COMBINED CYCLE FOR COLD STORAGE AND POWER GENERATION USING LOW TEMPERATURE RENEWABLE HEAT SOURCES

A DISSERTATION

submitted by

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in partial fulfilment of the requirements for the award of the degree

of

MASTER OF SCIENCE (BY RESEARCH)

SCHOOL OF ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY MANDI
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Dedicated to

My Late Grandfather

Declaration by the Research Scholar

This is to certify that the thesis entitled "**Combined Cycle for Cold Storage and Power Generation Using Low Temperature Renewable Heat Resource**", submitted by me to the Indian Institute of Technology Mandi for the award of the degree of Master of Science by Research is a bonafide record of research work carried out by me under the supervision of **Dr. P. Anil Kishan** and **Dr. Sateesh Gedupudi**. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of degree or diploma.

Mandi 175001

Date: Signature of the Research Scholar

THESIS CERTIFICATE

This is to certify that the thesis titled COMBINED CYCLE FOR COLD STORAGE AND POWER GENERATION USING LOW TEMPERATURE RENEWABLE HEAT SOURCES, submitted by Vijay Chauhan, to the Indian Institute of Technology Mandi, for the award of the degree of Master of Science (by Research), is a bonafide record of the research work done by him under my supervision. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

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Dr. P. Anil Kishan

(Supervisor)

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Abstract

Himachal Pradesh, located in north western Himalayas, is having a good annual apple production. Apple, which is the main cash fruit crop of the region, is exported to the other parts of the country. Due to short harvesting season, the problem of storage lies especially with the cull fruit used for making apple concentrate which gets over-ripened within short duration of time if left in an uncontrolled environment. The study is focused on the Kullu region, a major apple producing area in the state, which has a good geothermal potential in the form of hot water springs along the bank of river Parbati at Manikaran in Kullu.

A combined refrigeration and power cycle was proposed in order to solve the problem using its application for cold storage and power generation. The cycle is a combination of the Rankine cycle and an absorption refrigeration cycle. A binary mixture of ammonia and water is partially boiled to produce a vapour rich in ammonia. This vapour is further enriched in a rectifier and after that split into two lines. One line is expanded through a turbine. The vapour exiting the turbine in this cycle is cold enough to extract refrigeration output. The other line is sent through condenser and then throttled before sending though evaporator. By suitable selection of operational parameters for the cycle, the useful output can have a large range of refrigeration to work ratios. The proposed combined cycle is for applications with lower temperature heat sources, with the primary objective of producing both power and refrigeration. Some examples of energy sources include solar, geothermal, or industrial waste heat.

The present work deals with the usage of geothermal potential at Manikaran (Kullu) with a discharge of 7 kg/s from each bore and an average temperature of 96°C, for refrigeration (cold storage) and power generation for fruit processing. The Parbati river water flowing nearby hot water springs has a peak annual temperature of less than 9°C due to its origin from the nearby Parbati glacier and this river water is proposed for cooling the present thermodynamic system.

In order to check the performance of the combined cycle proposed, parametric analysis of the cycle was done. The parametric analysis shows the scope for optimization of the cycle. The cycle was optimized for varying ambient conditions. A better tool to analyse a system is the one which takes both thermodynamics and economics of the system into consideration. In this work, the thermoeconomic optimization of combined refrigeration and power cycle using an iterative method was presented. Study shows improvement in product cost rate.

Contents