TECHNICAL NOTE #33

Energy Efficient Technologies – Flue Heat Recovery

This study focuses on the feasibility and energy efficiency benefits of using "waste" flue gas energy to heat Heavy Furnace Oil (HFO) instead of electricity generated by South Africa's coal-fired power stations.

An Energy Systems Optimisation Assessment at Algoa Brick as part of the National Cleaner Production Centre (NCPC) initiative estimated projected energy savings of 43,600 kWh/annum. The demonstration is of national significance because the opportunity to recover energy from flue gas exists at most fixed kiln plants.

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ENERGY EFFICIENCY TECHNOLOGY DEMONSTRATION

FUEL OIL HEATING THROUGH HEAT RECOVERY FROM FLUE GAS AT ALGOA BRICK.

BACKGROUND

Algoa Brick (hereinafter referred to as Algoa) is a privately owned brick manufacturer operating from a site near Swartkops, Port Elizabeth. It manufactures a range of clay bricks focussed on non-facing plaster products (NFP) which it produces from raw materials mined on site.

Algoa's Swartkops facility consists of two separate plants employing a total of approximately 150 people depending on demand. Although Algoa Brick has implemented an energy management system aimed at managing and reducing its energy costs, both of its plants are old and there is significant potential to improve their energy efficiency with judicious capital investment.

ABOUT THIS ENERGY EFFICIENCY MEASURE

The EECB facilitated a targeted Energy Systems Optimisation (ESO) Assessment at Algoa Brick as part of the National Cleaner Production Centre (NCPC) programme. The audit report put forward the idea of using "waste" flue gas energy to heat Heavy Furnace Oil (HFO) instead of electrical energy. Due to its relative size and close proximity of the exhaust stack to the electric oil heaters, Plant 2 was ideally suited to aim for an estimated energy saving of 43,600 kWh/annum. This was a significant target and as the potential to recover energy from flue gas exists at almost all fixed kiln brick plants, the EECB undertook to co-fund the installation of a heat exchanger to pre-heat HFO at Algoa Brick Plant 2.

KEY ACHIEVEMENTS

	As measured data	Filtered data (exhaust temp. raised)	Heat exchanger only estimate (exhaust temp. raised)
Implementation period	February 2016 – January 2017		
Est. annual saving	R3,331		R28,553
Est. annual energy saving	3,682 kWh	31,557 kWh	31,557 kWh
Total project cost (including M&V and report as applicable)	R196,500 (actual project cost)	R196,500 (actual project cost)	R40,000 (estimate for additional cost of heat exchanger only)
Payback period	59 years	6.9 years	1.4 years
Est. GHG reduction (t CO_2)[1]	3.6t / year	30.9t / year	30.9t / year

[1] Eskom Annual Report 2013: 1 kWh = 0.98 kg CO_2

Implementation

The baseline electrical consumption was measured via a PowerStar electrical meter installed on the supply to the existing electrical line heaters. Various other data such as flue gas temperature, oil temperature and weather data was also collected.

Installation of the heat exchanger necessitated a plant shutdown. The kiln exhaust fan and other ducting was also replaced at the same time while oil lines were installed to tie into the existing oil piping. Altogether, the installation took approximately 6 days. Following the resumption of plant operation, post-implementation monitoring of the electricity consumed by the heaters was conducted in a similar manner.

Results

The raw data shows that the heat exchanger provided a 2.2% reduction in electrical consumption by the heaters equivalent to an annual energy saving of 3,682kWh. At the current electricity tariff structure available to Algoa Brick, this calculates to an annual electricity cost saving of approximately R3 331 and a simple payback of 69 years.

Notwithstanding, a closer look at the data shows that after the heat exchanger was installed, a statistical correlation can be seen between the average daily exhaust temperature of the kiln and the electrical energy used by the heaters. In brief, the hotter the flue gas temperature, the better the heat exchanger works. For this reason, if the dataset is filtered to remove days with average exhaust temperatures lower than 117^{o}C, the filtered dataset provides an electrical energy consumption reduction at the heaters of 18.7% or 31 557 kWh per annum worth an estimated R28 553 annually. If Algoa Brick is able to maintain the kiln exhaust temperature consistently in the range of 120 – 130^{o}C, the filtered data shows that payback on the heat exchanger would be reached in <7 years in addition to the fan and ducting lasting the maximum time possible.

(The lower limit of 117 ^{o}C was chosen as ideally, Algoa Brick believes that the kiln exhaust should run consistently in the range of 120 – 130 ^{o}C. Any lower than this temperature increases the risk of combustion by-products forming acidic residue on the inside of the exhaust ducts.)

Capital / finance considerations

A payback period between 7 and 59 years is not an attractive prospect. Nevertheless, all fixed kiln brick manufacturers replace exhaust fans and ducting from time to time without consideration of payback – it is a "stay in business" necessity. In this project, if only the additional cost of the heat exchanger is considered, the payback calculation should focus on a capital amount of approximately R40 000 rather than the full project cost of R196 500. In this case, payback could range from 1.4 years to 12 years depending on the kiln exhaust temperature.

Readers interested in undertaking similar projects are encouraged to refer to the "Clay brick Sector Energy Efficiency Finance Guide" available from the EECB or the Clay Brick Association (CBA) of South Africa. The difficulty in funding many EE projects is that it is often not straightforward to predict the potential savings accurately but similar projects delivered elsewhere can provide a useful guide. In the case of this project, the best results will only be achieved if Algoa Brick is able to maintain a flue gas temperature regime in the range of 120 – 130°C.

The 12L tax incentive (refer to the "Clay brick Sector Energy Efficiency Finance Guide" for more detail) cannot be regarded as a potential source of funding as monies are returned via a reduction in tax well after the expense occurs (likely to be >1 year later). In the case of this project (assuming the flue gas temperature is maintained in the correct range), a successful 12L application would see the annual estimated saving of 31,557kWh translate into a reduction in taxable income of R29,879 (R0.95/kWh). Applying company tax of 28%, the potential benefit would be R8,394 which is unlikely to exceed the potential cost of a 12L application.

Lessons Learned

- Although the energy efficiency issue can appear simple on paper, there is often more to successful implementation than immediately meets the eye
- In order to make the most gains out of an EE project such as this one, it may be necessary to focus on other operational issues such as the regulation of flue gas temperature within a certain range
- Good project management and measurement / metering is crucial to establish the effectiveness of the intervention
- Although the initial results appeared disappointing, further drilling into the data collected showed a positive pattern and suggested the means by which the optimum results

For further information:
Energy Efficient Clay Brick Project
The Clay Brick Association of South Africa
Website: www.claybrick.org/eecb