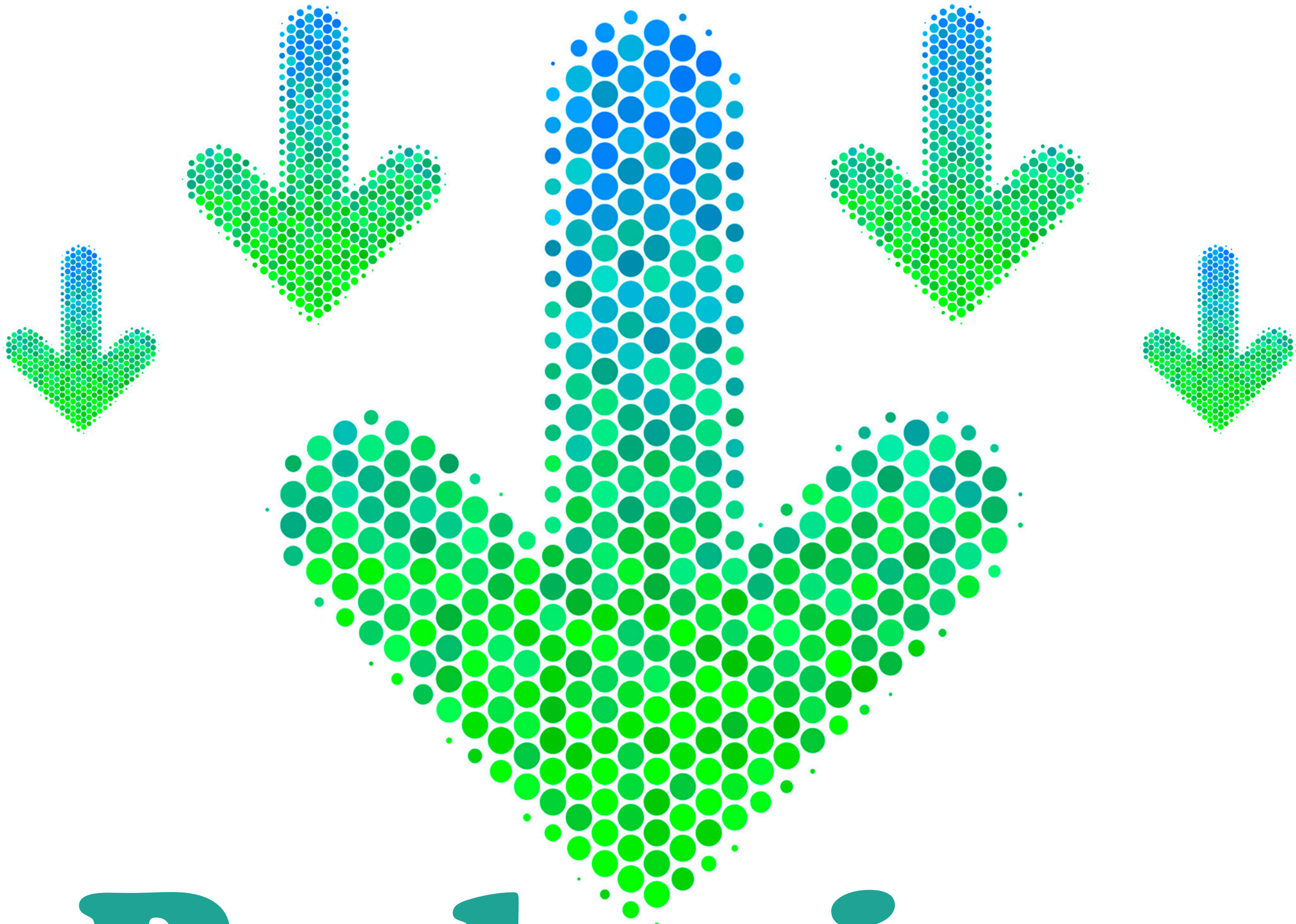


Reducing Key Pollutants

Janine Keune, Lechler, discusses emission reduction using air pollution control technologies.

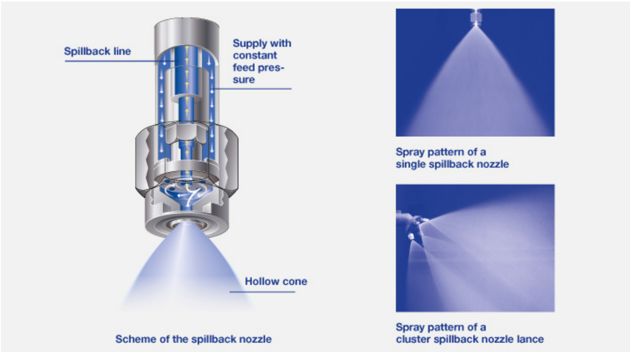
Introduction

For the last few decades, the focus of cement plant operators and manufacturers has been on increasing production rates while reducing energy consumption. The process of increasing efficiency and saving costs will continue in the future. Additionally, cement plant operators and OEMs meet the requirements of the increasingly stringent governmental regulations in regards to environmental protection. Strict emission requirements are creating a constant pressure to invest and innovate. Therefore, air pollution control technologies play an important role in cement industry.

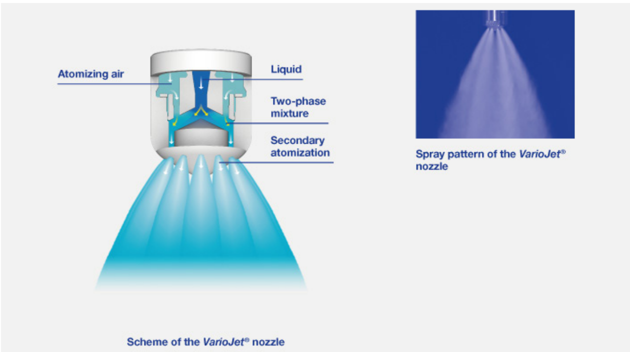
The main four key pollutant categories are identified as mercury (Hg), dust, sulfur dioxides (SO_x), and nitrogen oxides (NO_x). The several applications of gas cooling and conditioning in cement plants support the reduction of these pollutants.

Optimisation with gas cooling

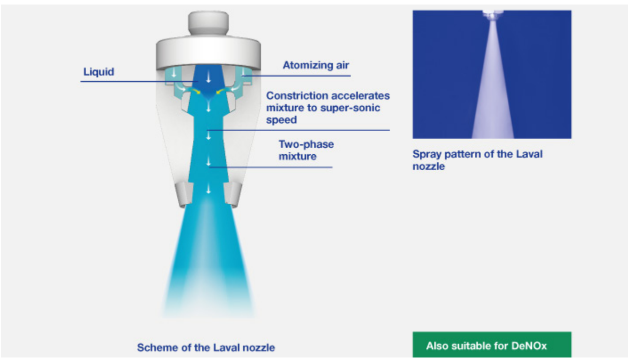
Cement dust can adsorb mercury. The dust is captured in baghouse or electrostatic filters. To protect the filters from damage of high gas temperature and to increase the efficiency of ESP, a gas cooling system is installed upstream e.g. in a gas cooling tower (GCT) or the downcomer duct.



Scheme for the Lechler spillback nozzle.



Scheme for the Lechler VarioJet® nozzle.



Scheme for the Lechler Laval nozzle.

As temperature is a physical factor that determines adsorption, the adsorption rate is higher at lower gas temperatures. The reduction of the temperature also reduces the volumetric gas flow rate and therefore increases the pollutants concentration, as well as the residence time inside the filter. This is beneficial for the overall dust removal performance and supports achieving higher efficiency. Thus, the adsorption of mercury is more efficient the lower the temperature.

Additionally, the required energy consumption of the ID fan is optimised. Lower gas temperature has positive effects on ID fan energy consumption by reducing overall gas volumetric flow rates, which decrease with cooler temperatures.

Furthermore, the gas cooling has further positive effects. With temperatures closer to dew point and reduced actual volume of the flue gas at lower temperatures, the interaction potential between hydrated lime and SO_2 molecules is enhanced. Additionally, the increase of moisture can reduce lime consumption.

Gas cooling has some main advantages that increase the efficiency of dust separation and reduce the consumption of reagents required for emission control of mercury and sulfur dioxides. Therefore, a cement plant can save thousands of dollars in operating costs.

Engineered solutions

Nevertheless, it should not be ignored that gas cooling systems also present multiple challenges for cement plant operators. To ensure a stable and trouble-free operation, the required spray performance must be achieved, droplet size and evaporation understood, and the influence of various operating conditions (mill on/mill off) must be taken into account.

As the dust, mainly consisting of raw material, is sensitive to increased humidity, a complete evaporation within the available evaporation distance is essential. Otherwise, a wet bottom in the GCT will cause build-ups, which in the worst case could lead to damage of the equipment and shutdown of the plant.

As each cooling tower is different, standard solutions do not always make sense. To find an appropriate solution, it is recommended to contact gas cooling experts, such as Lechler. With detailed knowledge about nozzles and an understanding of spray and atomisation processes, Lechler can provide complete tailor-made solutions from individual nozzle lances to integrated gas cooling systems.

Selecting the right nozzle

The purpose of the injection via gas cooling system is to produce the most liquid surface area for efficient gas-liquid interaction for heat and mass transfer by utilising minimum energy to generate the surface area. Both options, twin-fluid and spillback, are possible.

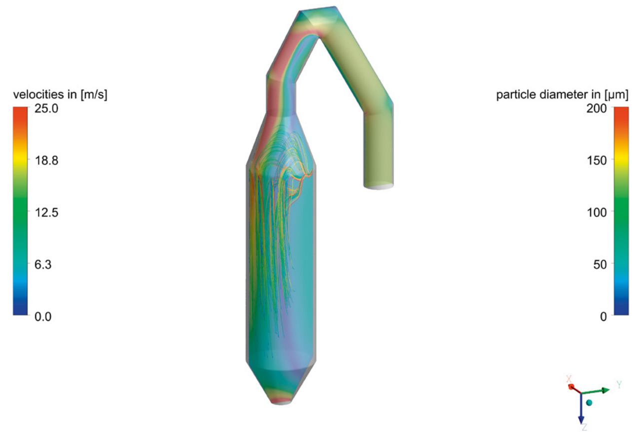
Lowest possible operating costs are realised with spillback nozzles, which require no compressed air for atomisation, but are limited in adjusting the droplet size. Gas cooling systems with spillback technology are not very resilient in terms of capacity increase or changing droplet size, while using same equipment.

Due to limited available space, the market is asking for small GCTs. This is why twin-fluid nozzles are often the only possible solution for many projects, as fine water spray is needed. Additionally, twin-fluid atomisation is more resilient in terms of retrofit by increasing air flow capacity to adapt the droplet size. Lechler designed its twin-fluid nozzles, such as VarioJet® or Laval, to allow an application-optimised fine droplet spectrum at low air consumption.

Only long-term comparison of investment, maintenance, and operating costs, based on individual local parameters of each cement plant (mill operation and reliability, energy prices, etc.), will give the operators a good position to decide the best system.

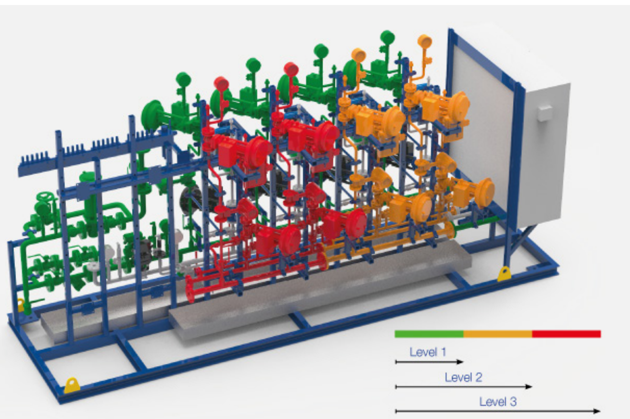
Proven technology meets individual design

The VarioCool® gas cooling system is an engineered solution according to individual customers' requirements and process conditions, considering design criteria, such

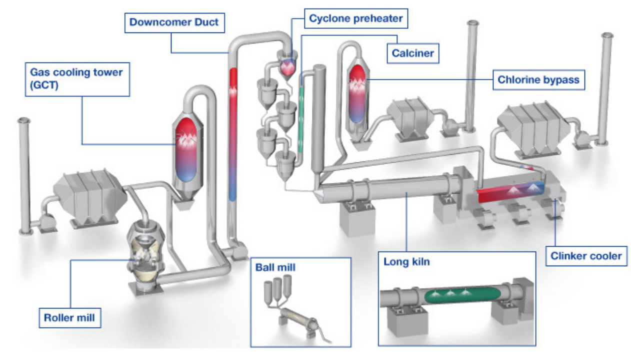


Gas flow before optimisation.

Gas flow after optimisation.



Lechler VarioClean® – NO_x.



Overview of gas cooling and conditioning applications in cement plants.

as available evaporation distance, process conditions (such as inlet temperature, required outlet temperature, and volumetric gas flow rates in several conditions [mill on/off]), optimum spray distribution and coverage of area, and flue gas distribution (ideal for efficient evaporation is less than 20% RMS velocity distribution).

The VarioCool valve skid unit is configured of proven components from well-known manufacturers designed for continuous operation. The most important functional components are also realised to be redundant. The PLC control unit ensures an optimum system performance by adjusting the spray performance according to process conditions to avoid upset conditions.

In addition to a well-designed injection system, the inlet parameters are of crucial importance. To ensure complete evaporation, a homogenous gas and temperature distribution at the nozzle level is required. A CFD study can help to detect unequal gas distributions and turbulences,along with suggestions for solutions with baffles or perforated plates.

Also, the arrangement of the lances plays a major role in efficient evaporation. Too much water in the centre, as well as too much water on the tower wall, increases the required evaporation distance and can create wet bottom and build-ups.

All this proves that gas cooling systems are tailor-made solutions, which have to be calculated carefully, considering the individual conditions. The experienced engineering team from Lechler is aware of the upcoming challenges and supports cement plants from technical design and detail engineering to commissioning, service within operating phase, and the supply of spare and wear parts.

A consultation onsite with experts in spray technology could help cement plant operators to modify the gas cooling system for more efficiency. With a troubleshooting, it is possible to detect whether the issue of wet bottom arose e.g. due to changed actual produced droplet size because of wear over time, interruption of compressed air supply or improper selection of the droplet size.

Efficient NO_x removal

Not only gas cooling, gas conditioning is also an essential technology in air pollution control. The process of cement manufacturing generates emissions of harmful nitrogen oxides (NO_x) – mostly thermal. In an effort to reduce these, many countries have already lowered the respective limit values – some even to a daily average of 200 mg/Nm³. In order to comply with current and future emission limits, cement plants are constrained to adapt their systems accordingly.

As more plants substitute fuels that offer higher caloric values, primary NO_x separators (e.g. low NO_x burners) are no longer sufficient to meet the demand for lower emission limits. For this reason, it is necessary to introduce secondary measures. By injecting aqueous ammonia or urea into the flue gas, the NO_x is chemically reduced.

The efficiency of the denitrification process is significantly dependent on the correct temperature window, proper residence time in this window, and sufficient turbulences to mix reagent with NO_x (interaction potential). For optimal use of the reagent and thus reduction of operating costs, drop size, and velocity are also of crucial importance.

In order to meet the varying process conditions, as well as local requirements, twin-fluid nozzle lances equipped with Lechler Laval nozzles are generally used for the injection of the reagent.

Their great advantage, compared to single-fluid nozzles, is the adjustability of the droplet size and realisation of a large flow-rate control range to control the droplet size and penetration depth, depending on the duct size and current process requirements. The nozzles must produce an optimum droplet spectrum to ensure penetration deep enough into the flue gas for optimum distribution of the reducing agent in the flue gas flow and evaporation.

Furthermore, the right control concept can help for an efficient reaction and keep NH_3 slip at a minimum. Lechler has joined forces with STEAG to provide a modular deNO_x system for different specified limits that can also be extended at a later time, in line with updated governmental requirements. The different configurations help cement plants to adhere to the specified reduction levels and NH_3 slip values, but also lower reducing agent consumption by 30% and more. Depending on the price of the reagent, this leads to a significant quicker return on investment for the injection system.

The injection system VarioClean-NO_x can be flexibly upgraded across the three configuration levels from basic to high efficiency SNCR. Each configuration is defined by the number of lances and injection levels, as well as in the software and sensor packages for the successful control of all necessary influencing factors.

Conclusion

Spray nozzles play an important role for efficient gas cooling and conditioning. For cement manufacturing operations, it is important for plant operators and OEMs to have a reliable partner that understands both the spray technology and process. A well-designed injection system can reduce maintenance issues and the cost of using expensive reagents required for emission control. It is very important that cement plant operators and OEMs ask nozzle manufacturers for assistance in gas cooling and conditioning applications. If design calculations are carried out correctly and considering all design conditions, then a gas cooling system should work reliably 24/7, without unscheduled interruption.

With a wide range of experience – and more than 500 references worldwide for gas cooling in GCT, ducts, clinker coolers, and gas conditioning, in deNO_x as well as deSO_x – Lechler products are used successfully in cement industry.

About the author

Janine Keune is the Product Manager for Environmental Division at Lechler GmbH.