Engineering Consulting & Training Services

CARMAGEN Engineering, Inc.

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Top Ten Ways to Improve Fired Heater Efficiency

By Robert Dubil

Carmagen's April 2014 newsletter identified the Top Ten Ways to Increase Site Energy Efficiency. This companion article focuses on improving fired heater efficiency. Note that many of the items listed below can be done at no or minimal capital cost, and could yield significant fired heater efficiency improvement.

1. Reduce excess air. There are several ways this may be accomplished.
   a. Install oxygen analyzer in closed-loop control with combustion air flow controller (i.e., burner plenum dampers, combustion air fan). Consider the installation of an oxygen analyzer with CO/combustibles analysis included to allow optimization and control of excess oxygen to a practical day-to-day minimum.
   b. Seal all casing openings and tube penetrations that are practical to achieve. Consider the addition of glass-covered observation doors to reduce inleakage. These also provide increased operator safety.
   c. Minimize tramp air inleakage by installing a bridgewall pressure controller in closed-loop with stack damper or induced draft fan. A practical day-to-day pressure at the arch should be in the order of -0.1" H_2O (2.5 mm H_2O).
   d. Consider performing tests to determine minimum excess oxygen levels achievable on a day-to-day basis, after having installed analyzer(s) and sealed casing openings.
2. Add combustion air preheat.
   a. Although a costly option, the economics may favor the addition of a flue gas-to-combustion air preheater. Either a static recuperative type or a rotary regenerative type may be considered. Both systems will usually require a forced and induced draft fan system as well as the associated ducting. Obviously, plot space will impact the choice. In some cases, multiple fired heaters may share a common air preheater system, which can enhance the economics, but will require sophisticated control instrumentation and additional safety systems.
   b. A less costly approach is to utilize an intermediate fluid such as DowTherm to remove heat from the flue gas, and exchange it with the combustion air. This will eliminate much of the required ducting (replaced with piping), but will be limited in the amount of heat that may be exchanged. Alternatively, waste heat from a process stream may be a good choice to preheat the combustion air.
   c. Consider checking the oxygen levels with a portable analyzer on a regular basis to look for air inleakage.

Work Highlights

Process, Operations & Safety

- *Provided fractionation troubleshooting and design consultation on a C3 splitter that was not meeting required performance requirements. Recommendations were made to modify the internals to improve the situation.*

Project Management

- *Full time, onsite construction management consulting support provided for a major Canadian oil sands facility. Responsibilities include development and review of execution plans, cost and schedule control, interface with contractor and facility personnel, etc.*

Training

- *Presented a five day training course covering safety in process design and relief system design for a client in Latin America. The course was very well received and follow-up activities related to process safety are anticipated.*
- *Recommended updates to the construction crane safety management manual used by a client company in order for it to meet revised OSHA requirements.*

3. Add extended surfaces to the convection section tubes. Normally, this will be through the use of finned tubes. If the fuel is a clean gas, the fins may be spaced quite close together to maximize the surface area increase. If the fuel is oil, fins may also be utilized; however, they are usually thicker and spaced further apart to allow for onstream cleaning with sootblowing equipment. Closely spaced fins can increase the effective heat transfer surface area by an order of five times that of bare tube, while the thicker more loosely spaced fins in oil service may increase the surface area by a factor of three.

4. Perform regular burner maintenance to achieve and maintain proper and complete combustion at reduced excess air levels. Consider upgrading burners to more efficient, low excess air models.

5. Consider the addition of fuel gas/oil cleaning facilities. Proper fuel gas and fuel oil filtration systems will assure that the burners perform as designed. These may include properly designed and insulated knockout drums with coalescing filters to remove condensable liquids from the fuel gas, automatic continuously self-cleaning fuel oil strainers, and parallel filters to allow one to be cleaned offline while the other is retained in service.

6. Conduct operator training with emphasis placed on heater efficiency, i.e., during regular surveillance of heaters and burners look for leaks, or other opportunities to improve efficiency. Operators spend the most time around a heater so have the best vantage point and can best detect subtle changes in heater performance.

7. If an oil fired heater with sootblowers installed, perform regular maintenance of the sootblowers, and check that they are passing the proper steam rate to keep the tubes clean. Generally, this will require about 10,000 lb/hr of steam per blower (4,500 kg/hr) and preferably about 250 psig pressure steam (17.6 $kg.cm^2$) or higher.

8. Monitor and track key parameters, such as stack O_2, tube metal temperatures, bridgewall and stack temperatures. As the stack temperature and/or bridgewall temperature begins to increase, these are indications of loss of efficiency. This may be due to tube fouling either on the fireside or tubeside. Monitoring and tracking the ratio of bridgewall temperature (BWT) to stack temperature (Ts) can be used as a fouling indicator, i.e., increase in the ratio of BWT/Ts indicates loss of radiant heat transfer, possibly through tubeside fouling/coking. Reduction of the BWT/Ts ratio will indicate convection section fouling, likely on the fireside. However, tubeside fouling or sedimentation in convection sections has been found, and may be eliminated by pigging the coil.

9. Develop turnaround checklist focused on efficiency. This may include planning for upgrades rather than replace-in-kind, sometimes at low or no additional cost. For example, glass-covered observation doors. Other examples include adding extended surfaces tubes, rather than simply replacing bare tubes in kind. In addition, consider the opportunity to upgrade burners, rather than continuing to repair existing low-efficiency models.

10. Consider soliciting the aid of experts. Carmagen Engineering can provide specialists who are familiar with fired equipment and can perform analyses of the refinery heaters and offer recommendations for efficiency improvement. In many cases, this will result in equipment maintenance savings as well. The end product would be in the form of a report itemizing the recommendations and listing the cost/benefits associated with the implementation of each.

About the Author

Robert Dubil has provided engineering consulting services in the field of fired equipment to the hydrocarbon processing industry for over 40 years; this includes engineering and design, as well as commissioning, maintenance, troubleshooting, operation, and training. Also, Bob has been very active in the development of Industry Standards governing the design and purchase of fired equipment through participation with the American Petroleum Institute. In addition, he participated in the development of similar international standards, working with the ISO Standards Committee.

Please contact Vince Carucci (vcarucci@carmagen.com) if you'd like more information on Carmagen's expertise in this area.