The High Efficiency Stillage Concentration (HESC™) System

By Jim Rieke, Sales Manager, HPD

The ethanol production process yields not only alcohol for fuel, but another component called stillage that is processed into a valuable co-product. Mainly used as animal feed, the stillage is concentrated through removal of water to the desired concentration necessary for the purposes of storage or transportation.

Water Removal from Stillage

Evaporation of water from thin stillage is an energy-intensive process that requires approximately 1000 Btu/lb (2300 kJ/kg) of water evaporated and as high as 1500 Btu/lb (3500 kJ/kg) in a conventional dryer. Concentrating a process stream by evaporation generally causes the viscosity and fouling tendencies of the stream to increase, adding additional expense and difficulty to the process.

Inside the ethanol plant, evaporation of water from still bottoms is required to produce concentrated syrup to be sold as distillers wet grain (DWG) as a co-product. Syrup production from thin stillage is generally accomplished through multiple-effect evaporation using falling or rising film indirect heating technologies.

The multi-stage configuration minimizes overall energy requirements through stages of heat reuse. As an example, using two or three effects of evaporation can reduce energy consumption by 400 to 500 Btu/lb (930-1160 kJ/kg) of water evaporated. This process can also realize additional efficiency through integration with other large energy users in the facility such as distillation.

Challenges at High Solids

Production of distillers dried grain with solubles (DDGS) requires additional water removal, and as a result, the syrup becomes quite viscous. As it is concentrated, conventional evaporation technology becomes impractical at higher solids. Typical film-type evaporators experience difficulty at 25 wt% Total Solids (TS) and rarely operate consistently above 35 wt% TS. Heat transfer efficiency drops at higher viscosities, and the heat transfer surface is subject to a higher rate of fouling.

Final water removal generally occurs in drying equipment utilizing direct contact heating and evaporation to reach the desired concentration.

Unfortunately, this method of evaporation is very inefficient, requiring as much as 1500 Btu/lb (1080 kJ/kg) of water evaporated. The ethanol plant dryers also represent the highest operating and capital unit costs in the facility. Clearly, maximizing water removal from syrup upstream of the dryer can result in substantial operating and capital cost savings for the modern ethanol plant.

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High Efficiency Stillage Concentration System

HPD's High Efficiency Stillage Concentration (HESC) system bridges the technology gap between the evaporation equipment and drying systems that are typically supplied to the standard ethanol plant. Designed as a modular, skidded system, the HESC can be easily integrated into an existing ethanol facility with little or no disruption to plant operations as a stand-alone unit (see Figure 1).

The HESC system incorporates unique heat transfer enhancing technology that facilitates processing of highly viscous fluids with minimal fouling. This proprietary technology utilizes an insert developed for tubular heat exchangers that allows a high degree of turbulence within the tubes at high viscosity. Called "enhanced forced circulation", this design operates at twice the heat transfer efficiency of a conventional forced circulation design, while decreasing the recirculation rate by 50%.

The integration of HESC into an ethanol plant allows syrup production to solids levels exceeding 50 wt% TS, offsetting energy requirements in the dryer and operational (fouling) issues normally experienced in conventional water removal.

HESC System Economics

The typical integration of the HESC unit would allow an additional 25,000 lb/hr of water evaporated from the syrup prior to final water removal in the dryer. The HESC requires approximately 102 Btu/lb water evaporated, whereas dryer efficiency is typically 1,500 Btu/lb water evaporated. The annual savings from for a typically sized plant, assuming a natural gas price of $9/MM, are calculated as follows:

25,000 lb/hr x (1,500 Btu/lb evaporation - 102 Btu/lb evaporation) X 8,760 hr/yr X $9/MM Btu = **$2,800,000 / year**

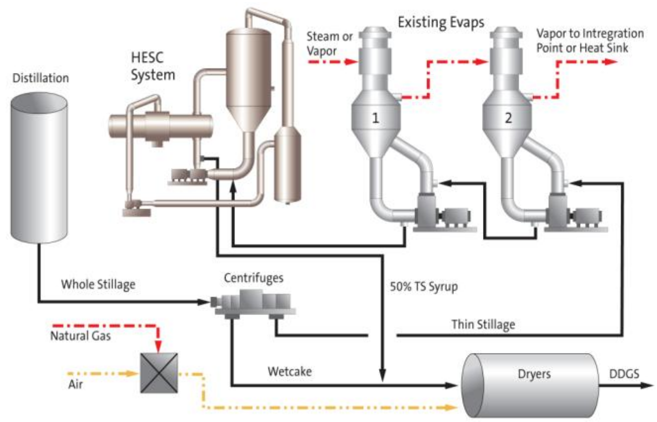
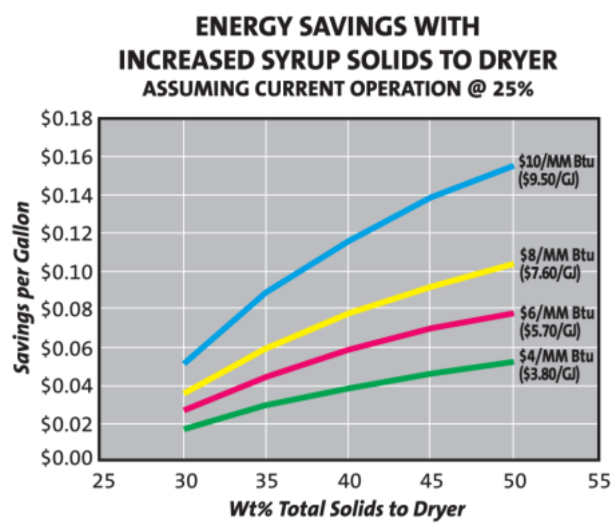


Figure 1: Water removal from stillage with integrated HESC module



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Additional revenue may be realized if the existing dryers and/or evaporators are the plant bottleneck. Less water in the syrup enables the existing drying systems to process more throughout, allowing more ethanol production.

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