Ethanol by-products can provide an important revenue stream for producers, but effective drying systems are needed before companies can take advantage of this

The hunt for cleaner, more successful drying

When producing ethanol from grain a by-product is left behind, stillage. This can be further processed to produce animal feed additives, but in order for it to be used for this application it must be dried.

The first step is spinning the stillage in a centrifuge to increase its solids content to 30-35%. The liquid and dissolved solids spun out during centrifuging form a thin stillage that is reduced by an evaporator system to a syrup.

Next, the centrifuge solids and the syrup are recombined and mixed with enough recycled final dry product to achieve a blend with 65% to 75% solids. This blend is fed to a drying system, which yields a final dry product called distiller's dried grain with solubles (DDGS), which ethanol plants can sell for use as a high protein animal feed additive.

The drying process is one of the most energy intensive in an ethanol plant. Having an energy optimised drying system that is integrated into the overall production process can reduce this energy consumption significantly.

Conventional drying systems

Most of the conventional drying systems are direct-heated rotary drum dryers. Hot, dry flue gas from a natural-gas-fired furnace is in direct contact with the product to be dried in the rotary drum. High temperatures cause the particles to burn and increase the gasification of organic compounds.

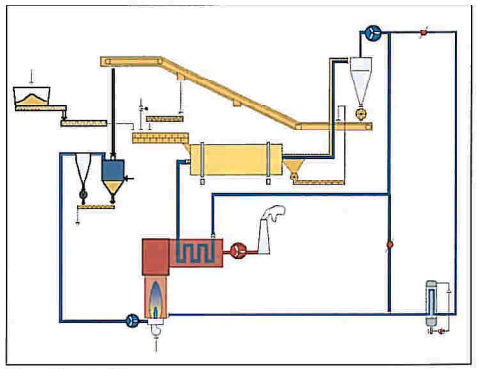
The exhaust gas from the dryer has to pass further process steps to remove entrained particles and air pollutants such as VOCs. This end-of-pipe solution such as a scrubber, filter or regenerative thermal oxidiser, adds another layer of maintenance and fuel cost. To reduce the exhaust gas flow and the heat consumption a part of the hot exhaust gas can be recycled back to the furnace.

New technology

Swiss Combi (also known as W. Kunz dryTec AG) offers a patented drying system called ecoDry with a closed-loop operation and an integrated thermal oxidation of the dryer exhaust gas. This not only eliminates any need for post-treatment of the dryer's exhaust gas but allows drying energy to be recycled back into the system and related equipment.

This system consists of several pieces of equipment connected by ducting in a closed-loop configuration. Its centrepiece is a gas/gas heat exchanger to separate the exhaust from the drying gas. This heat exchanger is specially developed to withstand rough conditions with high temperatures (up to 900°C at the inlet) causing strong heat dilatation.

Another key-component is the single-pass drying drum, designed for a low pressure drop, a wide tolerance for product variation and high throughput rates. This is essential due to the high product recycling rates, especially required in drying DDGS from wheat. The drum's cylindrical housing rotates on four independently driven, variable-speed trunnion rollers at a speed that can be easily adjusted to control the product's moisture content and throughput rate.



The ecoDry principle

Other equipment includes a gravimetric dosing bin, a single-shaft high-speed paddle mixer, a natural gas fired furnace with the possibility to co-fire alternative fuels (e.g. biogas, fusel oils), a cyclone, a product cooler, and a series of tightly sealed mechanical conveyors. The system can be linked to an ethanol plant's evaporator system for heat recovery.

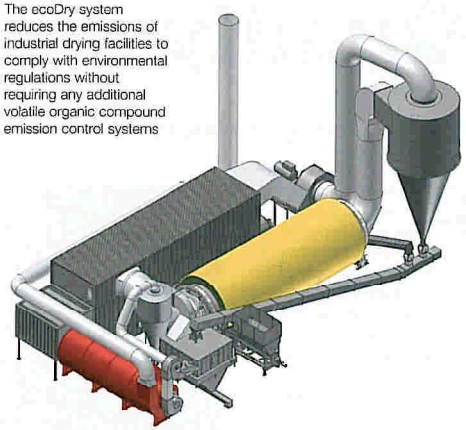
In operation, wet cake (the grain solids) from the centrifuges discharges into the dosing bin, which is mounted on load cells and has a dosing screw discharge to a transport screw conveyor. The bin monitors the centrifuge output and automatically controls the wet feed flow through the screw conveyor to the mixer, where the feed is blended with syrup from the evaporator system and the recycled dry product. This feed mixture continuously discharges from the mixer and is hurled into the adjacent rotary drum.

Flue gas from the furnace passes through the heat exchanger, where it heats the steam to approximately 450°C. The superheated steam passes through the dryer, directly contacting the wet feed mixture to heat it and evaporate moisture. The drum rotation and mechanical assistance inside the drum, combined with the steam flow, move the product toward the dryer discharge.

Most of the product – now DGGS – is discharged through a rotary valve to a tightly sealed mechanical conveyor, but the fines and steam pass on to the cyclones. After separating entrained particles from the steam in the cyclone the still superheated steam is recirculated through the closed loop ductwork back to the heat exchanger. These particles are dropped back into the mechanical conveyor, which transfers all the still-hot DDGS to a cooler that circulates ambient air in a counter-current pattern to reduce the product's temperature.

As the cooled DDGS discharges from the cooler, the cooler's heated exhaust air is routed back to the furnace air intake as primary combustion air. In a process called internal thermal oxidation, the furnace incinerates pollutants entrained in the cooler's exhaust air.

After the steam exits the cyclone, the evaporated water and leakage air is bled off and can drive the plant's evaporator system. The remaining steam and non-condensable are routed to the furnace as secondary gas so it can be thermally oxidised. The drying system's automatic control system adjusts the amount of steam that is bled off to the evaporator system in response to pressure conditions inside the dryer. The steam routed to the evaporator system enters it at approximately 120°C (about 95°C wet bulb temperature).



The ecoDry system reduces the emissions of industrial drying facilities to comply with environmental regulations without requiring any additional volatile organic compound emission control systems