The Implementation of Thermal Power Systems in Mega Kitchens for Sustainable Electricity Power Generation

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Abstract

In this paper, we discuss a unique approach to generating electricity using waste steam from mega kitchens. The need for environmentally friendly and sustainable energy solutions has increased due to rising worldwide demand and worries about climate change. The food industry presents a sometimes overlooked opportunity for renewable energy, particularly in large kitchens and huge food processing facilities that produce a lot of waste heat. In order to reduce energy consumption and greenhouse gas emissions, this thesis investigates the potential for generating power from waste steam from large kitchens. The suggested system harnesses the waste heat from stoves and cookers to generate steam, which in turn drives a turbine connected to a generator to produce power. Additionally, it has a battery storage unit to store extra energy for use at a later time, increasing dependability and efficiency. In this study, water had been heated in a boiler by a diesel stove, creating steam that drove a turbine-alternator system. This technique demonstrates a workable way to convert waste heat into useful energy, lowering dependency on non-renewable energy sources and enhancing the food industry's credibility.

Keywords: Waste Heat Recovery, Steam Power Generation, Mega Kitchens, Sustainable Energy, Electricity Generation from Waste Steam.

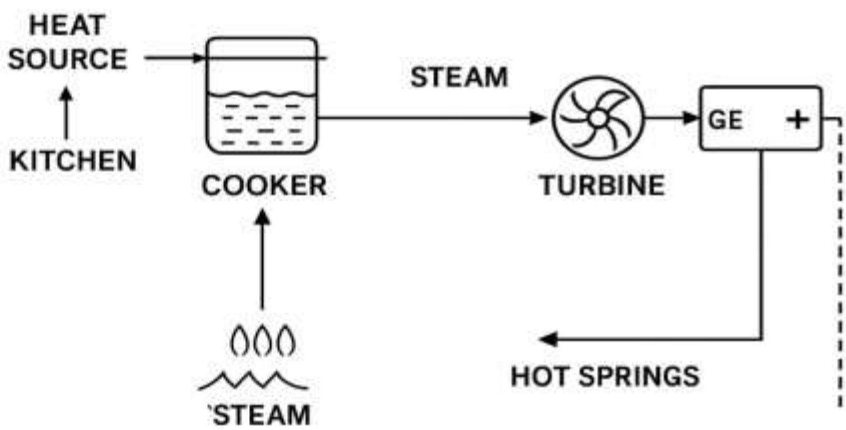
1. Introduction

Humanity's continued reliance on fossil fuel-based energy systems is a major contributing factor to the fast growing worldwide concern over climate change. The world's population is increasing, urbanization, industrialization, and other factors are driving the ongoing rise in energy demand [1]. This circumstance has compelled an urgent quest for renewable energy substitutes. Even though solar, wind, and hydropower frequently receive the majority of the public's attention, there is still a lot of unrealized potential for energy recovery and sustainability advancements in non-traditional industries like institutional food production. Mega kitchens, which are massive facilities that are usually found in hospitals, universities, military installations, places of worship, and commercial catering businesses, use extraordinary quantities of energy every day. Cooking machines like ovens, stoves, and industrial cookers are powered by this energy, and they produce a significant amount of waste heat that is frequently released into the environment. One possible way to increase operational efficiency and lessen the climatic effect of these plants is to capture this waste heat and turn it into usable energy [2].

2. Proposed System Design:

Our invention uses a giant kitchen's waste steam to create power. However, we utilize a diesel stove to boil water and create steam in a boiler tank in order to mimic this process. A turbine is then rotated by the steam that is produced. In order to produce energy, the turbine is coupled to an alternator, which is driven by the turbine's rotation [3]. The generated electricity could be stored or used directly by kitchen appliances.

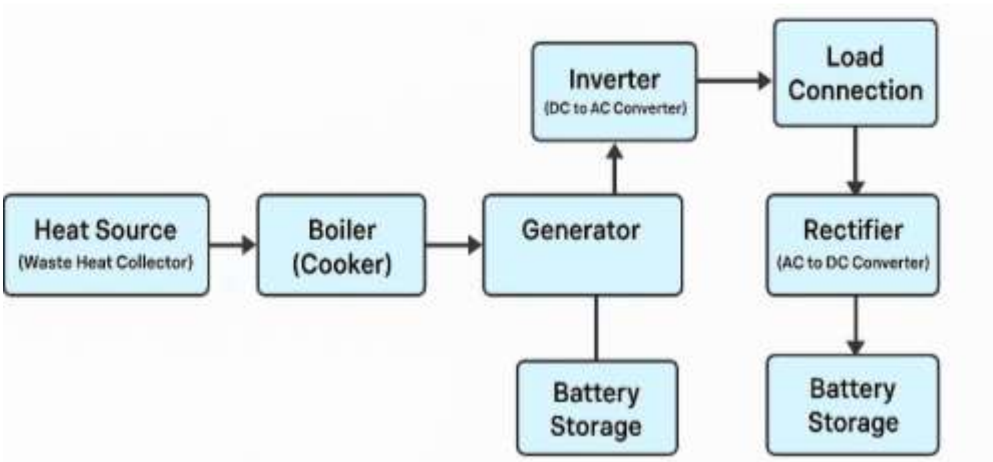
Figure 1: Layout of Thermal Power Generation System



It's block/system diagram includes:

- Heat source
- Boiler (cooker)
- Steam turbine
- Generator
- Rectifier (for battery charging)
- Battery storage
- Load connection

Figure 2: Block Diagram



System Description

Path 1: Mega Kitchen Waste Heat

- Kitchen Heat Source (Waste Heat Collector)

- Cooker/Boiler filled with water
- Steam generation
- Steam Turbine
- Generator (AC/DC)
- Battery Storage (Optional)
- Load (kitchen equipment or grid)

2.1 Key Elements for Electricity Generation from Waste Steam in Mega Kitchens

1. **Heat Source / Waste Heat Recovery System**

Description: The main source of heat is the waste steam or waste heat from cooking stoves, ovens, tandoors, boiling units, etc., in mega kitchens [4].

2. Boiler / Steam Generation Unit

Description: Captures waste heat to generate high-pressure steam.

Types:

- Traditional fuel-based boilers.
- Solar thermal steam generators (for hybrid systems).
- Electric boilers (if renewable electricity is available).

3. Steam Conditioning Components (optional, for safety & efficiency)

- Super heaters (to increase steam temperature).
- Pressure regulators.
- Moisture separators.
- Safety valves.

4. Steam Turbine

Description: Converts thermal energy (steam pressure) into mechanical rotational energy [5].

Types:

- Micro steam turbines (suited for small-scale kitchen systems).
- Key Parameters**:** Pressure range, steam flow rate, efficiency.

5. Coupling Mechanism

Description: Mechanical connection between the turbine and generator.

- Flexible couplings.
- Direct shaft connection.

6. Alternator / Generator

Description: Converts mechanical energy of a turbine into electrical energy.

Output: Typically, AC electricity.

7. **Power Conditioning Equipment**

- Rectifier: AC Input converts into DC output.
- Inverter: DC Input converts into AC output.
- Voltage regulators and stabilizers: To ensure consistent power output.

Figure 3: Hardware Design

Safety Systems

- Pressure relief valves.
- Emergency shutoff.
- Overload protection for generator.
- Fire suppression systems.

Structural and Support Components

- Piping for steam transport.
- Condensate recovery system.
- Insulation materials (to minimize heat loss).
- Mounting frames, support structures, and vibration dampeners [7].

Optional Advanced Components for Future Expansion

- Solar Concentrators: To supplement waste heat with solar steam generation.
- Biogas Units: Using organic kitchen waste for additional heat generation [8].
- Heat Recovery Steam Generators (HRSG): For maximum heat utilization.
- IOT Monitoring System: For real-time performance monitoring.

Conclusion

Using trash heat energy in mega kitchens, the suggested system could help lower greenhouse gas expulsions, energy usage, and energy expenses. This research promises to greatly assist the food industry in developing sustainable energy solutions. The outcomes of this study will offer perceptive knowledge on the feasibility and possible advantages of using thermal power systems in enormous kitchens, therefore opening the way for more development and research in this field.

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