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| Thesis Title | A Design and Construction of Heat Pipe Air Pre-Heater for Package Boiler | |
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ABSTRACT

The purpose of this study was to design and construct a heat pipe air pre-heater for package boiler with a capacity of 1 ton per hour. The operating data was obtained from a steam boiler with a steam production capacity of 0.166 ton per hour at The Pumping Tower Hotel in Chiang Mai, Thailand and used as basis in designing the heat pipe air pre-heater. The average temperature of flue gas was 231°C at a flow rate of 692.72 m³/hr. The computer program used to design the thermosyphon air pre-heater was Turbo Pascal version 7.0, and ESDU 81038. The optimum specifications for the air pre-heater was selected by comparing the heat transfer effectiveness as well as ratio of transfer energy and cost of the air pre-heater (EbyC) and finally the considered opinion of the designers. In the experiment, the condenser and the evaporator consisted of 30 steel pipes, 400 mm. in length with an OD. of 27.2 mm. The selected pipes had eight, 10 mm. height steel fins per inch along the two sections. The working fluid used in the experiment was water. The exhaust gas from the air pre-heater was 141.2°C higher than the dew point temperature of the Sulfer compound (117°C). When considering available

technology and the cost of coating the surface, the coated surface pipe was considered too expensive. Therefore, uncoated pipes were used. The results were expected to show an effectiveness of 45 percent and an EbyC of 0.62 watt per baht. However, at the conclusion of the experiment it was found that the effectiveness of air pre-heater was 58 percent. Test conditions for the air pre-heater were set according to the following criteria; flue gas inlet temperatures of 100, 120, 160, 200 and 240°C, flue gas flow rates of 300, 500 and 700 m³/hr, fresh air inlet temperatures of 30, 40, 50 and 60°C, and fresh air flow rates of 500 and 700 m³/hr. The pre-heater was found to be between 35 to 65 percent effective which closely matched the computer program's prediction. Tests, which mimicked normal working conditions of the boiler, showed that 176 kilowatts per day of waste heat could be recovered from the flue gas. It was calculated that investment costs could be recovered in about 1,000 days and the internal rate of return (IRR) was 27 percent. Pressure drop across the air pre-heater was 7 Pa and across the system as a whole was 56.28 Pa. It can be concluded that a heat pipe air pre-heater is suitable for the recovery of waste heat flue gas from package boiler working at a rate of 1 ton per hour.