

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

A DISSERTATION

submitted by

VIJAY CHAUHAN

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
MANDI - 175001, INDIA**

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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 through 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

Title Page	i
Declaration	iii
Certificate	iv
Acknowledgement	v
Abstract	vi
Contents	vii
Chapter-1 Background	1
1.1 Problem description	1
1.2 Solution potential	1
1.3 Geothermal energy	2
1.4 Geothermal potential at Manikaran	3
1.5 Refrigeration and power cycles	3
1.5.1 Rankine cycle	3
1.5.2 Organic Rankine cycle	4
1.5.3 Kalina cycle	5
1.5.4 Vapour absorption cycle	6
1.5.5 Combined cycles	6
1.6 Proposed cycle description	8
1.7 Ammonia – water mixture properties	10
Chapter-2 Cycle modelling and optimization methodology	12
2.1 Optimization background	12
2.2 Optimization using MATLAB	14
2.3 Cycle modelling	15
2.4 Performance criteria	25
Chapter-3 Cycle analysis	28
3.1 Parametric analysis	28
3.2 Thermodynamic optimization	29
3.3 Results and discussions	30
3.3.1 Cycle simulation and optimization validation	30
3.3.2 Parametric analysis	33
3.3.3 Optimization for fixed load	43

Chapter-4 Manikaran case study	47
4.1 Problem description	47
4.2 Optimization	48
4.3 Results and discussions	50
Chapter-5 Exergoeconomic analysis and optimization	58
5.1 Thermoeconomics	58
5.2 Stream exergy costing	59
5.3 Thermoeconomic optimization	60
5.4 Thermoeconomic optimization using iterative approach	62
5.5 Economic evaluation principles	63
5.6 Exergy analysis	64
5.7 Costing and evaluation	65
Chapter-6 Exergoeconomic optimization of combined cycle	71
6.1 Exergy costing	72
6.2 Thermoeconomic and optimization	76
6.3 Results and discussions	79
Chapter-7 Conclusion and future work	82
Nomenclature	83
References	85
Appendix	89
A.1 Ammonia – water mixture properties	89
A.2 Component cost curves	91
A.3 Refrigeration load calculation	94
A.4 Uncertainty Analysis of thermophysical properties and cost equations	97
A.5 Pilot plant cost estimation of Manikaran case study	100
Publications from Present Thesis	102
Bio data	103