GENERATION OF POWER FROM KILN WASTE HEAT: CASE STUDY OF EAST AFRICAN PORTLAND CEMENT LTD

STANLEY NGARI IRUNGU

A Thesis Submitted in Partial Fulfillment of the Requirements for the Award of the Masters Degree in Industrial Engineering and Management at Dedan Kimathi University of Technology

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2017

DECLARATION:

I declare that this research thesis is my original work and has never been presented to this institution or to any other institution for examination or for any other purpose.

Name: Stanley Ngari Irungu Sign _____ Date 24/3/2017

CERTIFICATION:

I certify that the above-mentioned student carried out the work detailed in this report under my supervision.

Name: Dr. Jean Bosco Byiringiro Sign _____ Date 31/03/17
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ABSTRACT:

East African Portland Cement limited runs an energy intensive plant in terms of both electrical and thermal energy. The average specific power consumption for EAPCC plant is 111 KWh/ton of cement with an average peak demand of 9.7 MW. The high cost of electric power at 0.14 USD/KWh results into very high cost of production that significantly lowers the company's profit margin and limits its competitive advantage. The generation of electrical power from waste heat recovery would reduce the electricity power bill through partially substituting the power procured from the national grid.

The research thesis's main objective was to determine the thermal energy in hot waste gases from the clinkering process and design steam generators for the waste heat recovery plant for conversion of thermal energy to electrical energy and evaluate its economic feasibility. The research employed gas dynamic theories and fundamentals for quantifying the waste gases vented into the environment and their parameters after which the thermodynamic knowledge was employed for determination of the heat energy content and eventually employed the energy theory in converting the computed thermal energy into potential electrical energy and utilized the obtained results in sizing and designing the boilers for the waste heat recovery plant. The research thesis required utilization of specific gas handling tools for field data collection and analysis.

The research thesis evaluated the potential that the plant has for generating electrical power from the hot waste gases vented into the atmosphere. It was found out that the plant has the net potential to generate 2.89 MWh of electrical power which reduces the company monthly electric power bill by 32.68%. The thesis recommends the installation of a steam rankine cycle for the generating plant. The research thesis designed the steam boilers for the waste heat recovery plant for conversion of thermal energy to electrical energy and selected a commercial steam turbine for the waste heat recovery power plant. Lastly, the researcher evaluated the economic feasibility of the waste heat recovery plant and established that the designed plant would have a simple payback period of 2.69 years. The design steam output from the steam boilers was at 5 bars and at a temperature of 230°C with a combined production capacity of 20.44 tonnes /hour. A commercial low parameter steam turbine (model S3-05), to suit the calculated optimum conditions of 5 bars and 230°C was selected for the waste heat recovery plant. This research work contributed to theory by employing the various industrial engineering concepts, thermodynamic as well as heat transfer to develop flow calculation sheets, energy balance tools that enabled the researcher to accurately quantify the amount of thermal energy contained in the waste gases from the kiln. This could be applied for the various units within a cement plant and across a waste heat recovery power plant.