Enhance EPDs with Burner Tech

How to employ innovative burner systems, controls for optimum environmental efficiency

BY JIM FEESE

Your burner design can be conducive to saving energy, reducing CO_2 emissions and improving your environmental product declarations (EPDs).

Aggregate dryer burner designs have evolved through the decades starting with many open-fired burner designs, which required the exhaust fan to induce combustion air into the flame/dryer, to more modern sealed-in burner designs with 100% air capability. The sealed-in designs have further evolved to improve energy footprint by way of reduced electrical energy consumption and British thermal units per pound (Btu/lb) of asphalt produced when operated with more sophisticated controls.

After over two years of intensive design and testing, Detroit Stoker Company Inc. (DSC), Monroe, Michigan, recently released the Detroit® HADES aggregate drying burner. The design capitalizes on DSC's 30+ years of boiler burner design and application experience in addition to staff's prior experience with a former aggregate drying burner OEM. The HADES design incorporates fast air/fuel mixing technology adopted from modern low NOx boiler burners with a rugged service duty and maintenance accessibility expected in the asphalt industry. More intense air/fuel mixing is achieved with the ability to shape the flame to obtain the necessary compact flame envelope to fit the dryer combustion zone with lower fan motor horsepower than previous designs. In addition, a control panel also designed by DSC provides air/fuel ratio control with additional features enabling plant hot-stops and light to waste oil fuel switch-on-the-fly capability, among others.

IN THE FIELD

A recent case study at Eureka Stone in Milford, Pennsylvania, now operating for over one year, demonstrates the energy savings potential of replacing an outdated burner design with this new technology. The plant is a 2-ton batch and produces approximately 120,000 tons per year of HMA. The dryer drum is approximately 8 feet in diameter by 30 feet long. The burner fires on either Compressed Natural Gas (CNG) or No. 2 fuel oil. The images on page 28 show the old open-fired burner replaced with a sealed-in Detroit HADES burner.

The open-fired burner utilized a high pressure 100-horsepower fan/motor whereas the new burner requires a 60-hp fan/motor and includes a variable frequency drive (VFD) for additional electrical energy savings. Furthermore, the single jackshaft arrangement (air and fuel damper/valve driven by a common actuator with mechanical linkage) was replaced with VFD only for airflow control and a direct coupled V-ball fuel flow control valve(s)/actuator(s) per fuel, which offer more precise flow control than the typical butterfly valves used on most gas burners. (See Sidebar below for details).

ELECTRICAL ENERGY SAVINGS

For a simplified look at the electrical energy savings, we'll assume a long-term average or "typical" burner operation at 40% burner output (approximately 50% VFD / fan speed). This simplified approach yields the following electrical energy savings compared to the old burner:

- Typical VFD operating range: 4mA = 16Hz (low fire), 20mA = 60Hz (high fire).
- Average 50% fan speed = 38Hz (approximately 60% of maximum rated airflow). Note that fan power consumption is proportional to the cube of the fan speed (fan laws).
- Further assume typical batch plant produces on average 45 tons per hour (TPH), which equates to 2,667 hours per year of operation.

Calculating electrical energy savings based on $0.109 / kilowatt-hour (utilizing Yaskawa Energy Savings Estimator formulas):

1. Converting New Burner Motor Hp to Kilowatt (kW):
   a. 60Hp x 0.746 = 44.76kW1
2. Fan at 60% of maximum flow results in a power ratio of 0.32 for VFD operation:
   a. 0.32 x 44.76kW1 = 14.32kW2
3. Old burner had 100Hp fan with an outlet damper (power ratio of 0.94 for outlet damper operation):
   a. Original: 100hp x 0.746 = 74.6kW3
   b. 0.94 x 74.6kW3 = 70.12kW4
4. Energy savings using VFD:
   a. 70.12kW4 − 14.32kW2 = 55.84kW5
5. Energy Savings:
   a. 55.84kW5 x 2,667Hrs x $0.109/kWh = $16,232 / year electrical energy savings
6. Additional electrical energy savings not considered includes the reduction of inrush / start-up current (6 times the normal FLA of the motor) multiple times throughout the day.

Eureka Stone in Milford, Pennsylvania, replaced its burner on a 2-ton batch plant. The burner fires on either compressed natural gas or No. 2 fuel oil. Here you can see the former open-fired burner replaced with a sealed in Detroit HADES burner. ***All photos courtesy of Detroit Stoker Company Inc.***

The David A. Bramble, Wye Mills, Maryland, burner replacement involved a comprehensive plant upgrade complete with new dryer, exhaust ducting, baghouse and exhaust fan. The old burner and the new light and waste oil fired Detroit HADES burner and HBC burner control panel are viewed from the burner end of the dryer in the photo above right.

The payback on the burner VFD alone is less than six months. Depending on plant location, the utility may offer additional incentives through rebates and/or reduced peak load demand charges.

Fuel savings from installing a new burner and control system are difficult to accurately quantify with the many variables that contribute to fuel usage in the first place, including material mix and varying moisture levels from season to season. Industry experience has shown that switching from an open-fired burner system to a sealed-in burner system in conjunction with controls upgrades can readily yield 5-10% in fuel savings. Let's look at the factors that make this possible.

First, the typical open-fired burner fan only provides about 30-50% of the stoichiometric combustion air required and relies on the plant exhaust fan to induce the balance. This can lead to inefficient air/fuel mixing and overall air/fuel ratio control; ultimately higher fuel consumption compared to a sealed-in burner with 100% total air fan. The sealed-in burner fully mixes 100% of the required combustion air intimately with the fuel at the burner nozzle(s) resulting in fast mixing, complete burn-out, and improved air/fuel ratio control.

Second, as already alluded to, the air/fuel control scheme can be much more precise with a sealed-in unit. In this case, we control 100% of the combustion air and can do so at any firing rate via a

FUEL SAVINGS WITH NATURAL GAS

Let's look at typical fuel savings assuming 268,000 Btu/ton of asphalt produced and firing natural gas.

268,000 Btu/ton x 120,000 ton/year = 32,160,000,000 Btu/year (32,160 MBtu/year). Or 32,160,000 cu.ft Nat. gas / year.

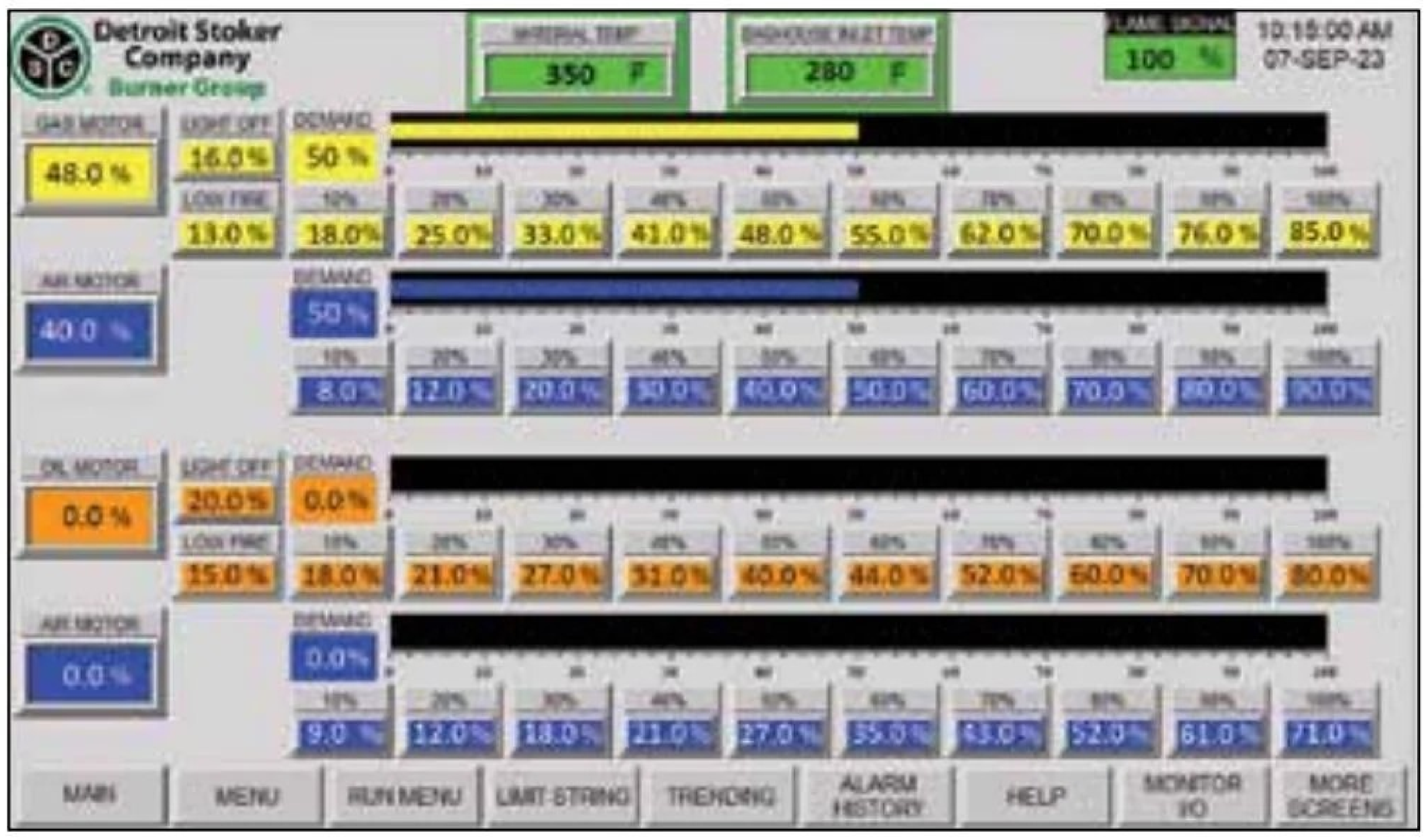
The producer now has improved control with a direct coupled fuel actuator (4-20mA with feedback typical) and a new VFD with 10-point tuning curve versus an old linkage type system with mechanical hysteresis that typically is only tuned at one firing rate and prone to performance drifting over time:

1. Conservatively assume 4% fuel savings (typical 5-10% fuel savings with parallel position versus a single point 'jackshaft' or linkage type system is common).
2. With a natural gas fuel cost of $10/MBtu equates to an additional:
   0.04 x 32,160MBtu/year x $10/MBtu = $12,864 / year fuel savings
3. CO_2 reduction. For brevity, the calculations are omitted for determining the CO_2,eq (carbon dioxide equivalent), but for this typical 120,000 ton/year batch plant, the total CO_2,eq is calculated to be 31.1 lbs/ton (1,866 tons/year) based on average 268,000 BTU/ton. A 4% reduction in fuel usage results in CO_2,eq reduction of 75 tons/year.

Other advantages include:

1. Fully independent control of air and fuel flows across the entire burner firing range; optimum air/fuel ratio at all production rates or mixes.
2. Advanced 4-20mA actuated control motors with hundreds of positional points of accuracy over a 90-degree stroke.
3. Controls directly available via touchscreen/HMI.
4. HMI offers improved visualization to operator, full status annunciation, and first out fault detection.
5. Improved safety, air/fuel too far out of control range prevents burner operation, unlike a failed linkage.
6. New/updated safety limits installed/verified.
7. Data logging/storage for fuel usage/ton and efficiency. Data can be directly input to NAPA's Emerald Eco Label EPD calculator and used for state or project reporting purposes.

Characterizable Air and Fuel(s) Curves



parallel position type control scheme. If your burner control system is not equipped with characterizable air/fuel curves as depicted in the screenshot of the HBC-1000 control panel, then your burner is likely running at non-optimal air/fuel ratio at multiple load points. The parallel position system is designed to operate with independent air/fuel ratio control [VFD for air and independent direct coupled fuel actuator(s)], with built-in safety limits to prevent operation beyond desired air/fuel ratios. Combined with the proper fuel flow control valves and precision actuators, this leads to very accurate air/fuel ratio control and eliminates slipping linkages and hysteresis common in mechanical linkages. (See Sidebar above for fuel information.)

Another recent example from David A. Bramble, Wye Mills plant, involved a comprehensive plant upgrade complete with new dryer, exhaust ducting, baghouse, and exhaust fan (via Herman Grant Company Inc.) with new light and waste oil fired Detroit HADES burner and HBC burner control panel. The pictures on page 28 show the new equipment package versus the old unit as viewed from the burner end of the dryer. Burner equipment including fuel trains and safety limits are now more readily accessible, and easier to set-up, tune, and service. Wiring is clean and orderly, further improving safety and troubleshooting.

The new burner with 1,800 rpm fan with VFD is quieter than the old unit even though the old burner was enclosed to help reduce noise pollution. The lower speed fan also reduces fan vibration, improves fan life and minimizes long-term wear from typical quarry/gravel dust particles. Following the above calculations for a "typical" drum mix plant producing in the neighborhood of 200,000 tons per year or more of HMA results in substantially more cost savings and an even quicker payback on the controls and/or burner investment upgrade in addition to various benefits cited.

A new, properly tuned burner and control system providing energy savings in terms of KWh/ton and Btu/ton of asphalt produced in combination with avoided/reduced CO_2 emissions is a positive step in improving an asphalt plant's EPDs with many additional benefits. AP

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