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SUMMARY

The worldwide Corona- epidemic has led to many large projects and investments in the cement industry being put on hold: new kiln lines, major upgrades and capacity increases. But even during the pandemic it was possible to execute small equipment revamps with short ROIs and significant benefits for the overall performance. The grate upgrade kit of the polytrack® clinker cooler was designed specifically to address issues which are gaining importance for cement plant operators: electrical power consumption, maintainability and debottlenecking production capacities within an existing footprint, with only a fraction of the effort required to completely renew the equipment. The clinker cooler can significantly influence the overall performance of any kiln line and modifications targeted at improving the aeration efficiency, like the kit, have positive effects on a range of operating costs. This is also illustrated in the results of the conversion projects presented here. The equipment is part of two lines belonging to a major Chinese cement customer and the conversions were carried out during the last days of 2020/ beginning of 2021. After a short kiln stoppage for upgrades the converted polytrack® coolers not only showed an improvement in power consumption and an increase in production capacity, but also a significant reduction in fuel consumption and clinker end temperature. The relatively small investment led to a large payoff and increase in customer satisfaction.

ZUSAMMENFASSUNG

Die weltweit verbreitete Corona-Epidemie hat dazu geführt, dass viele große Projekte und Investitionen in der Zementindustrie auf Eis gelegt wurden: neue Ofenlinien, große Upgrades und Kapazitätssteigerungen. Aber selbst während der Pandemie war es möglich, kleine Anlagenmodernisierungen mit kurzen ROIs und großen Vorteilen für die Gesamtleistung einer Anlage durchzuführen. Das Rost-Upgrade-Kit des polytrack®-Klinkerkühlers wurde speziell entwickelt, um Probleme anzugehen, die für Zementwerksbetreiber zunehmend an Bedeutung gewinnen: Senkung des Stromverbrauchs, Verbesserung der Wartungsfreundlichkeit und Engpassbeseitigung bei den Produktionskapazitäten innerhalb einer bestehenden Anlage, und das mit nur einem Bruchteil des Aufwands, der für eine komplette Erneuerung der Ausrüstungen erforderlich wäre. Die Effizienz des Klinkerkühlers kann die Gesamtleistung einer Ofenlinie entscheidend beeinflussen, und Modifikationen, die auf die Verbesserung der Belüftungseffizienz abzielen, wie der Bausatz, haben positive Auswirkungen auf eine Reihe von Betriebskosten. Das zeigt sich auch in den Ergebnissen der in diesem Beitrag vorgestellten Umbauprojekten. Die Anlagen sind Teil von zwei Linien eines großen chinesischen Zementkunden. Die Umbauten wurden in den letzten Tagen des Jahres 2020/Anfang 2021 durchgeführt. Nach einem kurzen Ofenstillstand für erforderliche Nachrüstungen führten die umgerüsteten polytrack®-Kühler nicht nur zu einer Senkung des Stromverbrauchs und einer Steigerung der Produktionskapazität, sondern auch zu einer deutlichen Reduzierung des Brennstoffverbrauchs und der Klinkerendtemperatur. Die verhältnismäßig kleine Investition machte sich bezahlt und fand große Anerkennung beim Kunden.

Grate upgrade kits give a new lease of life to older clinker coolers

Rost-Upgrade-Kits verlängern die Standzeit von Klinkerkühlern älterer Bauart

1 Introduction

Fourth generation clinker coolers can have operating lifetimes of at least twenty years, but increased competition and declining margins are putting pressure on plant owners to perform expensive conversions even on much newer equipment. The major driver is usually debottlenecking production capacities, but reducing maintenance costs and improving energy efficiency also play a role. Especially reducing fuel and power consumption are gaining importance, not only from an OPEX but also from an environmental perspective. thyssenkrupp recognized the need to improve the performance of the polytrack® clinker cooler in these areas not only for new projects, but also as retrofit solutions for older coolers. Grate upgrade kits can help restore the performance of older equipment at a fraction of the cost and duration of a full cooler conversion. The potential benefits of the new grate kit are illustrated by a recent upgrade of two polytrack® coolers by the CONCH Group – China's largest cement producer – in 2020/2021.

2 The project

thyssenkrupp designed and commissioned both coolers in 2010. The kiln systems of the identical plants consist of five-stage, double-string preheaters with three-station rotary kilns and polytrack® clinker coolers with the designation of 8T-3.5-4R-2.5, equipped with a 126 m^2 nominal aeration area and intermediate crushers. Each cooler was designed for a nominal capacity of 5500 t/d, with an installed aeration of 2,0 m^3/kg_{cli} (stp) and with an integrated 8900 kWh waste heat recovery (WHR) system.

After a little over ten years of operation some performance parameters of the polytrack coolers did not fit the new targets set by the CONCH group anymore. The clinker end temperature, which sometimes rose above 100 °C, was not satisfactory and the power consumption and the maintenance costs were also considered too high. Modernization of existing cement plants is also driven by the Chinese government's ambitious environmental and sustainability goals for the cement industry, such as the reduction of Greenhouse Gas (GHG) Emissions by reducing power consumption, switching to alternative fuel sources, reducing waste by-products, etc. Both machines needed an extensive overhaul and technological upgrade to improve their efficiency, to lower the maintenance requirements and to guarantee good performance for at least another ten to twenty years.

The upgrade kits tackle all major components of the cooler grate (❱ Fig. 1):

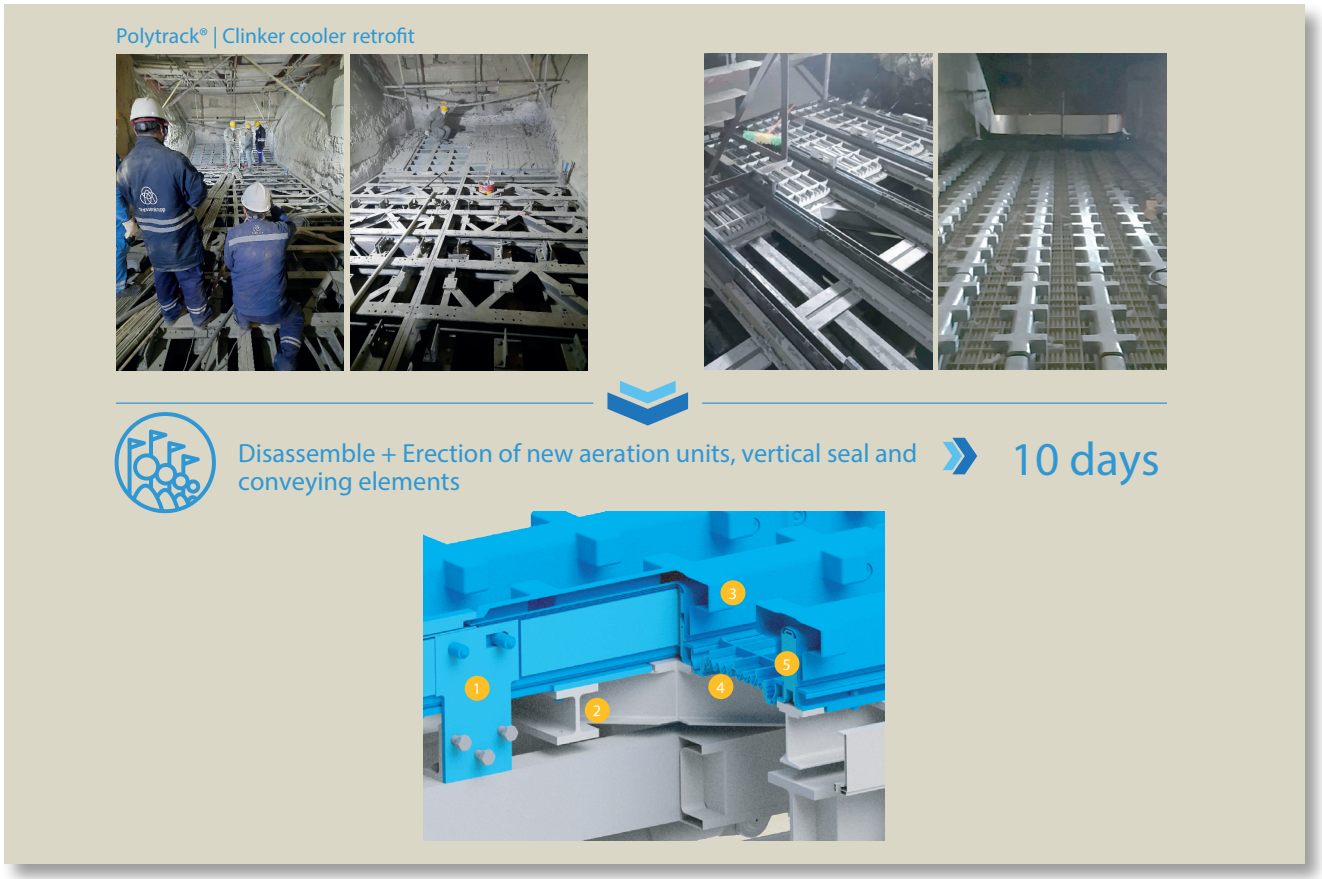

Figure 1: Scope of the modification of the grate including the sealing, aeration and conveying elements: (1) Mounting strap redesigned to fit the new sealing to the old sub-grate, (2) No more springs, which were part of the horizontal design as can be seen on the left, (3) new conveying elements, (4) new aeration units, (5) new seal concept

- the aeration elements, for which a new design with lower pressure drop was available,
- the conveying elements whose height has been changed to optimize the thickness of the stationary, protective clinker layer on the aeration grate, also for lower power consumption,
- and the sealing, which has been switched from a horizontal to a vertical design to reduce maintenance.

Changing the sealing arrangement is mechanically the most demanding of the steps, since it removes all the aeration and conveying elements and switches to a special mounting strap configuration to make the new sealing compatible with the old sub-grate design. thyssenkrupp supplied all the parts, including spares and the company's experienced and dedicated service personnel out of the Shanghai office supervised the work continuously to ensure speed and accuracy. Cement clinker prices in China are currently increasing as demand in the construction sector rises. As a result, cement plant producers are significantly reducing downtime periods to a maximum period of twelve days or less. Despite having a narrow time window and having to deal with several extra small, unforeseen modification works, the full cooler retrofits were successfully accomplished in just ten days – exceeding customer expectations. In addition to the upgrade of the grates, inspection and maintenance activities were also carried out for the hydraulic system and in the sub-grate compartments, in order to restore the coolers to near mint condition.

3 Results

In the four months that have passed since the retrofit, the operating results have shown an excellent quantitative and qualitative improvement compared to the previous plant performance (◗ Fig. 2). The power consumption of the cooler fans decreased on average by 0.6 kWh/t clinker, achieving the main target of the cooler upgrades. With the new aeration elements with decreased pressure drop, and with a thinner static clinker layer on the grate due to the new conveying elements, the aeration and cooling improvement translated not only to lower power consumption, but also into an overall improvement in process results. Similar to other projects, where grate modifications were done to increase the aeration efficiency, the improved aeration in the cooler led to an overall more stable and improved operation of the kiln system. Accordingly, the plant was able to increase its production from the guaranteed throughput of 5500 t/d up to 5700 t/d, without having any negative impact on other key performance indicators. On the contrary, the clinker end temperature decreased on average by more than 10 °C.

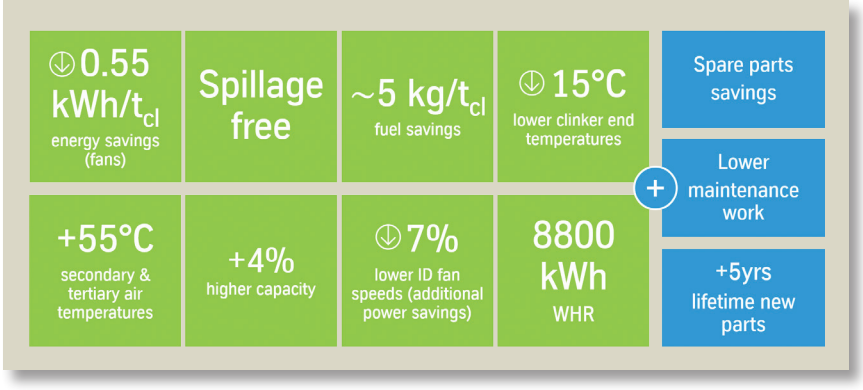

Figure 2: Key benefits of the grate retrofit

Table 1: Key results and operating parameters before and after the retrofit

Parameters	Unit	Before retrofit	After retrofit
Capacity	t/d	5500	5650
Spec energy consumption saving (fans)	kWh/t_{cli}	–	0.6
Fuel consumption savings	kg/t_{cli}	–	>5
Secondary air temperature	°C	1109	1150
Tertiary air temperature	°C	977	1045
Clinker end temperature	°C	>95	86
Exhaust gas temperature	°C	368	390
Clinker bed layer	mm	600	800 to 900
Waste heat recovery	kWh	8700	8800

Before the upgrade, the plant limited the active clinker bed height to approximately 600 mm but with a relatively high specific aeration volume, in order to keep both power consumption and clinker end temperature low. After the upgrade, thanks to the reduced conveying elements height and improved airflow distribution, the effective active bed height was increased resulting in a longer residence time of the clinker in the cooler. Additionally, the aeration profile of the cooler was optimized with support from our service specialists to maximize the overall energy efficiency. The mechanical upgrade combined with the operation optimization resulted in a combination of better recuperation efficiency, while still reducing power consumption and increasing clinker production. The increased secondary and tertiary air temperatures led to a measurable decrease in coal consumption, while maintaining and even slightly improving the power output of the waste heat recovery (WHR).

The new sealing represents a clear mechanical improvement for installation and maintenance purposes. The design has fewer components than the old one, which makes it faster to install and virtually maintenance free. It does not require adjustment during clinker shutdown periods and it is more effective at protecting against the fall through of very fine material below the grate than the horizontal arrangement. Accordingly, clinker spillage issues are a problem of the past. In ◗ Table 1 are summarized the results of the retrofit.

4 Final remarks

The increased productivity and reduced fuel and power consumption translated into a very attractive ROI of the modification for the customer. This kind of efficiency upgrade of a cooler is one small but important aim in the overall program "grey2green" of thyssenkrupp Industrial Solutions. This program aims at addressing the pressing environmental issues of the cement industry ranging from indispensable efficiency upgrades like in this case, over state-of-the-art emission abatement technologies, up to oxyfuel process developments. "grey2green" enables the customers to be at the forefront of the green developments in the cement industry. For each step on the way, this program has the suitable solution. ◂