Electrification of petfood dryers

New technology will reduce energy consumption of the drying process by up to 65%

Sander Geelen, March 2018

The grinding, extrusion, drying, coating and cooling of one metric ton of petfood requires between 250 and 380 kWh of thermal and electrical energy, depending on the product specs and process efficiency. Accounting for about 50% of that is the dryer. For a 10 ton per hour dry petfood production line, companies typically spend between 200.000 and 300.000 dollars per year on gas. So where better to start to improve a petfood plant's energy efficiency, reduce its CO_2 emissions and lower its operational costs?

Electrification has been a buzz-word for some time in many industries. In transport, the superior efficiency and lower operational costs of electric drive-trains have already triggered a revolution. In home and office-construction, electric heat pumps have proven that connections to the natural gas grid are no longer required. In industry, electrification with heat pumps is one of the solutions being developed along with bio-fuels and hydrogen, to replace fossil fuels and make progress towards reaching the goals of the Paris climate agreement.

In homes and offices, heat pumps are known for 'magically' generating around 3 to 5 units of thermal energy for every unit of electrical energy consumed. In other words, their Coefficient Of Performance (COP) in that case is between 3 and 5. That sounds like a perpetuum-mobile, which it is not of course. All that heat-pumps do is to transform low temperature heat into high temperature heat. They always consume not only electricity, but also a lot of low temperature heat from an external source. In buildings that external source can be outside air, or energy contained in ground water or the earth.

Up to recently most heat pumps were only capable of boosting temperatures to no more than 80°C. The smaller the temperature difference, the better the COP. In recent years a new generation of heat pumps has been developed which can achieve temperature boosts to as much as 125°C. This enables a quantum leap in the thermal efficiency of the drying process.

Looking at the energy balance of a typical petfood drying process, there are basically six major energy flows: the energy contained in the incoming hot product, the outflowing warm product, the incoming ambient air and the outflowing exhaust air, plus radiation, plus the energy consumed by gas burners or steam heat exchangers. Radiation in a properly insulated dryer is negligible. The outflowing exhaust air therefore contains nearly all the energy that the gas burners or steam heaters have injected into the process plus the net energy contribution of the product. That energy has been used to evaporate water from the kibbles and to warm up the exhaust air so it can contain as much water as possible without condensation. There is a big opportunity to improve the overall efficiency of the dryer if we can recover energy from the exhaust air and re-use it in the drying process.

That is what Geelen Counterflow's R&D team started work on when the goal of developing a 100% electric dryer was first defined. Since 2014 we have spent thousands of R&D hours developing and testing the Counterflow Electric Dryer. Most of 2016 was spent testing the new technology at 1:8 pilot scale, connected to an operational 11 mtph. extrusion line in a super premium petfood plant. We monitored the situation on site and by Remote Diagnostics. Many months' worth of process data were collected and analyzed. The Energy Recovery Unit with integrated CIP system (Cleaning in Place) went through many iterations, minimizing the cleaning frequency for the plant's maintenance team. At the end of 2016 we finished testing and

started ‘translating’ the lessons learned to a full scale unit. Most of 2017 we were testing components at full scale and optimizing cost, manufacturability and access for maintenance.

During testing in 2016 we found a COP (Coefficient Of Performance) between 2,4 and 3,0 depending on the required drying air temperature for a given product. Net energy consumption of the dryer is reduced on by up to 65%. Where our Counterflow Dryers on gas or steam will typically consume no more than 2700 kJ per liter of evaporated water, the Counterflow Electric Dryer will require less than 1000 kJ. Since dryers on gas consume around 50% of the total extrusion line’s energy, a very big improvement in overall energy intensity per ton of product can be achieved. CO_2 emissions per ton of product can be reduced by 99%, provided electricity is from certified renewable sources. Up to 65% of water is recovered.

The above savings will translate into a significant reduction in the operational costs of drying. The exact number depends on the price of gas and electricity, but even in European countries with relatively low gas prices such as the Netherlands, the energy cost savings are higher than 25%.

OPTIONAL HYBRID CONFIGURATION

The first full scale unit will be built for a customer that insists on keeping all options open, so we are installing gas burners as well as heat pumps with heat exchangers. This provides an optional temperature ‘boost’ function for products that require higher drying air temperatures. It also provides redundancy of the heat source and a fall back scenario for when electricity costs go up or gas costs go down. One of the big unknowns here is future energy- and carbon tax policy. The hybrid configuration opens up the opportunity to optimize drying costs as a function of energy prices; running the dryer on the heat pump if electricity prices are low during the night, or when there is ample low cost electricity on the grid from windmills or solar panels; and running the dryer on gas if electricity prices are high.

RETROFIT

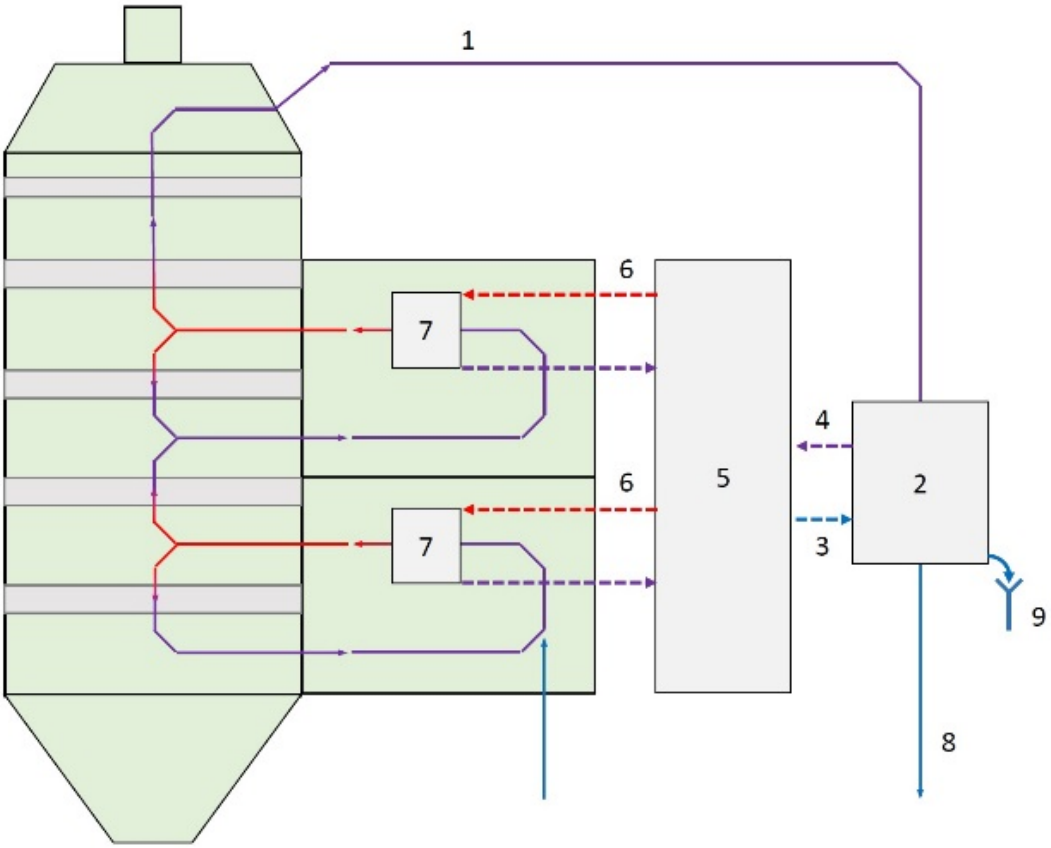
The Geelen Counterflow Electric Dryer’s compact air system has been designed so it can be retrofitted to existing multi-deck counterflow dryers with MkII or MkIII air systems. This means that the dryer itself and most of the components of the air exhaust system can be retained, while the air recirculation system will be completely replaced within the same footprint. New items such as the Counterflow Recovery Unit and the heat-pump must be added.

TOTAL COST OF OWNERSHIP

If you are considering expanding or upgrading petfood production capacity, it is worthwhile to analyze the developments in energy markets and energy- and carbon-tax policies. Bear in mind that your new dryer should run for 30 years, consuming more energy than any other equipment in your plant. Depending on where your plant is located, you may find that, in addition to the significant environmental benefits, the financial pay-back of this clean drying technology is shorter than you expect.

Explanation of flowsheet

The Geelen Counterflow Electric Dryer recovers most of the energy contained in the exhaust air by passing that warm, wet air (1) through a Counterflow Energy Recovery Unit (2). In that heat exchanger, relatively cold water from the heat pump (3) triggers condensation of the warm wet air. During condensation, energy is recovered from the air and transferred to the water (4) flowing back towards the heat pump (5). The heat pump then uses that energy plus electricity to boost the temperature of another water circuit to 125°C (6) which is used by heat exchangers next to the dryer to generate hot air (7) for drying the wet product. The ‘spent air’ (8) is exhausted to avoid food safety risks, but it now contains much less fines and odor molecules as these have been transferred to the condensate (9) which can be re-used in the process or passed to the water treatment system.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