DESIGN AND FABRICATION OF LPG REFRIGERATION SYSTEM FOR HOUSEHOLD PURPOSES

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ABSTRACT

The object of research: The objective of this research is to design and fabricate LPG refrigeration system for household applications that operates independently of electrical power. The proposed system utilizes Liquefied Petroleum Gas (LPG) as both the refrigerant and the fuel source, enabling simultaneous refrigeration and cooking using a single LPG cylinder. The primary objective of this work is to provide an energy-efficient, portable, and environmentally friendly alternative to conventional domestic refrigerators, particularly in regions experiencing frequent power outages or limited access to electricity.

Investigated problem: Unlike traditional vapor-compression refrigeration systems, the proposed design eliminates the need for electrically driven components while reducing dependence on refrigerants with high ozone depletion and global warming potential.

The main scientific results: The main scientific results of the research is the design using stainless steel as the primary construction material, with Metal Inert Gas (MIG) welding selected as the manufacturing process due to its strength and reliability. Prior to fabrication, several product development tools, including Market Survey, Quality Function Deployment (QFD), Functional Structure Development (FSD), and Break-Even Analysis, were employed to evaluate customer requirements, optimize the product design, and assess its commercial feasibility. Computer-aided design and stress analysis were also conducted to verify the structural integrity and safety of the major components.

The area of practical use of the research: The main area for practical implementations of this research is in household purposes which can save electricity and save costs significantly. This product is an innovative technological product which combines LPG gas and refrigerator to save electricity and save costs. The scope of this innovative technological product is vastly for household purposes which can save electricity costs significantly and can be more environment friendly.

Innovative Technological Product: The developed system demonstrates the feasibility of using LPG as an eco-friendly refrigerant while offering advantages such as zero electricity consumption, reduced operating cost, improved portability, and lower environmental impact compared to conventional refrigeration systems. The proposed LPG refrigeration system represents an innovative household refrigeration technology that integrates refrigeration and cooking into a single LPG-powered unit without requiring electrical energy. The proposed design has potential applications in rural households, disaster-prone areas, off-grid communities, and camping environments where reliable electricity is unavailable. Its scope includes domestic food preservation and cooling in locations with limited or no electrical infrastructure. This work contributes to the development of sustainable household refrigeration technology with promising practical and environmental benefits.

Scope of the innovative technological product: The proposed LPG refrigeration system is intended for household food preservation and cooling applications in rural communities, remote and off-grid regions, disaster-prone areas, and camping or outdoor environments where access to electricity is limited or unavailable. The technology has the potential to improve refrigeration accessibility, reduce dependence on electrical power, and support sustainable domestic refrigeration in developing regions.

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1. Introduction

1. 1. The object of research

The main object of this research is to design and develop LPG refrigeration system which is environment friendly as well as cost effective and energy saving.

1. 2. Problem description

Refrigeration systems are a staple item in homes, restaurants, shops and pharmacies all over the world for preservation purposes. The dependence and necessity of refrigeration systems come at price of ecological impact. Domestic refrigerators consume a vast amount of refrigerants such as CFC and HFC which highly instigate the depletion of ozone layer which is contributing immensely to global warming. Thus, the LPG refrigeration systems is proposed as a solution to this dire problem and provides many more benefits opposed to the conventional refrigeration system.

1. 3. Suggested solution to the problem

With no Ozone Depletion Potential (ODP) or Global Warming Potential (GDP), LPG is more affordable and environmentally beneficial. It is utilized for cooking all around the world. In this project, LPG was used as the refrigerant in the design and analysis of a refrigerator. LPG is kept in cylinders due of its high pressure. This pressurized LPG expands and undergoes an isenthalpic phase change as it passes through the capillary tube with a small internal diameter [1]. High-pressure LPG cylinders are available. This high-pressure LPG expands and undergoes an isenthalpic phase change when it passes through a capillary tube with a small internal diameter. The temperature decreases as a result of the liquid refrigerant gaining latent heat due to the phase transition from liquid to gas. LPG can create a cooling effect in a small area in this way [2]. R134a with a capillary tube length of 4 m and a charge of 100 g or LPG with capillary tube lengths between 4.0 and 6.0 and a charge of 50 g or more satisfy the necessary freezer air temperature of −12°C, according to continuous operating and cycling results [3].

In addition to being less expensive, LPG has no potential for ozone depletion and is environmentally benign. Additionally, local refineries offer LPG as a byproduct. The current research findings show that this propane-butane mixture can be successfully used in home refrigerators as a substitute for CFCs and HFCs. It would show how the LPG refrigerator is used in refineries, hotels, and chemical companies where there is a greater need for LPG. It would also contain an experimental setup of a functional model and a thorough observation of the refrigerator [4]. Air conditioning is becoming more and more necessary every day.

There are numerous varieties of air conditioners available. A few of them are engaged in electrical labor. However, a number of places still lack a steady supply of energy, and some of them are working on refrigerants like CFC and HFC and coolants like R134a and R12, which contribute annually to extremely high ozone depletion and global warming. [5] As the world transition to Clean LPG refrigeration systems, this activity is no longer independent but in line with global efforts to mitigate climate change and phase down of harmful refrigerants regulated under the Montreal protocol [6].

The research presented by [7] looked at how the thermodynamic system using LPG as a refrigerant gas with its current R404A equivalent. The research showed that the LPG system performed throughout the whole experiment and it had a comparable cooling capacity and a lower value of a coefficient of performance (COP) with much lower values of GWP and energy consumption. Likewise, [8] LPG refrigeration system was simulated and discovered that the new system provides more efficiency with regards to energy and sustainability environments compared to the old systems.

Moreover, the report by [9] was also a validation research which tested the use of LPG as a direct replacement for R22 in refrigeration systems. Their trial evinced the efficacy of an R22 substitute – LPG, as it contributed to the reduced power consumption and was environmentally friendly. Since CO_2 offers a much higher volumetric capacity, the problem of the higher working pressure can be overcome by mixing it with a lower pressure refrigerant. LPG on the other hand has a cooling capacity of about 10% higher than R12 and the vapor pressure is appropriate [10].

While the research results are encouraging, still exist certain research parts that remain unexplored. First of all, scientific literature has come up with laboratory trials to find the thermal performance of LPG refrigeration systems but more precise and long-term assessment taking into consideration reliability, durability and overall performance attributes is required. Furthermore, research regarding safety issues is necessary to enable application of these systems in multiple areas.

The methodologies utilized by the current researches are multiple, varying from the theoretical modelling and the simulations to the experimental diagnostic and field trials. A comprehensive picture is achieved from a combination of practical and theoretical approaches which are able to comprehend how the LPG (Liquid Petroleum Gas) fridges work. This ultimately may result in optimum strategies and designs.

The literature reviewed in summary, the replacing of traditional gas fridges with LPG fridges as an option that is eco-friendly and need less energy is what is therefore highlighted. Researchers have proven that thermodynamic performance and energy-efficiency of such materials are very nice in the past research, though they still have to figure out how to make them secure and worth the effort welcoming them to the market.

2. Materials and Methods

2. 1. Market analysis

The participants were street food vendors who need a refrigeration system at low cost. The survey period was 6 months from June 2023 to December 2023 and number of participants were around 150. The participants primarily consisted of street food vendors, local household owners, and small business operators aged between 20 and 50 years, chosen because they require low-cost and reliable refrigeration systems. Informed consent was explicitly obtained from all research participants prior to their participation in the Google Form questionnaire.

The survey was conducted through a google form. Descriptive statistical methods and percentage-based frequency analysis were used to analyze the survey results.

Based on the survey feedback show in **Fig. 1**, the following statistical facts have been analyzed:

– electricity consumption is a major concern for almost 95% people;

– environmental factor is a priority for a large portion of people;

– people are not against the idea for an alternative energy source for refrigeration system;

– people seek cost efficient refrigeration systems;

– reducing electricity bills is one of the main factors for which people might consider LPG refrigerators;

– cooling performance similar to conventional refrigerators is an important criterion for customers;

– portability feature would be helpful for a large portion of customers.

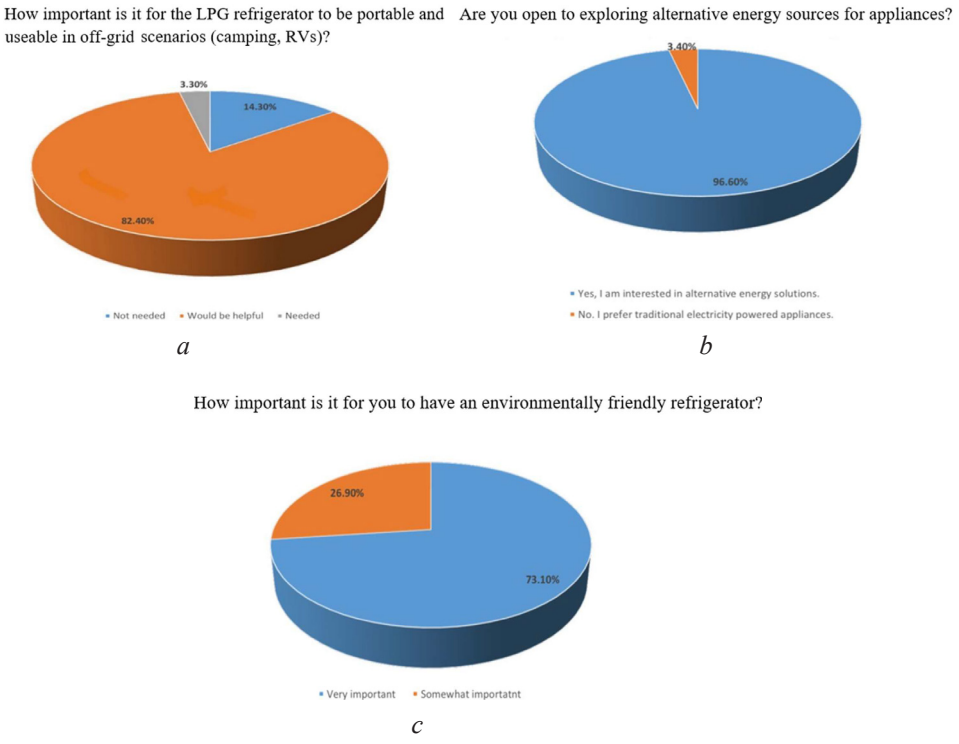


Fig. 1. Pie chart displaying responses to a few essential questions: *a* – how important is it for LPG refrigerator to be portable?; *b* – are you open to exploring alternative energy sources for appliances?; *c* – how important is it for you to have an environmentally friendly refrigerator?

2. 2. Quality function deployment

Fig. 2 shows the House of Quality for our product. Through QFD, it was successful in defining the customer requirements in terms of technical requirements. In terms of our product, the customer requirements were mainly cooling, availability, reliability, eco-friendly, affordability. From a technical point of view, certain aspects of our product such as dimension, capacity and temperature control were closely related and important to these requirements of the customers. By calculating the percentage of importance, our top priority technical requirement was found to be the cooling system and our top priority to improve is dimensioning aspect of our product. Our least priority to improve should be energy efficiency based on rankings.

3.8 House Of Quality

Project title: LPG REFRIGERATION SYSTEM
Project leader: NAFIS AHMED RAFI 20200207157
Date: 01-06-23

Correlation:

+	++	-	--
Positive	Highly Positive	Negative	Highly Negative

Relationships:

9	3	1	0
Strong(⊙)	Moderate(o)	Weak(.)	None

		Desired direction of improvement (↑,0,↓)	^	^	^	^	^					
	1: low, 5: high	Functional Requirements (How's) →							Competitive evaluation (1: low, 5: high)			
	Customer importance rating	Customer Requirements - (What's) ↓	Capacity	Dimensions	Cooling Sytem	Energy Efficiency	Temperature Control	Weighted Score	US	WALTON	SHARP	HITACHI
1	3.5	Reliability		o	0	•	•	49	3.5	3	3.5	4
2	4	Cooling	0	0	0	o	o	132	3.5	3.5	4	4
3	3	Safety	o	0	0	o	•	75	3	4	4	4
4	3.5	Availability			0	0		63	4	4.5	4.5	3.5
5	5	Eco-friendly		•	0	0	o	110	4.5	3	3	3.5
6	4	Affordability	0	o	0	0	o	132	4	3.5	3.5	3
		Technical importance score	81	90.5	207	137	45.5	561				
		Importance %	14%	16%	36%	24%	8%	98%				
		Priorities rank	**4**	**3**	**1**	**2**	**5**					
		US	76.5	85.5	202.5	135.5	42.5					
		WALTON	75	90	193.5	124.5	37					
		SHARP	79.5	96	202.5	126.5	39					
		HITCHI	75	96.5	198	118	39.5	1: very easy, 5: very difficult				
		Priority to improve	2	1	3	5	4					

Fig. 2. House of quality

3. Result and discussion

3. 1. Functional structure development (FSD):

Our product has two inputs and one output which is the cooling effect after the refrigeration process is completed. The inputs are shown on the left side of the black box and output is shown to the right and the sub inputs (if any) is shown at the bottom. Black Box diagram of our product is shown in **Fig. 3**.

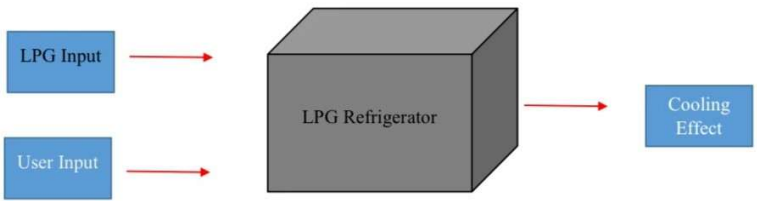


Fig. 3. Black model dox of LPG refrigeration system

Our product consists of three main functions: gas flow, pressure minimization and absorption. These main functions are accomplished by sub-functions involving specific items and thermodynamic processes as depicted in **Fig. 4.**

Fig. 5 shows the reverse engineering process for our product. Reverse engineering starts with cooling effect and ends with the components utilized to achieve it. The four segments of reverse engineering are: requirements, functions, solution concepts and embodiments.

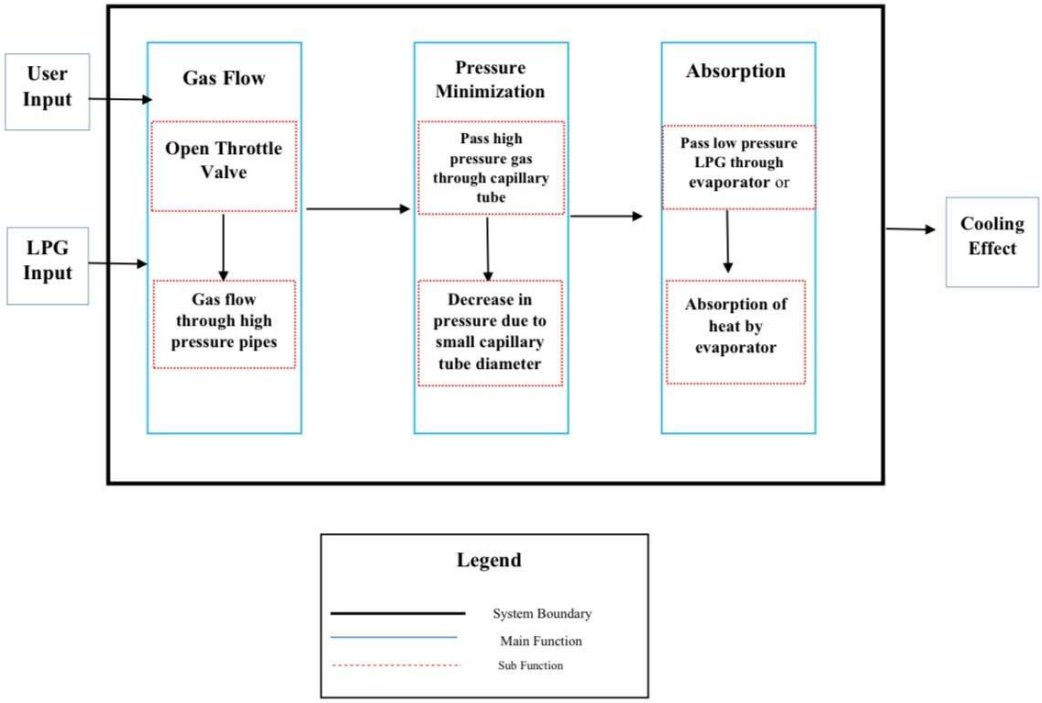


Fig. 4. Functional structure of LPG refrigeration system

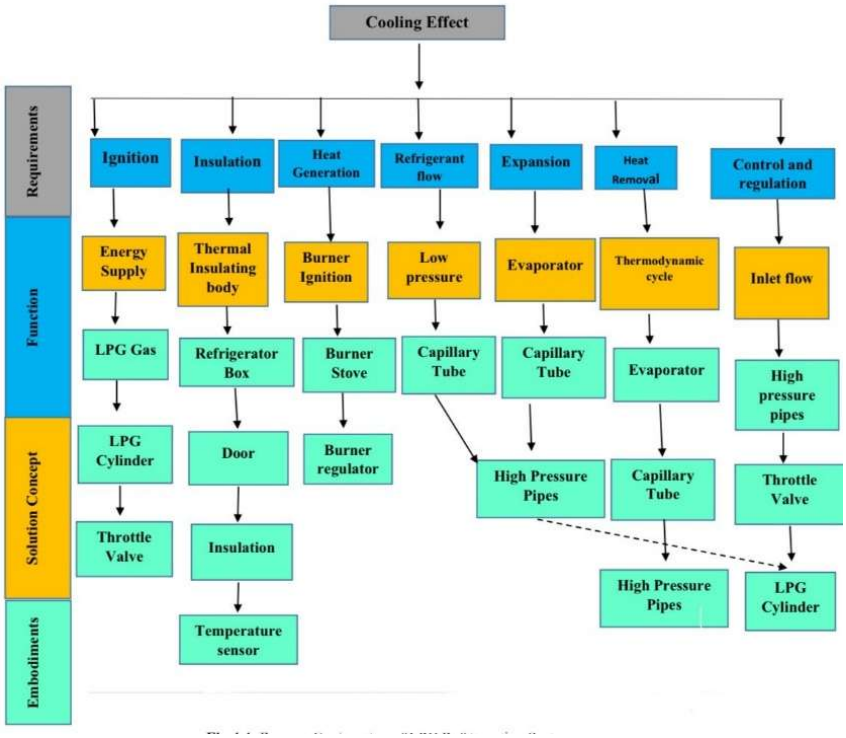


Fig. 5. Reverse engineering of LPG refrigeration system

3. 2. Proposed design

The whole design is done in Solid works. All the components of the product are shown individually in **Fig. 6** as well as different views of the assembled product. Stress analysis of certain components with risk factors is also done in Solid works which is a very crucial part of this process since it shows when a failure is likely to happen in the product.

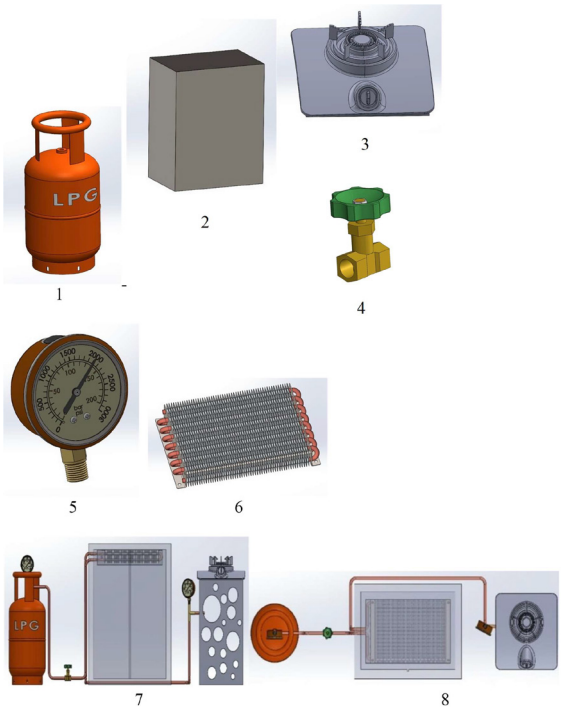


Fig. 6. Main components of the proposed product: 1 – LPG cylinder; 2 – refrigeration body; 3 – single burner; 4 – gas valve; 5 – pressure gauge; 6 – evaporator; 7 – front view; 8 – top view

3. 3. Design for environment

Our product uses LPG gas as refrigerant instead of the conventional refrigerants. LPG is much more eco-friendly than CFC and HCFC gas. It does not contribute to the degradation of ozone layer like the conventional refrigerants, thus providing a sustainable environment. The LPG gas is also recyclable in our product so there is fuel wastage minimization as well. And since our product runs completely without electricity, energy consumption is also minimized.

3. 4. Stress analysis

The stress analysis of LPG cylinder in **Fig. 7**, **8** shows that the maximum pressure it can withstand is7.965e+03 MPa. Since the LPG cylinder can be seen in the safe zone that means it is below 7.960e+ 03 MPa. And the stress analysis for burner shows that the maximum pressure it can withstand is 8.886e+04 MPa and minimum 4.318e+04 MPa. As the burner is shown to be in safe zone, the pressure is below 3.572e+04.

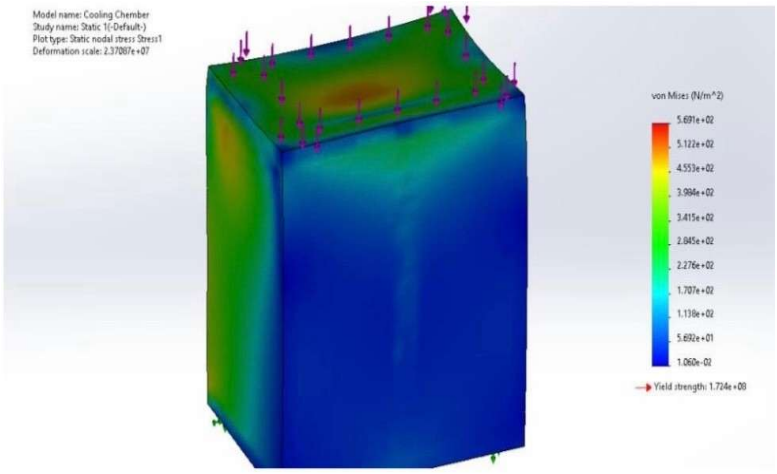


Fig. 7. Stress of burner

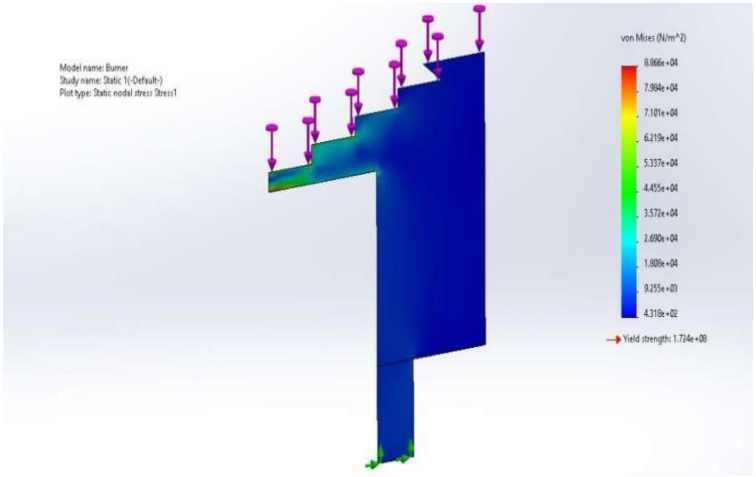


Fig. 8. Stress of refrigeration body

3. 5. Factor of safety

From the safety factor it is possible to see all the components are in safety area after exerting pressure.

From **Fig. 7–11** it is observed that the components are in blue region which indicates a safe zone for the product. From **Fig. 12**, it is observed that the break even for the product is 200 units which corresponds to a money value of around 5000000 BDT.

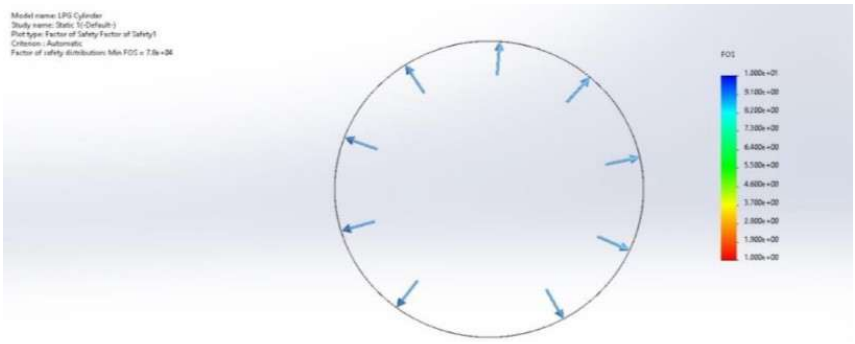


Fig. 9. Factor of safety of LPG cylinder: breaking range – 1.000e+00 to 1.900e+00; moderate range – 3.700e+00 to 9.100e+00; safe range – 9.100e+00 to 1.000e+01

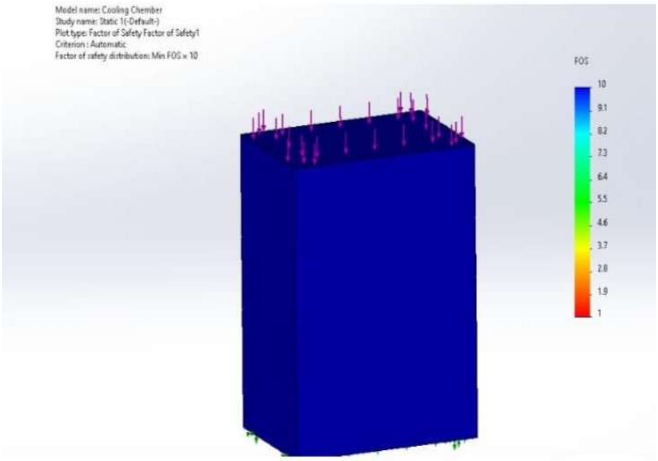


Fig. 10. Factor of safety of refrigeration body: breaking range – 1 to 1.9; moderate range – 3.7 to 9.1; safe range – 9.1 to 10

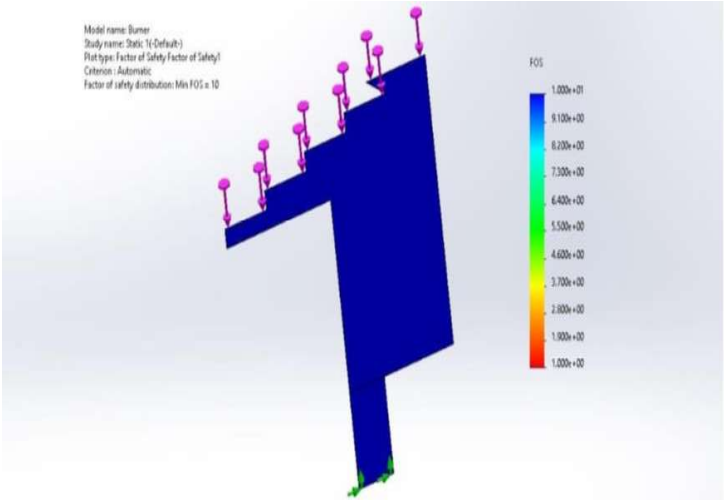


Fig. 11. Factor of safety of burner: breaking range – 1.000e+00 to 1.900e+00; moderate range – 3.700e+00 to 9.100e+00; safe range – 9.100e+00 to 1.000e+01

Unit	FC		VC	Total Cost	Revenue
0	1165300		0	1165300	0
200	1165300		3914000	5079300	5000000
400	1165300		7828000	8993300	10000000
600	1165300		11742000	12907300	15000000
800	1165300		15656000	16821300	20000000



Fig. 12. Break even analysis: break-even point in unit, BEPx = 200 units; break-even point price, BEPp = 5000000 BDT

The market analysis of the product represents that the product consumes less electricity and is more environment friendly. The FSD analysis shows that the output of the product is better cooling effect from LPG input. The QFD represents the relationships between the customer requirements and technical requirements. The main guidelines for manufacturing the product were design for environment, design for assembly etc. Finally, the product is an environment friendly product which can save electricity significantly.

Limitations and future scope of the research. The design, construction, and experimental assessment of a prototype LPG refrigeration system meant for residential use are the only focus of this work. Long-term dependability, safety, durability, and economic viability were not thoroughly examined because the performance analysis was carried out under particular operating conditions. Furthermore, the system has not been tested for extensive commercial applications or in a variety of environmental settings. Future researches should concentrate on increasing the cooling efficiency of the system, strengthening safety features, optimizing refrigerant flow and heat transfer characteristics, lowering LPG use, and carrying out long-term performance and reliability testing. To increase the viability and sustainability of LPG-based refrigeration technology, additional re-

search may look into cutting-edge materials, automated temperature management, integration with renewable energy systems, and marketing tactics.

4. Conclusion

The LPG refrigeration system is designed for safeguarding the environment and also for solving the existing power crisis problem. We aim to provide people with a refrigerator that runs on a widely available eco-friendly fuel like LPG while also utilizing the gas for secondary purposes such as cooking. We hope to legitimize our product and expand it on an industrial level in the future.

The main finding of the research is the design and fabrication of LPG refrigeration system for household purposes. The research focuses on designing and fabrication of LPG refrigeration system at low cost. The designed refrigeration system is more environment friendly and cost effective. This invention is a cutting-edge technological innovation that saves money and electricity by combining LPG gas with a refrigerator. This cutting-edge technology device has a wide range of applications in the home and has the potential to greatly reduce electricity expenses while also being more environmentally friendly.

With benefits like zero electricity use, cheaper operating costs, better portability, and less environmental effect than traditional refrigeration systems, the created system shows that employing LPG as an eco-friendly refrigerant is feasible. The suggested LPG refrigeration system is a cutting-edge home refrigeration technology that combines cooking and refrigeration into a single LPG-powered device without the need for electricity. The suggested design may find use in off-grid communities, rural families, disaster-prone places, and camping settings without dependable energy. It covers cooling and food preservation at home in places with little or no electrical infrastructure. With potential practical and environmental advantages, this work advances the development of sustainable home refrigeration technology.

Conflict of interest

The authors declare that there is no conflict of interest in relation to this paper, as well as the published research results, including the financial aspects of conducting the research, obtaining and using its results, as well as any non-financial personal relationships.

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Data availability

Data cannot be made available for reasons disclosed in the data availability statement

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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Authors' contributions

Mojahidul Islam: Conceptualization, supervision, and review of the research design; **Nafis Ahmed Rafi:** Data curation, methodology, software design, and drafting the initial manuscript; **Al Shahriyar Fardeen:** Formal analysis, investigation, and data visualization; **Resalat Nawal:** Validation, resources, and editing the final manuscript.

References

[1] Manohar, M., Sahu, P. K., Sahu, P., Singh, D., Chandra, A. (2020). Design Analysis and Performance of Low Cost Refrigeration System using LPG. International Journal of Engineering Science and Computing, 10 (5), 25633–25636. Available at: https://www.academia.edu/download/97316771/1c58ceee9a810532dab0c45ce2b82687.Design_20Analysis_20and_20Performance_20of_20Low_20Cost_20Refrigeration_20System_20using_20LPG.pdf

[2] Gavatalkar, A., Kamad, A., Chopade, N., Gajar, S. (2021). LPG refrigeration system with zero operating cost. International Research Journal of Engineering and Technology, 8 (2), 1634–1637. Available at: https://www.academia.edu/download/68829657/IRJET_V8I2270.pdf

[3] Fatouh, M., Kafafy, M. E. (2006). Experimental evaluation of a domestic refrigerator working with LPG. Applied Thermal Engineering, 26 (14-15), 1593–1603. https://doi.org/10.1016/j.applthermaleng.2005.11.026

[4] Patel, P. Y., Sathvara, V. S., Raval, S. A., Shaikh, A. G., Parikh, K. (2017). Model of LPG Refrigerator: A Literature Review. International Journal of Advanced Engineering Research and Science, 4 (1), 240–243. https://doi.org/10.22161/ijaers.4.1.39

[5] Gijare, S., Pagar, A., Kamble, S. (2018). LPG as an Unconventional Refrigerant for Refrigeration. International Journal of Engineering Research & Technology, V7 (2). https://doi.org/10.17577/ijertv7is020097

[6] Satwik, N., Kumar, B. S., Krishna, T. G., Ravinder, M., Kumar, B. K. (2016). Refrigeration System by Using LPG (Liquefied Petroleum Gas). International Journal of Mechanical Engineering and Technology, Management and Research, 3 (5,) 23–26. Available at: http://www.ijmetmr.com/olmay2016/NSatwik-BSatoshKumar-TGopalaKrishna-MRavinder-BKiranKumar-23.pdf

[7] Prajapati, S. H., Modi, J. J., Patil, N. D., Patel, J. K., Patel, G. H. (2020). LPG Refrigeration System. International Research Journal of Engineering and Technology, 7 (4), 3960–3965. Available at: https://www.irjet.net/archives/V7/i4/IRJET-V7I4760.pdf

[8] Srinivas, P., Prattipati, R., Ravi Kumar, M., Yogi Manash Reddy, N. (2014). Experimental Investigation of LPG as Refrigerant in a Domestic Refrigerator. Journal of Mechanical Engineering Research and Technology, 2 (1), 470–476. Available at: https://www.researchgate.net/publication/285633106_Experimental_investigation_of_LPG_as_refrigerant_in_a_domestic_refrigerator

[9] Oshodin, T. E., Bolaji, B. O., Olorunfemi, B. J. (2023). Mixture of Carbon-Dioxide and Liquefied Petroleum Gas as Refrigerants in Vapour Compression Refrigeration System: A Review. FUOYE Journal of Engineering and Technology, 8 (1), 89–95. https://doi.org/10.46792/fuoyejet.v8i1.945

[10] Rai, A. K., Kumar, A., Kumar, P., Ansari, A. A. (2015). Experimental Study on a Domestic Refrigerator Using LPG as a Refrigarant. International Journal of Mechanical Engineering and Technology, 6 (11), 43–49. Available at: https://iaeme.com/Home/article_id/IJMET_06_11_005