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Defrosting In The Evaporator Of A Refrigerator Using Different Defrosting Methods

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Abstract: Refrigeration is the process of removing heat from a confined space in order to lower the temperature below that of the surrounding environment. Refrigeration is the process of cooling a surface or volume by boiling and condensing a refrigerant. In order to prevent the accumulation of the ice that could layered-up around the cooling coil defrosting mechanism is employed in refrigerators. We used four different defrosting procedures and compared them based on the amount of time it took to defrost. Among the procedures given, defrosting the ice using a dryer is the best and fastest.

1. Introduction

Jacob Perkins, an American inventor living in London at the time, built the world's first operable vapour-compression refrigeration system in 1834. His prototype gadget functioned and was the original model for modern refrigerators, but it was not commercially successful. Since then many researches have been done to introduce the new methods of refrigeration which are efficient for regular as well as commercial uses.As the temperature drops below that of the room, the air around the cooling coils condenses and crystallises, forming layers of ice. To prevent this formation, refrigerators and freezers have a defrosting mechanism, which is the act of eliminating ice build-up from the refrigerator named.

The space compact tube-fin evaporators have been widely employed in light commercial refrigeration. Silva[1] conducted an experimental investigation into the frost accretion of tube-fin evaporators while taking fan characteristics into account. Experiments were conducted, and it was discovered that the rate of frost production rises with the air flow velocity, super cooling degree, and number of the fins provided. It was also shown that fan parameters have a significant impact on evaporator thermal performance, implying that the fan-evaporator combination must be designed as a coupled system under icing conditions.

In supermarket refrigeration systems, defrosting is often controlled by a predetermined time cycle, with most display cabinets set to defrost every 6 hours. Timed defrost creates superfluous defrost cycles, reducing refrigeration system efficiency and control. Datta et al. [2] analyses the feasibility of employing artificial neural networks to simulate the amount of frost on the coil and suggests a demand defrost approach. There are two types of defrost methods: hot or cool gas defrosts and electric defrost. These defrosting methods can be utilised on both traditional, single compressor refrigeration systems and multiplex refrigeration systems, which are now frequently employed in large retail establishments.

Based on a temperature-humidity chart, Zhu et al. [3] worked on developing a new frosting map for air-source heat pumps (ASHPs). Based on the test results and the produced map, reference defrosting periods for distinct frosting zones were proposed, and they can be used in association with a traditional defrosting management approach to prevent possible mal-defrosting.

Llewelyn et al. [4] reports a significant development in defrost monitoring for ice removal in refrigerators, freezers, cold stores, and heat pump cooling coils in their study. This control operates on the basis of measuring the thermal insulation effect of the frost layer, with automated defrost on demand.

O'Neal et al. [5] evaluated previously published studies on frost generation on various geometries. They concentrated their efforts on the examination of empirical outcomes and the development of defrosting analytics. The limiting facts, as well as the correlations, were thoroughly explored, and the future scope in this subject was provided. A new innovative experimental work on the use of photoelectric technology for the defrosting has been done by Xiao et al. [6]. The goals of their work were to carry out investigate the link between the photoelectric sensor output signal and the frost height, and then to create a generalised direct correlation to forecast the frost height precisely.

Bhavna et al. [7] discussed ozone-depleting refrigerants, waste heat recovery technologies, and the creation of new supermarket refrigeration systems that utilise less refrigerant. Their research includes secondary fluid loops on both the refrigerating and condensing sides, as well as heat recovery using brine-to-air heat pumps and passive heat exchangers. This concept could serve as a link between energy consumption and demand.

We attempted to compare the time required to defrost the ice using various methods; the approach is outlined briefly in the second section, and the results are displayed in section three. Section 4 discusses the conclusions reached, followed by the references utilised in the research.

2. Methodology

Total 4 defrosting processes were used to calculate the least time taken for defrosting from all methods. The four defrosting processes that were experimentally done are electric heating defrosting process, hot gas defrosting process, off-cycle defrosting process and defrosting using blower.

2.1 Electric defrosting

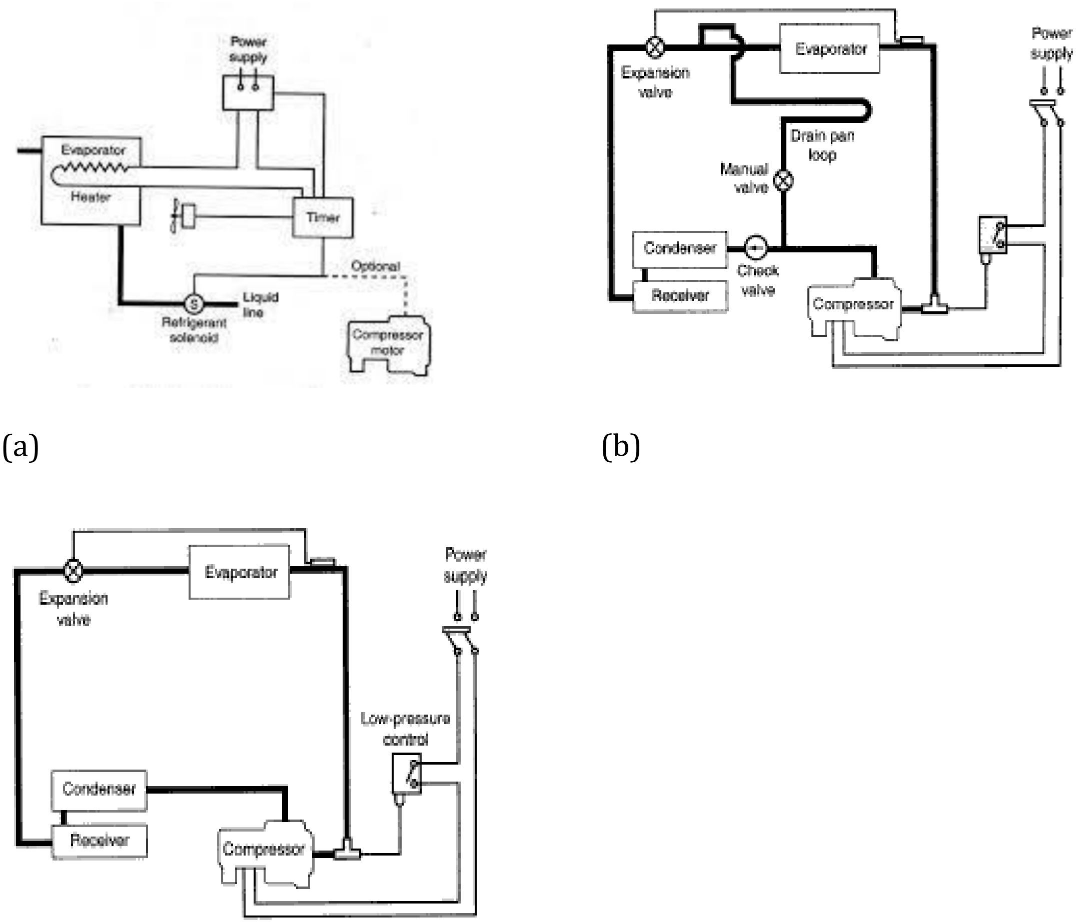
Heaters are integrated inside or around the evaporators of unit coolers. Drain pans and the drain line contain some of the resistance. This avoids refreezing and allows for proper drainage.A timer can easily be used to control the direct electric approach automatically. If required, it can be augmented with a thermostatic or pressure control. Separate limit switches are used in some electric heater systems. They are thermostats(fig. 2(a)) that, if the evaporator becomes too hot, open the circuit to the electric heaters. During the defrost stage, evaporator fans on unit coolers in freezer boxes are typically turned off. Start-up after defrost is frequently delayed until the evaporator coils reach temperatures below 32°F. Baffles in some unit coolers are closed to prevent heat from entering the chilled space.

2.2 Hot gas defrosting

The hot gas system transmits heat from the discharge gas to the evaporator metal and frost on the exterior of the evaporator (fig. 2(b)). Sensible heat is transported first, followed by latent heat. For a short time, the defrosted evaporator serves as a condenser, and the heated refrigerant turns to liquid refrigerant.

2.3 Off-Cycle Defrost

Heat in the refrigerated area itself can be utilised to defrost evaporators when storage temperatures are above freezing, particularly at 35°F. The system's low-pressure control on the condensing unit can indirectly adjust chilled area temperature. The "cut-in" setting of the low-pressure control is set to a pressure that exists (fig. 2(c))when the coil is frost-free and the produced water from the melted frost has drained away. The temperature of the refrigerated compartment is indirectly regulated by the saturation pressure of the refrigerant in the evaporator using this method. It corresponds to the evaporator's temperature.



(a) (b)

(c)

Figure 1. Layout for different process; (a) Electric defrost (automatic), (b) Hot gas defrost (manual) and (c) Pressure based defrost

2.4 Components for the defrosting process:

A regular nichrome electric heating rod with a 1kW power supply is employed, along with a 1kW 3 litre induction cooker. The heating rods are held together with screws and bolts, while the 40cm X 15cm hardwood plates are wrapped with aluminium foil. We used a 1kW blower for the blower defrosting operation. The entire experiment is carried out with a 200W Godreg refrigerator.

3.Result

The evaporator is set to defrost 100g of ice in 6 minutes 31 seconds utilising hot gas defrosting. While defrosting the ice from the heating rod took 6 minutes and 51 seconds, thawing the ice from off-cycle defrosting took 1 hour and 21 minutes. When using a dryer, the identical operation took 3 minutes and 21 seconds.

Based on this experiment, we believe that using a dryer, which takes 3 minutes and 21 seconds, is the quickest technique to defrost ice. However, it is not the most efficient technique of defrosting because it requires personnel to hold the dryer until the defrosting is complete.

Conclusion

The investigation concluded that utilising a dryer/blower to defrost 100 gm of ice takes the least amount of time. The total time was 3 minutes and 21 seconds. However, because it involves manpower, it is not the most efficient technique of defrosting. Off cycle defrosting takes the greatest time of any defrosting method, thus hot gas defrosting and electric heating rod defrosting are the most efficient. Further suggestions are made for the auto-defrost function, which ensures the best operation of the refrigerator and is an important feature to consider when selecting a refrigerator. Inverter compressors, which can change speed dependent on food load, outside temperature, and other factors, are widespread in newer models. Each brand calls it something different, but the functionality is fundamentally the same.

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