ESA-048-2 United States Steel Corporation - Gary Works
FINAL PUBLIC REPORT

Introduction: The U. S. Steel plant in Gary, IN is a fully integrated steel mill which covers approximately 3,000 acres. The plant makes its own metallurgical coke for the blast furnaces which is the operating division of the plant that is the subject of this steam ESA. The Gary Works is over 100 years old and was built around the beginning of the 1900's and has under gone many changes over the years. The coke plant powerhouse equipment is a mixture of relatively new and old equipment some of which was installed during the 50's and 60's and most recently 2 boilers were added about 2 years ago. The boilers burn primarily coke oven gas and generate an average of approximately 300,000 lbs/hr of 900#/700°F superheated steam. The plant operates 2 steam back pressure turbines and keeps one condensing turbine on hot standby to respond to emergencies. The plant has several steam pressure levels but for modeling purposes the primarily steam pressure levels are 900/150/15#. The 900# steam is used primarily for the steam turbines and the 150# and 15# steam is used for process.

Objectives of ESA: Training in the use of SSST, SSAT, and 3E+ along with recognition of steam best practices, review of SSST results, the development of the SSAT base model, evaluation of steam system energy efficiency measures, and reduction of plant coke oven gas.

Focus of Assessment: Plant steam system optimization and evaluation of several energy cost savings measures using the DOE steam system software program SSAT.

Approach for ESA: A kick off meeting was held and copies of the various DOE forms such as, the attendance sheet, the intake questionnaire, 10-day summary report, evaluation sheet, and plant activity steps were distributed and discussed. Following a brief discussion of the forms a short PowerPoint presentation was made covering the ESA purpose, objectives, and deliverables. After the kick off meeting the SSST spreadsheet was developed from which some energy efficiency measures were identified. A limited plant tour was made followed by more detailed review of the powerhouse that included discussions with the boiler and turbine room operators. Some field measurements were taken on the first day and more were taken on the second day. The boilers were tested for excess air and flue gas temperature measurements taken during the ESA to assist in determining combustion efficiency. The remaining time was spent working with the plant lead establishing the steam system base case and analyzing various energy efficiency measures. A wrap up meeting was held where energy efficiency measures were discussed.

General Observations of Potential Opportunities:
Since the boilers are generating steam using coke oven gas which is a by product of the coke manufacturing process for years the coke plant steam had been thought of as free energy. The coke plant is a unique position in that whatever coke oven gas it does not use it can sell to other departments in the mill like the strip mill. The strip mill can use either coke oven gas or natural gas so obviously the strip mill wants to use as much coke oven gas as possible due to cost. In addition the more coke oven gas that can be sold by the coke plant the better financially it looks which also helps off set the cost of natural gas because other departments can reduce their natural gas use. The approach that was taken is to base the steam savings evaluated by SSAT on the cost of natural gas since selling more coke oven gas to the strip mill reduces the overall mill natural gas cost. A summary of the natural gas and purchased electricity for base year 2006 is provided below:

- Natural Gas
  - 21,456,175 MMBtu/yr

- Electricity
  - 1,338,628,000 kWh/yr

The initial focus of the ESA was to develop a steam system energy balance that would be used to identify energy efficiency measures. The balance was calculated from field measurements and other available data using SSAT.

Various energy efficiency measures were evaluated to lower steam system operating cost and reduce natural gas cost. A brief summary of each recommendation is described below.

1. Repair steam leaks.
Numerous steam leaks were observed throughout the coke plant. The Coke plant maintenance department has assigned personnel full time on leaks and has made considerable progress but there is still much more savings that can be captured as pointed out during the review. This is a near term opportunity that can save an estimated $1,518,000/yr.

2. Repair steam traps.
The plant currently has no condensate return so most of the traps discharge to atmosphere. The traps have not been surveyed or tested for more than 10 years and many traps have been misapplied. A trap survey, identification, and testing program is needed to make repairs to minimize steam losses. This is a near term opportunity that can save an estimated $464,000/yr.

3. Improve insulation.
The plant has several areas where steam lines are bare and exposed to the atmosphere at all of the pressure levels in the coke plant. In addition many of the branch steam lines are in poor condition. There's one insulator for the entire coke plant so even though progress in this area has been made there's a lot more that can be done to lower steam use and save energy. This is a near term opportunity that can save an estimated $373,000/yr.

4. Condensate return.
The coke plant does not return any of its condensate. This is not only a large energy waste but also adds to the water treatment cost. Several of the steam users in the coke plant are in close proximity to the boiler room water treatment system so it would take some doing but it would not be that difficult to begin returning condensate beginning with the Booster House. The savings calculated for this project is based on returning 25% condensate and best practices is in the range of 80% return. This is a medium term opportunity that can save an estimated $674,000/yr.

5. Recover 15# flash steam.
Currently the coke plant demucker and stripper vent off their condensate flash steam to atmosphere. The steam used is at 250# and 150# so there's considerable energy to be recovered that could be piped into the 15# low pressure system. The proposal would be to install a flash tank for the demucker and stripper 250# and 150# condensate and recover 15# flash steam. This is a near term opportunity that can save an estimated $256,000/yr.

6. Tune #8 boiler to have the efficiency similar to #4 boiler.
The boilers were tested for combustion efficiency and #4 and $8 were found to be running in a range of 12-13 % oxygen. Number 9 and 10 boilers were tested and found to have an excess air of 6% oxygen. It's a difficult to say exactly what efficiency a coke oven gas boiler should run at but since #4 and #8 boilers are approximately the same vintage it's reasonable to expect they could run at close the same efficiency if tuned correctly. The savings for this EEM was evaluated assuming the both #4 and #8 boilers run at approximately the same efficiency. This is a near term opportunity that can save an estimated $316,000/yr.

7. Install blowdown heat exchanger.
The plant boiler currently recovers the flash steam from their continuous blowdown but discards the heat in the blowdown water. The proposal would be to add a heat exchanger to the blowdown system to preheat the makeup water going to the water treatment system. This is a near term opportunity that can save an estimated $202,000/yr.

8. Improve steam tracing.
The coke plant process has numerous areas where steam tracing is used. This is one of those situations where it's difficult to say exactly what all the problems are but tracing without insulation is not an effective use of steam. Tracing without insulation has a limited effectiveness and coiling tubing around piping and valves is not recommended. The savings by improving tracing was determined by SSAT using an estimated steam demand reduction. This is a near term opportunity that can save an estimated $739,000/yr.

By implementing the fuel savings projects described above independently in the near term there's a potential energy cost reduction of 15% and a medium term reduction of an additional 3%.

Management Support and Comments:
1. The kick-off meeting and brought out some items that the plant needs to consider by comparing the current operation to best practices using the SSST spreadsheet.
2. Each of the SSAT project models were evaluated and reviewed with the plant before leaving the site.
3. The Coke Plant department will need a plan on how to implement the cost savings projects outlined during the review.
4. Other energy savings opportunities exist in the process.

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