OPTIWOOD

Improving the Performance and Efficiency of Biomass Boilers

A joint UK-France Project 2018-2020

Interreg
EUROPEAN UNION
France (Channel Manche) England
European Regional Development Fund

Case Study – Large NHS Hospital (Kent)

Optiwood Biomass Boiler Monitoring and Assessment of Site Operating Efficiencies and Recommendations

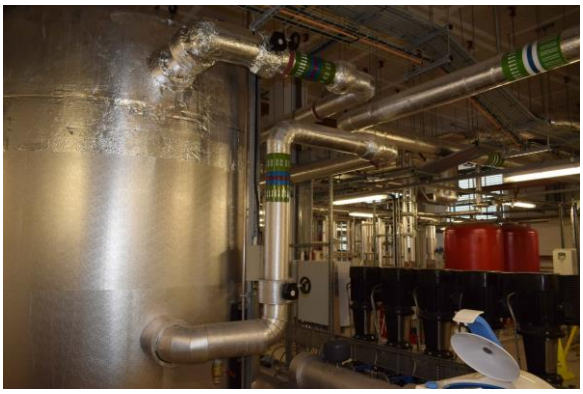
Project and data monitoring duration: Late 2018 to early 2020

Introduction

This is a 900kW Schmid underfed hearth boiler. It was installed in 2009 in an NHS Hospital to provide an estimated 10% of the heat load of the hospital. The boiler was de-rated from 1200 to 900kW and re-commissioned in 2018. It has a 10,000 litres buffer tank, is supported by three hook bin wood chip fuel silos, and is accredited under the RHI system. The boiler room also contains 3 x 2000kW gas boilers.

The boiler has had a difficult history, with significant breakdowns, a lack of attention for regular servicing and cleaning, and a series of minor problems being neglected which led to more significant problems. Prior to late 2018, the estimated efficiency was around 60-65% at best and it offered only around 7-8% of the total hospital heat load.

Schmid 900kW Boiler



10,000 litre buffer tank

Hook Bins (3 of) in Fuel Delivery Area

Data Collection and Optiwood Work:-
The biomass boiler control panel has a facility to store historical alarm data. Battery powered data loggers have been installed (see technical page at end) to measure the biomass boiler flue oxygen content, boiler flue temperature, boiler combustion under-pressure, boiler flow and return temperatures, buffer vessel storage temperatures high and low level, ambient temperature and humidity, and the flow and return water temperatures of the heating circuit to the main building. Fuel delivery data is held by SEWF. The Moisture Content (MC) accuracy of data has been improved through more frequent testing of fuel.

Main Initial Results from Data Logging
These show a good operating regime (see Figure 1 below), decent efficiency levels and appropriate temperatures in the flue which suggest good combustion. Due to the lack of an automatic cleaning system and the design using an underfed hearth rather than step grate system, the boiler system loses up to 2 days of operations each weekend when the boiler is shut-down for cleaning hearth operations (see Figure 2). The heat exchangers were being cleaned every 4 weeks in line with the hearth shut-down. One of the results of the data work under Optiwood was to increase the frequency of cleaning to every three weeks.

Initial Overall Action Points

- Improve the moisture content accuracy of fuel testing through more frequent testing - done
- Gather more frequent metering data – weekly - and refine efficiency calculations. Accessed via FM company and NHS Trust
- Increase the heat exchanger c leaning frequency from 4-weekly to 3-weekly
- Offer training session(s) for all Operator staff and Management
- Make adjustments to ash bins to stop air ingress to the boiler
- Assess whether the ‘down time’ for cleaning at week-ends can be reduced

Figure 1: Biomass Boiler Flow and Return Temperatures (12 day duration)

Figure 2: Buffer Tank Flow and Return

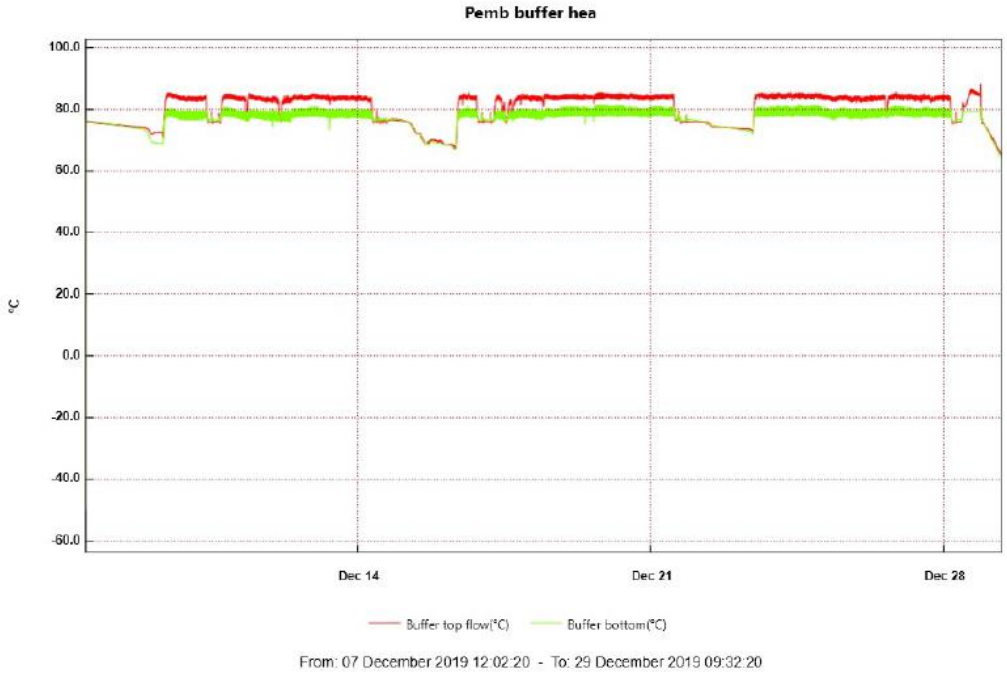


Figure 3: Biomass Exhaust Flue Temperatures (over 30 days)

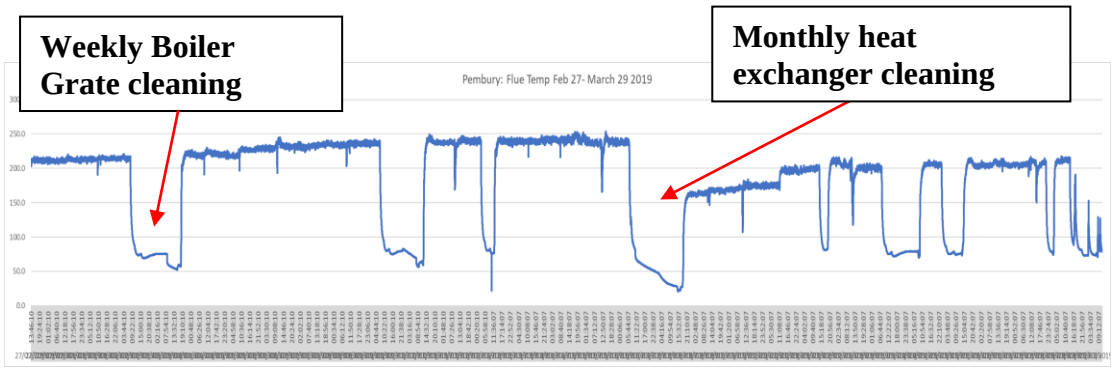
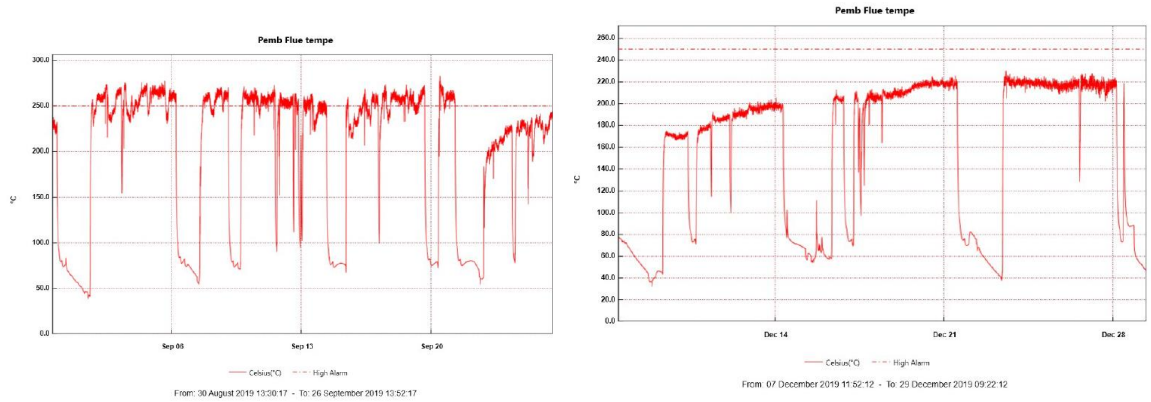
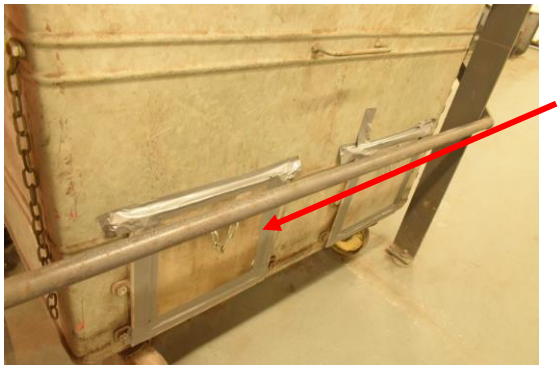


Figure 4: Increased cleaning reduces flue temperatures from 250°C to 200°C



As can be seen in Figure 4 there is a slow and steady upwards drift in the boiler exhaust flue temperatures over the month between heat exchanger cleaning. This indicates a slow deterioration in the efficiency of heat exchange between the boiler tubes and water jacket surrounding it. In summary an increasing amount of energy from the wood fuel is ending up as wasted heat via the exhaust flue.

With the increased frequency of cleaning to every 3 weeks, the flue temperatures remain below 200^{o}C (see Figure 3), hence keeping energy losses lower. An estimated 2-3% efficiency improvement has been obtained.



Ash bin air leakage. Due to bad design, the ash bin access gates at the base of the bins are buckled and allow air to be sucked in to the main boiler combustion area. This will cause turbulence, and a mixing of air temperatures leading to inefficiencies of controls. A simple fix ensuring a good seal was being installed in late February 2020. It will likely lead to a further 2-3% efficiency improvement.

Overall Boiler System Efficiency
Prior to October 2018 – estimated 60-65%
March–October 2019 - c.72% +/-5% (after improved servicing regime, enhanced cleaning)
December 2019-January 2020 – 75% +/-3% (increased frequency of cleaning)
Target efficiency (March 2020) – 78% +/-3% (once ash bin work completed)

Operator Training Session 17th July 2019 – Hospital. SEWF and Boiler Servicing Staff run training for FM Operators + Management

Recognising the importance of Operators in achieving good boiler performance, this was a hands-on training session around the boiler system, allowing Operators to understand the importance of regular maintenance and servicing. Optiwood results were shared with staff. The main service engineer from Eco-Fuels led the first part of the training session.

SUMMARY

- **Since late 2018 the boiler efficiency has improved by around 15% to c.75% with a further 3% improvement predicted once all Optiwood proposals are adopted**
- **The Optiwood data logging output has shown a well performing boiler with few residual issues**
- **Despite having a basic design for a boiler this size, and greater down time for cleaning than more modern boilers, the boiler now has few outages and is achieving its 10-12% heat contribution target for the hospital as well as delivering significant RHI income to the NHS Trust**
- **The knowledge and input from the Operators has improved and regular dialogue between this team and the servicing team has significantly reduced any boiler down time or costly repairs**

TECHNICAL DATA OUTPUT- OPTIWOOD MONITORING PROGRAMME

Battery powered data loggers have been installed to measure the biomass boiler flue oxygen content, boiler flue temperature, boiler combustion under-pressure, boiler flow and return temperatures, buffer vessel storage temperatures high and low level, ambient temperature and humidity, and the flow and return water temperatures of the heating circuit to the main building. This is summarised in the Figure shown below.

The purpose of the data logging and related equipment is to assess how well the boiler system is operating in terms of combustion efficiency, day to day operation, overall efficiency and the temperatures sent out into the downstream heating network.