

Beating The Heat

Sabrina Santarossa, Turboden, explains how ORC technology works as an efficient waste heat recovery method and how it could help contribute to a greener cement production process.

The topic of climate change and the actions to mitigate it is becoming more prominent in daily discussions. Recently, the European Union announced a green deal to invest in a climate-neutral and circular economy in the next 30 years.

The target is ambitious and challenging, however many green technologies are already available and are installed worldwide, even in some cement plants.

Besides increasing cement production process efficiency, focusing on carbon capture and industry 4.0, waste heat recovery (WHR) could have an important role to play in moving towards a greener clinker product.



Increasing the efficiency of cement production

The efficiency of the cement production process has been improving in the last few decades but, despite this trend, the temperature of the exhaust gas is high enough to install a WHR plant that converts the recoverable heat into electricity. The Organic Rankine Cycle (ORC) technology, with which Turboden has 40 years of experience, is recognised as a competitive alternative to steam technology, especially in sizes between 5 – 15 MWe. This is due to several advantages, such as: no water consumption, low operation and maintenance, and no need for supervision. The increase of efficiency leads to a decrease in exhaust gas temperature, so in future, it is expected that lower temperatures will need to be dealt with. This trend benefits ORC technology as it can exploit low temperature sources better than steam technology and with a high electrical efficiency.

Waste heat in cement plants

Waste heat, in the form of exhaust gas, is available at two points: the pre-heater tower (PH) and the clinker cooler (CC). In cement plants, depending on the preheater stage number, the gas temperature at the outlet of the PH tower varies between 250 and 400°C and at the outlet of the CC, it varies between 250 and 350°C.



Çimko Turkey (top) and Holcim Slovensko, Slovakia (bottom) – electric power production from waste heat in the cement production process.

Normally, two separate heat recovery exchangers are installed in by-pass to the main gas duct. Following the different characteristics of the exhaust gas (sticky gas from the pre-heater and abrasive dust from the clinker cooler), the technical features of the heat exchangers are different and are optimised case by case.

The heat contained in the exhaust gases is typically transferred indirectly by an intermediate loop (thermal oil or pressurised water circuit) to the ORC plant, which produces electric power. The amount of electric power accounts for 10 – 30% of the cement plant's electricity consumption, leading to a consequent reduction of the monthly electric bill.

Besides the lower cost for electricity, in most of the cases studied there are other benefits. In fact, in many cement plants, the gas from both the pre-heater and clinker cooler has to be cooled down before entering the filtration system. Nowadays, the cooling of the gas is done using quenching towers in the PH side and air-to-air heat exchangers in the CC gas. Cooling the gas temperature in the heat exchangers instead of in these systems helps to further reduce the electric consumption of air-to-air exchanger fans and save a significant amount of water that can be very valuable in arid countries, by not spraying it in the quenching tower. Cement plants with their own power plants based on engines or gas turbines can consider recovering heat from the power plant and from the cement production, feeding a single ORC unit. In this way power plant fuel consumption reduces, leading to a reduction of CO₂ emissions as well as lower costs of self-produced electricity.

Advantages of ORC

Turboden was founded in 1980 in Italy and it is now part of Japanese company, Mitsubishi Heavy Industries group. Today, there are currently about 400 Turboden ORC plants, and 34 out of those 400 are used in WHR plants. The average availability of the operating fleet exceeds 98% and more than 15 000 000 operating hours have been reached.

Clients using the ORC system recognise several advantages. Firstly, the system can operate in fully automatic mode without risk, and there is no requirement for supervision personnel, thus reducing operational cost. In addition, the ORC has flexible operation in a wide range of thermal power loads. In fact, it can be operated very quickly and automatically at partial loads, following the cement plant production programme without interruption of the electricity production, thus increasing the power plant reliability. On this point, an important feature is the high efficiency even at partial load. The ORC needs minimal maintenance. In particular, no partial condensation occurs at the level of the turbine. The blades are not exposed to wear or corrosion

due to the properties of the working fluid, and this is a key factor in lowering long-term operation and maintenance costs. Finally, the possible configuration with no water consumption and consequently no need of water treatment, means that the ORC is a beneficial technology in countries with scarce water supplies.

Case studies

With regards to heat recovery from the cement production process, there are several references from successful projects deployed in the last 10 years. The first plant was for Italcementi, now Heidelberg group, in Morocco. A 2 MWe Turboden ORC unit was installed to recover the heat from the PH. After this, Holcim group developed two projects – one in Alesd, Romania, with a 4 MWe ORC started up in 2012, and a second one in Rohoznik, Slovakia, now part of CRH group, in 2014. In Slovakia, the ORC installed has a capacity of 5 MWe. A second 4 MWe plant in Romania was installed in 2015 in Carpat Cement (Heidelberg group). Also in Switzerland, there are 2 WHR plants based on Turboden ORCs. In both cases, the heat source is hot water at a temperature lower than 200°C. The size is smaller; 2.3 MWe in Wildegg, Jura cement, and 1.4 MWe in Holcim Eclepens. The last WHR projects with ORC have been awarded in Turkey where there are several WHR systems based on

steam turbines. Cimko, part of Sanko group, and Sonmez selected ORC because of its reliability, high performance, lack of water consumption and no need for additional personnel. Since 2019, the ORC working in Cimko has been producing more than 6.5 MWe while the ORC under construction for Sonmez will produce 7 MWe later in 2020.

Conclusions

ORC technology is a proven technology in the field of cement WHR, helping to increase the sustainability of cement production, thanks to its ability to recover heat even at low temperatures and with good efficiency. Considering the trend towards a greener industry, adopting a broader vision that accounts for the environmental benefits of reducing wasted energy and global CO₂ emissions, and the benefits of decreasing electrical energy consumption, is a smart decision. ■

About the author

Sabrina Santarossa is Sales Manager for Industrial Heat Recovery at Turboden with focus on projects in the cement, glass and steel production process. Sabrina helps potential customers to find an optimised solution for each project. She holds a Masters degree in Chemical Engineering and has worked at Turboden since 2008. She enjoys reading, sport, and travelling.