IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

ISSN: 2581-9429 Volume 5, Issue 1, May 2025 Impact Factor: 7.67

Design and Fabrication of LPG Refrigerator

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Abstract: *This project presents the development of a refrigeration system that operates using Liquefied Petroleum Gas (LPG) as a heat source, instead of conventional electricity. The design is based on the absorption refrigeration cycle, which utilizes an ammonia-water solution to produce a cooling effect. By heating the solution with LPG, ammonia is separated and cycled through condensation and evaporation processes, effectively lowering the temperature within the cooling chamber.*

This system is especially beneficial in rural and remote areas where electricity is either unavailable or unreliable. The fabricated unit is compact, cost-effective, and environmentally friendly, making it a practical solution for preserving food and medical supplies in off-grid regions. The project demonstrates that LPG-powered refrigeration can be a sustainable and accessible alternative to traditional electric refrigerators.

Keywords: LPG refrigeration, absorption cooling, ammonia-water cycle, off-grid solution, sustainable technology, non-electric cooling

I. INTRODUCTION

Refrigeration is essential for preserving perishable goods such as food and medicine. However, in many rural and remote regions, access to a reliable electricity supply is limited or non-existent, making traditional electric refrigerators impractical. To overcome this issue, alternative cooling methods that do not rely on electricity are needed.

This project explores the design and construction of a refrigerator powered by Liquefied Petroleum Gas (LPG). The system works on the absorption refrigeration principle, using an ammonia-water solution to generate a cooling effect through heat input from burning LPG. This approach allows refrigeration without the need for electrical energy, offering a reliable solution for off-grid communities. By developing this LPG-based refrigeration system, the project aims to provide a cost-effective, portable, and environmentally friendly option for areas facing energy shortages.

II. AIM & OBJECTIVE

Aim:

To design and fabricate a compact refrigeration system that utilizes the cooling effect of LPG (Liquefied Petroleum Gas) during its expansion, offering an alternative refrigeration solution in areas with limited electricity access.

Objectives:

1. To utilize the pressure, drop of LPG through a nozzle to achieve a cooling effect.
2. To develop a simple, portable, and cost-effective refrigeration unit that operates without electricity.
3. To explore the feasibility of LPG as a refrigerant based on its thermodynamic properties.
4. To reduce energy dependency and provide cooling solutions for remote or disaster-affected regions.

III. METHODOLOGY

The approach taken for this project follows a systematic process to design and build a refrigerator that operates using LPG as the cooling medium. The methodology is divided into clearly defined steps:

1. Problem Identification

The need for refrigeration in areas with limited or no electricity prompted the idea of using LPG for cooling, taking advantage of its temperature drop during expansion.

2. Principle Selection

The project relies on the Joule-Thomson effect, where a high-pressure gas (LPG) cools down when allowed to expand through a nozzle or small orifice. This effect is used to achieve the refrigeration process without electrical energy.

3. Material and Component Selection

- LPG Cylinder: Used as the source of compressed gas.
- Pressure Regulator: To control the flow and pressure of LPG safely.
- Copper Tubing: For gas flow, chosen for its strength and thermal conductivity.
- Nozzle/Capillary Tube: Where gas expansion occurs, creating the cooling effect.
- Cooling Chamber: Made using sheet metal and thermal insulation to retain low temperatures.

4. System Design

A layout was prepared to connect the LPG cylinder to the nozzle via tubing, with the nozzle placed inside an insulated chamber. The design ensures safety, compactness, and effective cooling.

5. Fabrication

- The chamber was built using metal sheets, then lined with insulation.
- Copper pipes were bent and connected from the cylinder to the nozzle.
- All joints were sealed securely to prevent leakage.
- The nozzle was installed within the chamber to allow gas expansion inside it.

6. Safety and Leak Testing

Leak detection tests were performed using a soap solution. The system was also monitored under pressure to ensure no gas escape or equipment failure.

7. Performance Evaluation

After successful setup, the refrigerator was tested for:

- Temperature drop inside the chamber,
- Time taken to cool,
- LPG consumption rate, and
- Operational stability.

IV. IMPLEMENTATION

The implementation phase involved turning the theoretical design into a functional LPG-based refrigeration system. Each step was carefully executed to ensure safety, performance, and adherence to the intended design objectives.

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1. Assembly of Components

All selected components — including the LPG cylinder, pressure regulator, copper tubing, nozzle, and insulated chamber — were procured and inspected for quality and compatibility. The parts were assembled following the planned layout, with proper alignment and secure fittings to prevent leakage.

2. Construction of Cooling Chamber

The cooling chamber was fabricated using galvanized or mild steel sheets shaped into a box and insulated internally using polyurethane foam. This helped minimize heat exchange with the surroundings and improved the system's overall cooling efficiency.

3. Installation of Gas Flow System

Copper pipes were cut and bent to connect the LPG cylinder to the nozzle inside the chamber. The pressure regulator was attached to the cylinder to control gas flow, and the nozzle was positioned precisely to allow gas expansion within the chamber. All joints were sealed with high-temperature- resistant sealants.

4. Leak Testing and Safety Checks

A soap solution was applied to all joints and valves to detect any gas leaks. The system was tested under moderate pressure before actual operation to ensure that it was safe for use. Proper ventilation around the unit was ensured as an added safety measure.

5. Initial Operation and Performance Monitoring

After confirming the system was leak-free and safe, LPG was slowly released. The gas expanded through the nozzle inside the insulated chamber, producing a noticeable cooling effect. Thermometers were used to measure the internal temperature drop over time, verifying that the cooling process was working as expected.

6. Troubleshooting and Adjustments

Minor adjustments were made to the nozzle size and gas flow rate to optimize performance. Based on the observed data, the insulation and nozzle placement were refined to achieve better and more uniform cooling.

V. RESULTS AND DISCUSSION

Results

After successful implementation, the LPG-based refrigeration system was tested under controlled conditions. The following key results were observed:

• Cooling Performance: A temperature drop of approximately 15°C to 20°C was achieved inside the cooling chamber within 15 to 30 minutes of operation, depending on ambient temperature and gas flow rate.

• Gas Efficiency: The system consumed a minimal amount of LPG for each cycle, making it efficient for short-term refrigeration tasks like storing medicine or perishable food in remote areas.

• Response Time: The cooling effect was almost immediate after opening the valve and allowing gas to expand through the nozzle.

• Portability and Usability: The compact size and absence of electrical components made the system highly portable and simple to operate, especially in off-grid locations.

Discussion

The results confirmed the effectiveness of LPG as a non-conventional refrigerant using the Joule- Thomson effect. The system demonstrated that:

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• LPG can serve dual purposes: It acts not only as a fuel but also as a refrigerant when expanded properly.
• Energy independence: Since no electricity is required, the system is ideal for use in rural or disaster-prone areas.
• Cost-effectiveness: The setup and operational costs were relatively low compared to traditional refrigeration systems.

VI. CONCLUSION

The design and fabrication of an LPG-powered refrigerator successfully demonstrated the potential of using liquefied petroleum gas as an alternative cooling source. By utilizing the cooling effect generated during the gas expansion process, the system was able to provide a reliable refrigeration solution without relying on electricity.

The project fulfilled its primary objectives by delivering a cost-effective, portable, and energy- independent cooling system. It is particularly suitable for remote or rural areas where access to power is limited or unreliable. Additionally, the quick response time and simplicity of operation make it practical for emergency use.

While the system shows promise, it also highlights the importance of implementing robust safety measures due to the flammable nature of LPG. Future enhancements may focus on improving temperature control, increasing insulation efficiency, and integrating automated safety features.

Overall, the project illustrates a viable approach to sustainable refrigeration and opens opportunities for further research and development in non-conventional cooling technologies.

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