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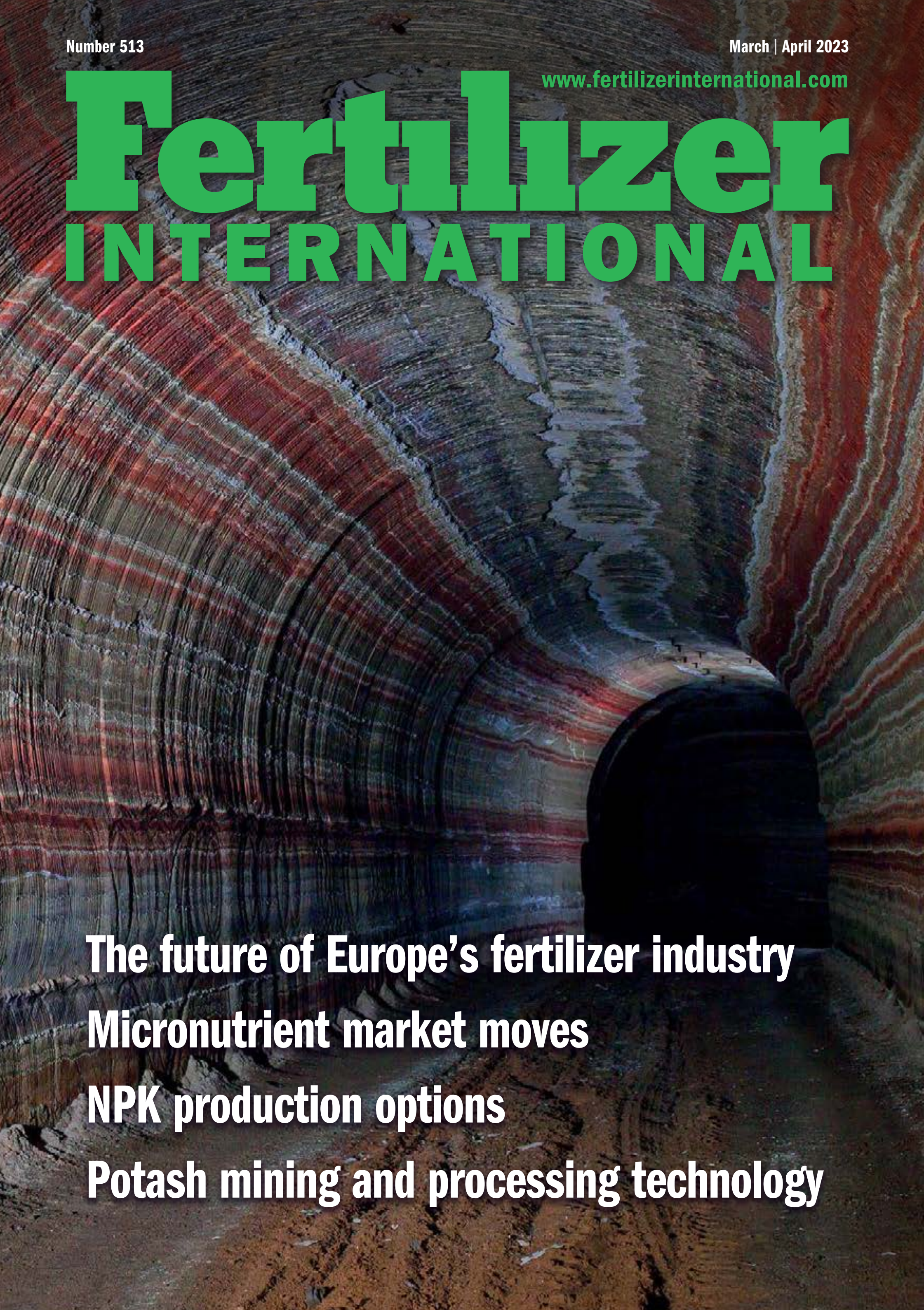


The future of Europe’s fertilizer industry

Micronutrient market moves

NPK production options

Potash mining and processing technology

SOLEX THERMAL SCIENCE

Potash cooling – the decarbonisation challenge

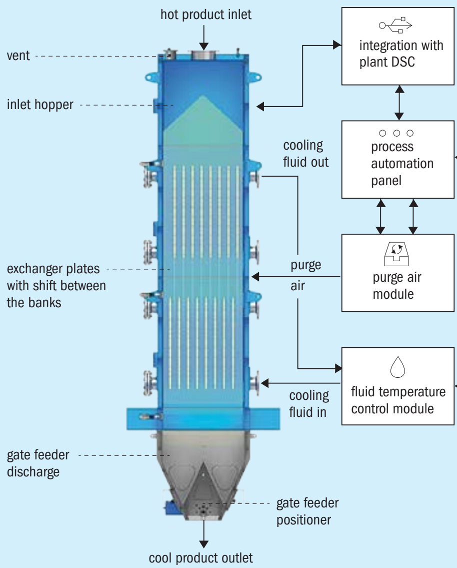
Igor Makarenko

Raw bulk materials go through numerous steps while being transformed into valuable products. Yet these steps often require emissions-intensive equipment and high energy inputs – which carry considerable operational costs.

Such equipment creates a dilemma for today's fertilizer producers who, as they seek to minimise the environmental impacts of their operations, require scalable and low-cost options for decarbonising production. These low-carbon production options also need to achieve a high return on investment while still delivering high-quality final products.

In December 2015, 196 countries famously adopted the Paris Agreement, the central aim of which was to limit global temperature rise to 1.5°C above pre-industrial levels by 2030. However, late last year, the UN Environment Programme (UNEP) reported that, to meet Paris Agreement commitments, a cut in global annual greenhouse gas (GHG) emissions of 45 percent was still necessary, compared with emissions projections under policies currently in place. These reductions also need to be accomplished in less than eight years. This represents a mammoth challenge, particularly for energy-intensive industries such as fertilizer production.

Fig. 1: **Schematic of a typical plate-based moving bed heat exchange system used in a potash cooling application**



Source: Solex Thermal Science

Potash producers take action

For the potash sector, this struggle is playing out in real time. Potash producers have already acted – or are committed to firm future targets – to improve their energy efficiency, reduce their operational carbon intensity and make the transition to renewable energy. The industry is also exploring the potential for capturing production emissions using carbon capture and storage (CCS) technology.

Despite this, many common pieces of production technology that are still in place in the potash industry today are actively working against the sector's carbon-cutting efforts. The cooling stage being one example.

During its processing, potash must be cooled to a specific temperature – typically 50°C or lower – before it can be safely stored and transported. Yet traditional direct-contact (e.g., convection) cooling equipment, such as fluidised beds and rotary drums, require large energy inputs to get the job done and can also generate significant dust and GHG emissions.

Moving bed heat exchangers (MBHEs) based on vertical plate technology are emerging as an increasingly popular cooling equipment choice within the fertilizer industry. This is particularly true for those potash producers who are looking to improve the overall energy status of plant operations, cut dust emissions and reduce their carbon footprint, while still producing a high-quality product.

In fact, MBHEs have been proven to reduce energy demand at the cooling stage to one tenth of normal. Also, new advances in MBHE processes now provide potash producers with the ability to recover energy at the cooling stage for use elsewhere in the plant. This reduces fossil fuel consumption further and delivers extra energy savings that translate into reduced GHG emissions.

The advantages of MBHEs

One of the biggest differences between plate-based MBHEs and direct-contact alternatives is how heat transfer occurs. With MBHEs, potash enters through the top of unit and flows by gravity through banks of parallel vertical stainless-steel plates. At the same time, a heat transfer fluid – typically water – passes through the plates to cool the potash by conduction (Figure 1).

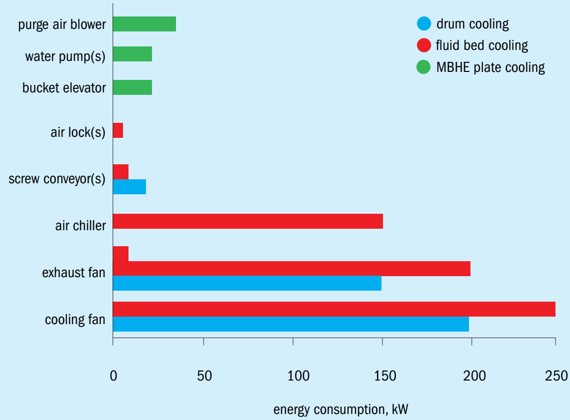
This passive, indirect form of heat transfer – the flow velocity of the potash is typically less than 0.3 m/min – means MBHEs do not contribute to any additional dust emissions or the degradation of potash granules. In contrast, fluidised beds operate by forcing air through the solid material within the fluid bed. Rotary drums, meanwhile, rotate and lift the potash through a counter-current air stream.

Both these direct-contact methods involve a lot of agitation and can therefore cause abrasion, attrition and dust emissions. Critically, they also require high-horsepower blowers, ducting and associated air-handling and -cleaning equipment to circulate the air and then clean it before it can be discharged to the environment. Heat recovery from these air streams is generally not technically or economically viable, so the thermal energy is simply lost to the environment.

MBHEs, meanwhile, do not use air to get the job done, and therefore do not need these ancillary pieces of equipment. The associated savings are therefore substantial.

In a standard 75-tph cooling system, for example, a plate-based MBHE requires only 90 kW of installed power (Figure 2). By comparison, a rotary drum needs

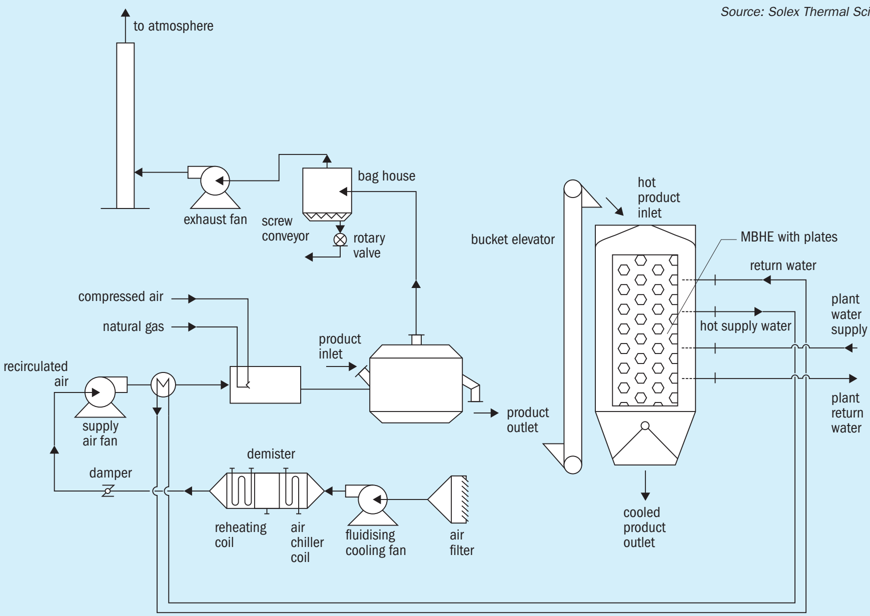
Fig. 2: **Energy consumption comparisons between fluidised beds, rotary drums and plate-based moving bed heat exchangers (MBHEs)**



Source: Solex Thermal Science

Fig. 3: **Recovered low-grade thermal energy from a plate-based MBHE can be used upstream to pre-heat the combustion air for a fluid bed dryer**

Source: Solex Thermal Science



365 kW and a fluidised bed 612.5 kW. Annually, based on 8,000 operating hours and $0.17/kW, it costs just $122,400 to operate a plate-based MBHE, compared with $496,400 and $833,000 for a rotary drum and fluidised bed, respectively.

By cutting energy consumption, potash producers also have an opportunity to reduce CO_2 emissions. Based on 0.19 kg of CO_2e per kW, the carbon footprint of a plate-based MBHE is 138,960 kg – compared with 563,560 kg for a rotary drum and 945,700 kg for a fluidised bed.

Capture of low-grade thermal energy

Furthermore, during cooling, MBHEs produce a hot transfer fluid that can provide low-grade thermal energy for use elsewhere in the plant. This can be converted to hot air using a finned-tube heat exchanger and then ducted to various points for end-use.

One upstream use for this recovered low-grade thermal energy is the pre-heating of combustion air, via an air-to-fluid preheater, for equipment such as a fluid bed dryer (Figure 3) or rotary drum dryer. This, in turn, can significantly cut natural gas consumption, further reducing both energy costs and the plant's carbon footprint.

"During cooling, MBHEs produce a hot transfer fluid that can provide low-grade thermal energy for use elsewhere in the plant.

The cooling of the transfer fluid, via the finned-tube heat exchanger, also reduces the load on the plant's cooling water system. This working fluid requires only minimal cooling as it is returned to the water module at a temperature well below 70°C.

Conclusion

In its report last year, the UNEP notes that many industrial sectors already have the necessary technology to hit their GHG emissions reduction targets. What's needed instead is a more robust audit to identify whether all the equipment still in place can deliver on these targets. If not, a rapid transition to equipment that that can deliver on energy and climate targets will be necessary.

In the case of potash cooling, moving bed heat exchangers (MBHEs) based on vertical plate technology are providing potash producers with the necessary means to reduce their emissions. By design, MBHEs are a near-zero-emissions, low-energy cooling option – one that has been proven to reduce the carbon footprint of operations around the world. What's even more exciting is how recent improvements in MBHE technology are helping to further decarbonise operations – by using a new waste heat recovery process that can cut natural gas consumption.

Fertilizer production technology will undoubtedly need to improve and do more in future – to align with companies' ESG commitments and allow plant operators to make changes that positively affect the world around us. By moving to near-zero-emissions equipment and recovering waste heat, potash producers now have a real opportunity to move closer to achieving their shared climate ambitions. ■