintained.
- Further use of the existing roller breaker at the cooler end.

In the first assembly step the existing side wall structure was supported for the lower and the upper part. Afterwards the cooler's lower part was completely gutted except for the side wall. At the same time the existing hydraulic drive, air ducts and cooling air fans were disassembled and the existing side wall was prepared for the new connections. The cooler was now ready for the assembly of the new components. The work started with the installation of the supporting structure for the static inlet and the new side wall profiles with integrated side aeration, as shown in Figure 2. By means of the side aeration a controlled air supply to the critical areas, where red rivers could occur, was achieved.

After welding in the first chamber partition wall, the cooler was installed section-by-section from the front to the end. Figure 3 shows the first partition walls in the area of the side aeration.

In the next step, as shown in Figure 4, the installation of the rollers and the drive supports, as well as the pre-assembly of the hydraulic cylinders, started.

Afterwards the lanes could be installed from the front to the end and could be connected with each other in a longitudinal direction. After installation of the longitudinal seals between the lanes, the static inlet including the transverse sealing to the movable lanes could be completed. Figure 5 shows this transition area, which requires special attention in every cooler. Due to the relatively slow clinker movement of 3 – 4 spm, an almost completely even clinker bed height is guaranteed. Critical temperatures that occur in conventional grate coolers are unknown in the ETA cooler. Thermal sensors that have originally been installed in the lower area of the lanes show consistently low temperatures of around 50˚C so that these measuring points are no longer required and can be omitted, as is also the case for this modernisation project.

While the work inside the cooler was going on, all required work outside also took place, such as the installation of the hydraulic drive, the cooling air fans plus air ducts and, for instance, the new installation of the existing roller breaker at the end of the cooler. After the installation of the new brickwork, the required measuring and control technology and the completion of the remaining mechanical work, the lanes were filled with river pebbles to form a protective layer and then the cooler could be commissioned without material in April 2015. The first clinker was cooled only a few days later.

Operation of the ETA cooler

At a specific load of 45.3 t/dm² and 1.78 Nm³/kg cooling air, a cold clinker temperature of 65˚C above ambient temperature is achieved. The intensive cooling of the clinker is realised by a long retention time inside

Figure 4. Cooler prepared for the installation of the lanes.

Figure 5. Transition between static inlet and lanes.

the cooler. At maximum stroke numbers of 4 min-1 the ETA cooler can be operated with clinker bed heights of up to 1300 mm. This effects the degree of recuperation, which is incomparably high with 75.5% at low recuperation air quantities. Referring to KPIs of renowned producers, this corresponds to a K-value of 1.74, or a benchmark of 116.3%.

Solutions for difficult operating conditions

Can the formation of snowmen be safely prevented? The counter-measures relating to the raw materials are largely known, but can only be realised to a limited extent due to the characteristics of the stockyards. The increasingly used secondary combustion materials do not always meet the requirements with regard to the requested stable quality requirements. Although it is possible to adjust modern kiln burners in such a manner that fast combustion can be achieved, which also reduces the formation of snowmen, a residual risk remains.

A particularity of the coolers operated in China are the so-called pushers. They are mostly arranged at the front side of the cooler and can, if required, be pushed by approximately 1 m into the cooler. Such pushers had also been installed in the original cooler and were maintained upon the request of the customer. In Figure 5 they can be seen approximately 0.5 m over the static grate. The pushers are moved at the first signs of the formation of a snowman and should prevent a further increase of the snowman together with other measures implemented by CP.

Due to the existing discharge height under the kiln outlet, an inclination of 9° has been selected for the static inlet. This will lead to a slightly increased clinker layer compared to that of the standard 15° inclination and will thus reduce the immersion depth of any deposits which could further the formation of snowmen. This way the risk of snowman formation will be reduced. Concerns that a too flat design may prevent a fast slipping of the material off the static inlet have not been confirmed.

The known phenomenon of the red river is just as obstructing for the cooler operation as the formation and growth of snowmen. Mostly on the fine flow side of the cooler, the fine hot clinker flows faster towards the cooler outlet than the remaining clinker. In the ETA cooler this process is slowed down by the lane which is delaying the forward movement of the material. As known of the ETA cooler from its first commissioning in 2004, the varying movement cycles of the single lanes can actively influence the transport behaviour and the retention time of the clinker over the width of the cooler. A delay of the forward movement increases the retention time in the critical side area. At the same time the side aeration shown in Figure 2 forces the cooling air to flow through the clinker layer in this area. In case of difficult clinker conditions resulting from the kiln operation these two features – the increased retention time and the controlled aeration – lead to an early stop of the red river and ensure that its heat is transferred to the recuperation air.

Outlook

Due to the positive results following the replacement of the existing clinker cooler by a CP ETA cooler, TCC decided in 2016 also to replace the existing clinker cooler of Chongqing kiln line 2 and that of Anshun kiln line 2 by an ETA cooler of the same construction type.

Currently more than 70 ETA coolers with capacities of up to 13 000 tpd are in operation.