South American Publishing

SAP Multidisciplinary Open. 2025; 3:50
doi: 10.62486/mo202550

REVIEW

Factors that affect electricity consumption in refrigerators

Factores que inciden en el consumo de energía eléctrica en refrigeradores

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Cite as
Flores BO. Factors that affect electricity consumption in refrigerators. SAP Multidisciplinary Ope. 2025; 3:50. https://doi.org/10.62486/mo202550

Publication History
Submitted: 21-04-2024
Revised: 01-08-2024
Accepted: 25-12-2024
Published: 05-01-2025

ABSTRACT

Introduction: the increase in electricity demand on a global scale implies damage to the Earth's biodiversity. Several Latin American countries had a significant economic increase, which generated a greater demand for energy.
Objective: to characterize factors that influence the consumption of electric energy in refrigerators.
Method: a review of the bibliography available in databases such as SciELO, Scopus and ClinicalKey was carried out, from which a total of 10 related articles were consulted. Empirical methods such as logical history and analysis and synthesis were used.
Results: currently, the issue of energy use, especially in relation to household appliances. Refrigerators represent a significant part of electricity consumption in homes. One of the key factors that influence the energy consumption of refrigerators is ambient temperature. Overloading the refrigerator can also significantly affect its energy efficiency. The frequency of opening the door is also an important factor to consider. Preventive maintenance of a refrigerator is recommended to be performed at least once a year.
Conclusions: the critical importance of energy efficiency, the importance of education and the promotion of sustainable practices to reduce electricity consumption are highlighted.

Keywords: Electric Energy Consumption; Energy Efficiency; Household Appliances.

RESUMEN

Introducción: el incremento de la demanda eléctrica a escala global implica el daño en la biodiversidad de la Tierra, varios países de Latinoamérica tuvieron un incremento económico relevante, que generó una mayor demanda de energía
Objetivo: caracterizar factores que influyen en el consumo de la energía eléctrica en refrigeradores.
Método: se realizó una revisión de la bibliografía disponible en bases de datos como SciELO, Scopus y ClinicalKey de las cuales se consultaron un total de 10 artículos relacionados, se utilizaron métodos empíricos como el histórico lógico y de análisis y síntesis.
Resultados: en la actualidad, la cuestión del uso de energía, especialmente en relación con los electrodomésticos. Los refrigeradores representan una parte significativa del consumo de energía eléctrica en los hogares. Uno de los factores clave que influyen en el consumo de energía de los refrigeradores es la temperatura ambiente. La sobrecarga del refrigerador también puede afectar significativamente su eficiencia energética. La frecuencia de apertura de la puerta también es un factor importante a considerar. El mantenimiento preventivo de un refrigerador se recomienda realizarlo al menos una vez al año.
Conclusiones: se destaca la importancia crítica de la eficiencia energética, la importancia de la educación y la promoción de prácticas sostenibles para reducir el consumo de energía eléctrica.

Palabras clave: Consumo de Energía Eléctrica; Eficiencia Energética; Electrodomésticos.

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INTRODUCTION

Electricity is a key issue in this century. The increase in global electricity demand is damaging the Earth's biodiversity. According to various international reports on residential electricity consumption, the domestic refrigerator is the biggest electricity user in the home, as it operates non-stop. As a result, the technological advances in its design have been aimed at maximizing its energy efficiency.[1]

Several Latin American countries have experienced significant economic growth in recent decades, generating greater energy demand. This increase has been driven by various sectors, such as industry, commerce, and transport, which produce more significant energy requirements, making it difficult for them to increase energy output to meet this demand. Therefore, to meet this increase in demand for electricity, efforts have been made in most cases to improve energy efficiency. The Latin American Energy Organization (OLADE), in a study for Latin America and the Caribbean, stated that one of the most widely used devices globally and especially at the residential level, is the domestic refrigerator; this is an appliance that operates continuously throughout the year, which is why it implies a high energy consumption in household electricity bills.[1]

With the haste and determination to achieve profits alone, as economic models demand, two elements that interrelate with the economy have been neglected: society and the environment. This is why the overexploitation of resources has not been respected not only by this generation but has also not thought about or reflected on the progeny of tomorrow, generating socio-environmental conflicts, according to several authors.[2,3,4,5,6]

The geographical location of the houses conditions the demand for energy in the housing sector in Ecuador; the proportion of electricity consumption of food cooling equipment in Ecuadorian families is 23 % in the coastal region and 14 % in the Andean region. In the country, most households tend to extend the useful life of electrical appliances, leading to energy consumption; that is, operating equipment for more extended periods than designed for generates a prolonged delay in energy consumption savings.[7]

The Ministry of Energy and Non-Renewable Natural Resources (MERNNR) and the Institute of Geological and Energy Research (IIGE) show that electricity consumption per inhabitant increased by 2 % between 2018 and 2019, from 1,488 kWh per inhabitant to 1 517 kWh per inhabitant. Furthermore, it is essential to point out that in the residential sector, some initiatives of the Ministry of Electricity and Renewable Energy (MEER) have been implemented to reduce energy consumption in the homes of Ecuadorian families.[8]

Currently, energy consumption, especially in the context of household appliances, has become critical due to the continuous increase in the global demand for electricity. The environmental impact of excessive energy consumption and the search for sustainable solutions are central issues on the global agenda.

The aim is to fill a gap in understanding the factors contributing to high electricity consumption. The information obtained will be valuable for designing energy efficiency strategies and will raise community awareness of the importance of sustainable practices.

By identifying and understanding the factors contributing to high consumption, the foundations are laid for implementing energy efficiency measures that reduce the environmental footprint. The awareness generated by the research can also lead to behavioral changes in the community, thus contributing to environmental sustainability.

Given the above, this article aims to characterize factors that influence the consumption of electrical energy in refrigerators.

METHOD

The available literature was reviewed using articles retrieved from SciELO, Scopus, and ClinicalKey databases. Filters were used to select articles in English and Spanish, and empirical methods such as logical history, lysis, and synthesis were used to compile and understand the information obtained. The terms "Electricity Consumption," "Energy Efficiency," and "Household Appliances" were used as keywords in the article. A total of 10 references were selected that addressed different considerations on factors that affect the electricity consumption of refrigerators.

RESULTS

The issue of energy use, especially about household appliances, has become critically important due to the constant increase in the global electricity demand. The environmental impact associated with excessive energy consumption and the search for sustainable solutions are fundamental issues on the international agenda. It is necessary to create spaces that raise people's awareness of climate change and provide the tools needed for mitigation and adaptation, thus promoting feasible and environmentally friendly solutions in line with the landscape and urban planning of cities in the search for an improvement in people's quality of life.[9]

Electrical energy consumption in homes, mainly when using appliances such as refrigerators, is highly relevant due to its impact on total energy consumption and families' electricity bills. Several factors can influence the energy consumption of refrigerators, and understanding these factors is essential for developing effective energy efficiency strategies.[10]

The use of electrical energy in homes, especially in appliances such as refrigerators, is crucial for modern life. Refrigerators represent a significant part of electrical energy consumption in homes, as they operate continuously to keep food fresh and safe for consumption. This constant demand for energy poses challenges regarding energy efficiency and user costs.

One of the key factors influencing the energy consumption of refrigerators is the ambient temperature. At higher temperatures, refrigerators have to work harder to maintain an adequate internal temperature, which increases their energy consumption. Therefore, placing the fridge in a cool, well-ventilated place can help reduce its energy consumption.[1]

Overloading the refrigerator can also significantly affect its energy efficiency. Overfilling the refrigerator obstructs the air ducts, hindering cold air circulation and increasing energy consumption. Therefore, it is essential to avoid overloading the fridge to allow for proper circulation of cold air.[7]

In addition, door seals play a crucial role in refrigerator energy efficiency. A faulty door seal allows cold air to escape, forcing the refrigerator to work harder to maintain the proper temperature. Therefore, it is essential to regularly inspect door seals and replace them if damaged to prevent cold air loss.

The frequency of door opening is also an essential factor to consider. Opening the door frequently and leaving it open for long periods makes the refrigerator work harder to recover the internal temperature, which increases its energy consumption. Minimizing the frequency and duration of door opening is advisable to reduce the refrigerator's energy consumption.[1]

Users can significantly influence the electricity consumption of their refrigerators through more efficient use practices, such as maintaining an adequate temperature, avoiding overloading the fridge, and minimizing the time the door is left open. Furthermore, it is indicated that users believe that the refrigerator operates autonomously and directly, connected directly to the power outlet without requiring other equipment, possibly revealing a lack of knowledge about the actual operation of the appliance and how external factors, such as the location of the refrigerator, the ambient temperature and the quality of the electrical installation, can influence its energy efficiency.

Likewise, it is shown that the majority of users do not defrost their refrigerators regularly, which can lead to the accumulation of ice in the freezer and increase their electricity consumption. The frequency of cleaning varies from every week to every six months, which may indicate a lack of knowledge about the importance of regular maintenance on the refrigerator to guarantee its energy efficiency and prolong its useful life.

It is noted that there are different perceptions about refrigerator energy consumption. Some users consider that their refrigerators have moderate consumption, possibly because they are modern and more efficient models, while others believe that the refrigerator is one of the appliances that consume the most electricity, which may be an erroneous perception.

In terms of the factors that can affect the electricity consumption of refrigerators, it is recognized that temperature settings and door handling can have a significant influence, mentioning that keeping the fridge at its maximum freezing capacity or setting the freezing volume to the maximum can increase energy consumption, as can leaving the refrigerator door open or setting the temperature freezing at its maximum freezing level.[10]

Several key factors affect a refrigerator's energy efficiency. The ambient temperature is fundamental since the higher the ambient temperature, the more work the refrigerator has to do to stay cold, which increases its energy consumption.

Another critical factor is overfilling the refrigerator. When overfilled, the air ducts become obstructed, making it difficult for the cold air to circulate and causing the refrigerator to consume more energy to stay cold. Likewise, a faulty door seal allows the cold air to escape, forcing the refrigerator to work harder to maintain the proper temperature.

The frequency with which the door is opened also affects energy efficiency. Opening the door frequently and leaving it open for long periods makes the refrigerator work harder to recover the internal temperature, thus increasing energy consumption.[10]

Finally, proper maintenance is crucial. A poorly maintained refrigerator with dirty coils or a faulty compressor will consume more energy. Therefore, cleaning the fridge regularly and maintaining it properly is essential to ensure its energy efficiency.

It is essential to regularly check the temperature of the refrigerator and freezer with a specific thermometer, keeping the refrigerator between 2-4°C and the freezer at approximately -18°C. It is also necessary to regularly inspect the door seals to ensure they are in good condition and seal properly, replacing them if damaged to prevent the loss of cold air.

To maintain good air circulation and prevent the compressor from overheating, the condenser coils at the back or underneath the refrigerator should be cleaned. It is also essential to ensure that the refrigerator is level so that the door closes properly and there are no cold air leaks, as well as to avoid obstructing the ventilation ducts.[7]

Finally, it is recommended that a professional technician periodically check a refrigerator to detect and solve potential problems before they become major failures.

Preventive refrigerator maintenance is recommended at least once a year to ensure optimal performance and prevent future problems. However, suppose the refrigerator shows signs of deterioration or issues, such as lack of cooling, strange noises, or water leaks. In that case, it is advisable to perform corrective maintenance immediately to avoid further damage. In these cases, the frequency of corrective maintenance will depend on the severity of the problem and the manufacturer's recommendations.

Modern refrigerators have several features that help improve their energy efficiency. These include inverter compressors, which adjust their speed according to cooling demand, energy-efficient LED lighting, improved insulation to reduce cold loss, precise temperature control systems, energy-saving features such as eco or vacation modes, and open-door sensors that prevent unnecessary cold loss. These features make modern refrigerators more energy-efficient than older models, which can result in significant long-term energy savings.[1]

To reduce the energy consumption of refrigerators, it is essential to follow these practical tips:

- Place the refrigerator in a cool, well-ventilated place, away from heat sources.
- Set the thermostat to the recommended temperature (between 2-4°C for the refrigerator and -18°C for the freezer).
- Avoid overloading the refrigerator to allow for proper circulation of cold air.
- Regularly clean the condenser coils, ventilation grilles, and door seals.
- Inspect door seals regularly and replace them if damaged.
- Defrost the refrigerator regularly if it is not self-defrosting.
- Consider replacing old refrigerators with more energy-efficient models.
- Use energy-saving settings if available.

Yes, there are improvements in energy efficiency when certain additional elements are used in the operation of a refrigerator. For example, air circulation fans can improve cold air circulation inside the fridge, reducing the compressor's workload and improving

energy efficiency. Voltage regulators can stabilize the power supply, avoiding voltage spikes that can damage the compressor and reduce efficiency. Programmable thermostats can adjust the refrigerator temperature as needed, thus reducing energy consumption. Temperature and humidity sensors can precisely control these parameters, preventing the refrigerator from overworking. In addition, evaporative cooling systems can reduce the compressor's workload by cooling the air more efficiently. It is essential to install these elements correctly and follow the manufacturer's recommendations to ensure their effectiveness and safety.[7]

To improve the efficiency or functionality of a refrigerator, several additional elements can be connected, such as voltage regulators, to stabilize the power supply and protect the fridge from damage due to voltage fluctuations. Programmable thermostats allow for more precise and efficient temperature control. Temperature and humidity sensors automatically adjust the temperature and humidity inside the refrigerator. Air circulation fans improve cold air circulation, reducing the compressor's load. Evaporative cooling systems optimize cooling and reduce energy consumption. In addition, air filters keep the air inside the refrigerator clean and fresh.[10]

CONCLUSIONS

The critical importance of energy efficiency is emphasized, as well as the importance of education and the promotion of sustainable practices to reduce electricity consumption, thus avoiding factors that increase electricity consumption by household appliances such as refrigerators.

FINANCING

The authors did not receive any funding for the development of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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