Renovation of Boiler Flue Gas Heat Recovery and Solar Hot Water System

Shanghai Chest Hospital, China Building Technique Group, China Academy of Building Research

GGHH Agenda Goals: Energy

Hospital Goals

- Build a boiler flue gas heat recovery system and solar hot water system, to heat water with the waste heat of flue gas and solar energy.
- Reduce energy consumption and improve energy efficiency.

Progress Achieved

- Boiler flue gas heat recovery system achieved energy savings of 6.1%-7.3% and the efficiency of boiler was enhanced greatly.
- With the use of solar hot water system, the total replacement rate of fuel heating has reached 31.67%. Annual energy saving is about 50 tce, and the decrease rate of heating resource cost (energy-saving rate) is 30.44%. The energy saving effect is significant.

The Issue

The hot water supply system of the hospital's second ward building has four storage heat exchangers, two of them are for the 13th-15th high floors and the others for lower floors. Cold water is supplied from the roof water tank, and the vapor is supplied centrally through the boiler room where there is one Shuangliang steam boiler (rated capacity is 6-tons/hour), and two Cochran "Wee Chieftain" six type quick-install steam boilers (rated capacity is 4.5-tons/hour). They were all fuel-fired boilers before retrofitting to be fuel gas boilers. From the purchase of diesel fuel to the vapor into the heat exchangers, the estimated energy utilization ratio and the heating cost were 13.44%-22.25% and USD $.034 - $.037 USD/MJ (0.2403-0.2675 yuan/MJ) respectively.

Sustainability Strategy Implemented

In order to reduce energy consumption and cost, and to improve energy efficiency, the hospital implemented the following two projects:

- Boiler flue gas heat recovery system: The system directs the boiler flue gas into a waste heat recovery device. Water in the exchangers is heated by absorbing the sensible heat in the exhaust gas, achieving the objective of making use of waste heat.

- Solar hot water system: A new solar heat collector was added on the roof of the second ward building. By increasing the temperature of water supplied into the heat exchange room in the basement, the heating demand was decreased, thus achieving energy savings.

Implementation process

- Boiler flue gas heat recovery system

The hospital installed an air lock valve and a branch pipe in the main gas flue pipe of the three boilers. Then a superconducting heat exchange device was installed behind the branch pipe (configure according to 10.5t boiler). The equipment was on the roof beside the boiler room. The recycled waste heat was used to circularly heat water in the nearby 6-ton heat insulating water tank. Under normal operating conditions of the boilers, the water temperature can be raised to 60-65℃. Then the water is sent into the original plate heat exchanger on the roof of outpatient building, by the water pump, to supply the building's hot water system.

Picture 1: The boiler room after transformation

Picture 2: The boiler gas flue pipe

- Solar hot water system

The solar hot water system is composed of a heat collector, hot water tank and circulating pump, as well as a measurement and control system. The collector has 142 1.8m×1.5m heat collection units. The volume of the hot water tank is 24 m^3. There are two hot water circulating pumps, one for normal use and the other as standby. Temperature measurement and electronic control valves are set on the inlet end of the hot water tank (they automatically control the inflow according to the water level), and temperature measurement and flow measurement devices are installed on the outlet. Temperature sensors are placed inside the hot water tank and heat collector respectively. The system is heating water with the collected solar energy through solar collectors. The control mode of the system is that based on the temperature sensors, when the water temperature of the heat collectors is 5℃ higher than that in the hot water storage tank, the hot water circulating pump automatically opens and then puts the water with lower temperature, in the hot water storage tank, into the heat collectors for heating, then the water of higher temperature in the collectors is sent into the storage tank for reserve.

Tracking Progress

- Boiler flue gas heat recovery system

The superconducting heat exchanger fully absorbs the sensible heat in the exhaust gas and heats the water in the exchanger. The temperature of the discharged exhaust gas falls by 110℃ from 200℃ to 90℃, which contributes to 6.7%-7.3% energy conservation, and saving 1392908×6.1%=84967m^3 fuel gas every year, saving about USD $48,000 (339,018 RMB). The expected service life of the system is 10 years, so the static income is about USD $490,000 (3.4 million RMB). The benefits are even more significant when the expected rise of gas prices are taken into account.

- Solar hot water system

After put into use, the total replacement rate of fuel heating reached 31.67%. In terms of energy savings, the heating resource cost of the central hot water system fell from 0.041533 kgce/MJ to 0.028889 kgce/MJ, saving about 50 tce each year, and the decreased rate of heating cost (energy-saving rate) was 30.44%. The annual energy conservation economic effect was about 311,000 RMB (about $45,000 USD). The energy savings are significant.

Picture 3: solar collectors on the roof

Challenges and lessons learned

Hospitals, as a special type of public building, have characteristics of complex functional layout and active crowds, lots of large-scale equipment, complex energy systems, year-round operation, a higher overall energy consumption than the general public buildings and have great potential for energy savings. Therefore, it is of great significance to strengthen the hospital energy management, improve the hospital energy efficiency and build energy-saving hospitals.

Both the renovation project of boiler flue gas heat recovery system and solar hot water system were implemented by means of contract energy management with the third-party energy service companies, which provide a very reasonable and effective way to promote hospital energy conservation management.

Demographic information

Shanghai Chest Hospital was built in 1957, which is the earliest 3-A-Class hospital specialized on the diagnosis and treatment of heart, lung, esophagus, trachea and mediastinal diseases, integrating medical treatment, teaching and research in China. The hospital is located in Xuhui

District, Shanghai, covering an area of 26,000 m^2, admits more than 300,000 emergency patients, outpatients and inpatients from the whole country each year.

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