EPI
Energy Products of Idaho

Board Plant Energy Systems with Total VOC Destruction Using Closed Loop Fluidized Bed Combustion Technology

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SYNOPSIS

Today's stringent environmental requirements imposed on new and existing composite board plants mandate maximum emissions abatement of dryer exhaust, press room vent, and other gases laden with volatile organic compounds (VOC's) and other pollutants. Until recently, employing costly wet electrostatic precipitator (WESP) and regenerative thermal oxidizer (RTO) technologies were necessary to comply with the new regulations. Energy Products of Idaho (EPI) has developed a process that permits all of the waste exhaust gases to be returned to the combustion cell, as combustion air, to destroy essentially 100% of the VOC's contained in these waste streams. This goal is achieved while supplying all the energy requirements of the plant with only a minimal increase in fuel requirements. This new and innovative approach, made possible by the advanced fluidized bed combustion technology, will go a long way in meeting the needs of modern day board plant emissions requirements and will prove to be a major economic advantage over current technologies. This unique process is applicable to all board plants including OSB, MDF, LVL, LSL and plywood.

TYPICAL BOARD PLANT OPERATING CONDITIONS

MDF plants normally require thermal fluid heat for the press, steam for the refiners and a relatively low temperature gas for the flash tube dryers. Typical OSB plants require thermal fluid for the press and log vats and a higher temperature gas for the rotary drum style dryers. Add steam to OSB for an LSL plant. LVL and plywood differ from all of these only in the veneer drying process. In all board plants, building make up air heating in the winter can represent a significant load and is usually provided by thermal fluid and/or natural gas fired unit heaters. In the past, EPI provided an energy system to supply all the loads from a single fluidized bed combustion system. The hot combustion products (flue gas) from the combustion cell are directed to a thermal fluid heater and/or a boiler/economizer system. Oil temperature and steam pressure are independently controlled by modulating dampers at the outlet of each unit. The combined exhaust from both units is then directed to a blend chamber where it is mixed with flue gas from the vessel to provide the mass flow and temperature required by the various dryers. In these systems all of the combustion products are utilized and the dryer stack becomes the single emissions point. Due to the particulate loading and dissolved solids in the dryer exhaust, contamination of the RTO ceramic heat exchange medium often occurs, requiring additional particulate abatement in front of the RTO, normally in the form of a wet ESP. This combination is initially very capital intensive and the operating and maintenance costs have a significant impact on all future plant production economics.

In addition to the dryer stack, other VOC emissions sources in typical board plants include the press area vent system and sometimes, in MDF, LVL and plywood plants, the board cooler and paint lines. These sources, collectively, hereinafter called building exhaust, typically represent very large mass flows, but relatively low concentrations of VOC's, making VOC destruction very costly and inefficient through the normally applied RTO route.

Coincidently, the wood waste used as the energy system fuel in these plants, in the form of bark (hog fuel), sander dust, board trim and dry screenings from the furnish, is typically and collectively, very dry and requires unusually high combustion air (excess air) flow rates to control the combustion temperatures and prevent slagging. These high combustion air requirements provide an excellent fit for the VOC reduction requirements in a fluidized bed energy system. The unique combination of factors lead EPI to develop the process described in the following paragraphs.

ADVANCED FLUIDIZED BED CLOSED LOOP PROCESS DESCRIPTION

The unique fluidized bed closed loop process is depicted on the attached illustrations, the first for a typical MDF plant and the second for a typical OSB plant. This concept, first introduced by EPI in a "Panel World" article in 1993, has been in further development since that time, particularly in heat exchanger technology and design. In general, the process applies to all board plants and differs only in the loads normally required to be supplied by the plant energy system and the dryer supply inlet temperatures and mass flows.

Dryer Supply Loop

As shown in figure 1, the dryer is supplied with the relatively clean air from the building exhaust streams, mixed with recirculated dryer exhaust. The mixed gases are heated in a "tube-and-shell" type heat exchanger by primary side flue gas from the combustion cell.

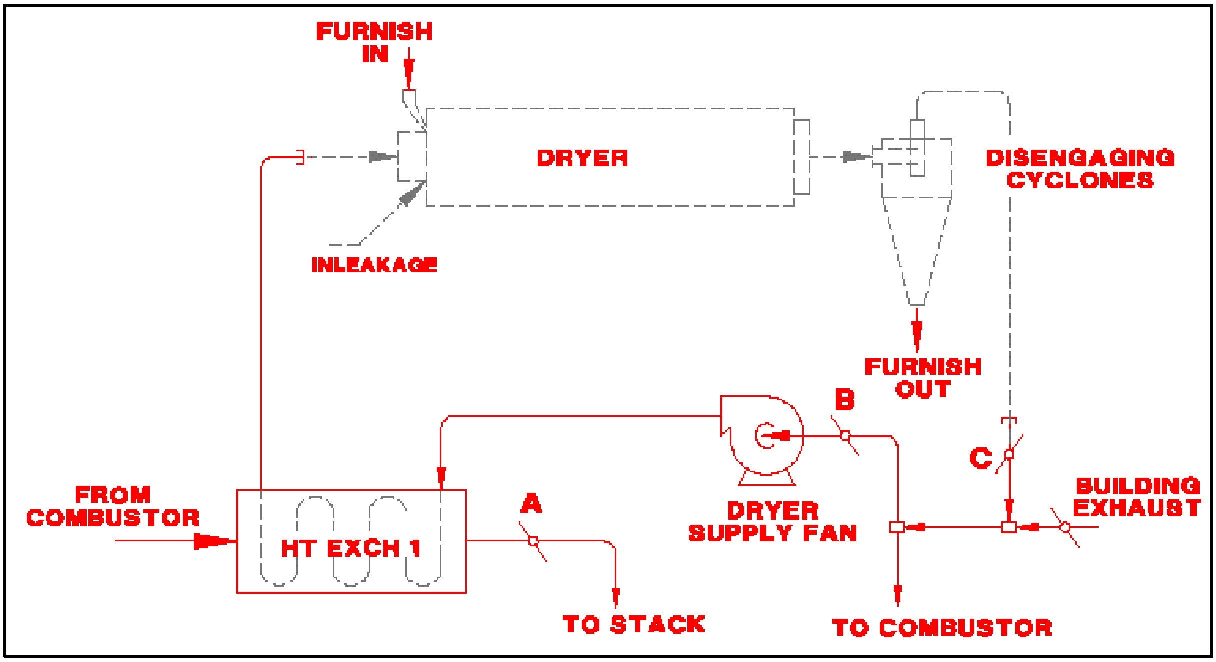

Fig 1 - Dryer supply loop

The dryer supply inlet temperature is controlled by modulating the primary side mass flow with the damper (A) at the outlet of the heat exchanger. Thus precise temperature control is assured with infinite turndown capabilities. The mass flow through the dryer is controlled in the normal manner, by the dryer supply fan inlet damper (B). Damper (C) is used to isolate the dryer from the rest of the system in the event the dryer is shut down. The dried product, or furnish outlet moisture content is controlled by a “cascaded” set point signal to the dryer inlet temperature controller. This set point signal can be either the moisture content directly, from an on-line moisture meter or, as more common, from the dryer outlet temperature. The heat exchanger is designed for a primary side outlet temperature of about 350 ˚F, consistent with the desired stack temperature. This arrangement provides several benefits to the drying operation:

1. No combustion products to the dryer, therefore no ash or other particulate to contaminate the plant furnish.

2. The moisture content of the dryer supply gases are maintained at high levels for most efficient drying, absence of “case hardening” and dryer fire suppression.

3. Mass flow through the dryer and the inlet temperature are independently and precisely controlled for consistent furnish residence time and maximum dryer efficiency.

4. Rapid and precise system response time to changes in furnish flow rates and/or inlet moisture content is assured, for consistent outlet furnish moisture content.

5. One common stack for the entire plant for ease of emissions measurement, recording and reporting.

VOC Destruction Loop

The balance of the mixed building and dryer exhaust gas, not required by the dryer, is passed through a second heat exchanger (recuperator) and thence to the combustion cell. The recuperator preheats the gas to about 900 ˚F, to support the in-cell combustion temperature (typically about 1650 ˚F), for complete destruction of the VOC's. (Without the recuperator additional fuel would be required to achieve the desired in-cell temperature and the excess energy would have to be exhausted to the atmosphere at a much higher temperature). The outlet temperature, on the primary side of the recuperator, is designed to be consistent with the desired stack temperature of about 350 ˚F. The upper combustion cell is expanded to accommodate the additional over-fire air and provide a generous "time-at-temperature" for complete destruction of the VOC's.

Thermal Fluid and Boiler Loads

The energy required for the thermal fluid heater and/or boiler is taken from the combustion cell in the normal manner with oil temperature and steam pressure controlled by dampers down stream of the respective unit. Again, precise control and infinite turndown is provided for the two loads.

Building Make-Up Air Heater

The typical thermal fluid heater exhaust gas temperature, due to the relatively high oil temperatures, range upwards from about 650 ˚F. To recover some of this high quality energy, improve overall system efficiency and reduce the common stack temperature, a third heat exchanger is incorporated to heat ambient air for the building heat system in the winter. During the summer months this energy is exhausted to the atmosphere to retain the low stack temperature feature.

Particulate Abatement

The flue gas exhaust from all the loads is collected into a common header and directed through either a baghouse or a dry ESP to collect the particulate. Cost considerations and collection efficiency favor a baghouse and at the design stack temperature are easily adaptable to the duty. Collection efficiencies of 0.01 grain/dry standard cubic foot are easily attained to meet nearly any environmental authorities abatement requirements.

SIGNIFICANT ADVANTAGES

In summary, the EPI advanced closed loop fluidized bed energy system has several significant advantages over previous technologies:

1. **No Wet ESP's or RTO's** - The fluidized bed energy system enables EPI to use the exhaust from the product dryers and the press vent as combustion air, thereby guaranteeing essentially 100% destruction of the VOC's and eliminating the need for RTO's or other emissions clean-up equipment for those sources.

2. **Load Following** - Responsiveness to load changes and stable control with varying fuel moisture contents and heating values are key considerations in the design of the fluidized bed energy system. Unlike other technologies, this system operates with a minimal fuel inventory in the combustion cell enabling rapid load following changes.

3. **Turn-down Capability** - EPI's advanced fluidized bed combustion system has a turn down capability of up to 10-to-1 which is greater than any other solid fuel fired system available. This creates significant operating and fuel saving advantages during load transitions, start-up, and reduced load operating scenarios. In addition to the total system turn-down capabilities, each energy load (the dryers, boiler and thermal fluid system) has infinite and independent turn-down.

4. **Wide Range of Fuels** - In a fluidized bed system, the large mass of the bed material creates a thermal inertia that absorbs moderate swings in fuel moisture contents and heating values without adverse output changes. The EPI system operates on fuels with moisture contents ranging from less than 5% to 60% or more.

5. **No Moving Parts** - *The fluidized bed combustor has no moving parts*. Repairs and maintenance are significantly reduced, if not eliminated, because the combustion equipment is comprised of fixed solid equipment. This is a significant advantage in operating cost and on stream availability compared to rotary combustion and moving grate technologies.

6. **Unsurpassed Experience** - 64 of the 76 fluidized bed energy systems that EPI has provided use wood waste as fuel. In 27 years, EPI has never failed a performance or an emission test. EPI systems are not only the state-of-the-art, they are also the most reliable and proven systems available.

7. **On-Line Ash/Tramp Removal** - On-line tramp removal and bed recycling capabilities substantially reduce bed fouling caused by noncombustible material delivered with the fuel and by low melting point ash constituents in the fuel that may cause agglomerations. The fluidized bed combustion system described herein is based on EPI's patented and proprietary design and includes the most effective tramp removal and bed recycling system available. Combustion temperatures are closely controlled which substantially reduces clinker formation during normal operation (as typically experienced with other technologies). No shut-downs are required to clean grates or chip slag from high temperature combustion chambers.

8. **Lowest Achievable Emissions** - The fluidized bed technology provides the proven lowest achievable emissions rates (LAER) of any combustion technology on the market. The emission requirements for board plant facilities (including NO_x) are easily achievable with this advanced and proven technology.

9. **Factory Installed Refractory** - The EPI manufacturing facility installs about 1-1/2 million pounds of refractory per year. Our refractory quality control is unsurpassed. Factory installation significantly reduces field erection cost and time and furthermore, the responsibility for the refractory stays with EPI, the supplier, rather than shifting to the contractor.