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Comparison of Capillary Net Cooling System with Other Cooling Systems

Xu Shukang

Dalton Academy, Affiliated High School of Peking University, Beijing, China

Abstract: *This article discusses capillary network cooling systems and compares them with other cooling systems such as air conditioning and fireplaces. It also focuses on introducing the cooling system as a new cooling method. Compared to previous cooling methods, it has unique advantages. This article introduces some drawbacks and challenges of capillary light cooling systems. Finally, the user's acceptance of the system was evaluated through system evaluation and Analytic Hierarchy Process. A scientific evaluation model is used to simulate the human brain and predict the difficulties people encounter when purchasing cooling systems. This, combined with company reports, helps with the screening process. This article adopts a combination of qualitative and quantitative analysis methods. In quantitative analysis, the hp model is used for evaluation. In this article, a large amount of data calculation and matrix evaluation are usually used to obtain results that avoid subjective influence as much as possible. The results of the ahp model were analysed qualitatively. Based on the data, a prediction is made about the development prospects. Finally, a unique prediction model was used to predict the future development of our fine tube network cooling system.*

Keywords: *Ahp model, Temperature control system, Social cost*

1. Introduction

Traditional refrigeration or heating systems are divided into air conditioning, heating, and fireplace. These three methods may not sound from the same era, but they belong to three different types of heating methods. Air conditioning utilizes the liquefaction and gasification of air to transfer heat to the outside, making the indoor environment cooler[1]. The fireplace generates energy through material combustion, making the air inside the room warmer. Pipeline intelligent systems and heating are designed to exchange heat between water and air, thereby increasing or decreasing indoor temperature. I will focus on introducing pipeline cooling systems[2]. Capillary pipe network refrigeration system is a newly discovered refrigeration system, that has unique advantages compared to air conditioning, Firstly, it does not cause indoor airflow, which is more friendly to sick people and pregnant women(VAN DER HOEVEN,2018). And children are also easily affected [12].

Secondly, it is more concealed than air conditioning, Air conditioning may quickly catch people's attention, but ducted cooling systems are not easily noticeable because they are located in walls[3].

These advantages are unique to pipeline refrigeration systems. This unique advantage has promoted the development of pipeline refrigeration systems[4].

1.1. Research Problem Restatement

The main model of the study focuses on whether people need a new model.

Therefore, the choice to use the AHP model can solve this problem. This is because hierarchical analysis can make a choice judgement. It helps to "choose" a cooling system based on specific data within the existing evaluation criteria.

1.2. Problem Hypothesis

In this question, I assume that people's choice of cooling system is only related to eight factors: appearance, temperature difference, minimum temperature, maximum temperature, marketing price, environmental friendliness, and noise level. The other factors that influence the choice are not included in the statistics.

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(1) Introduction to terminology

(2) Main Model Development

(3) Conditions of use Hierarchical Analysis

Using hierarchical analysis does not require securing large amounts of data, but the source of the data will determine the population to be analyzed[5]. Unstructured problems must be defined and transformed into structured problems. And decompose the hierarchical structure.

2. Literature Review

Previously, some cooling systems such as air conditioning or some heating systems such as fireplaces had obvious drawbacks. For example, air conditioning would bring obvious wind, and it would produce a large amount of carbon dioxide to pollute the environment. The newly developed cooling system is not without its drawbacks, which leads to condensation of water droplets on the walls of the pipeline system. Temperature control is required. Different cooling systems have different cooling effects, different minimum temperatures, and different cooling speeds, which greatly affect people's perceptions.

2.1. Using in Space

J. H. Strutt Introduced the application of capillary network systems in space, which allows us to observe the capillary network systems not only in architecture but also in other aspects, it can also be studied how to make the capillary network system cover a larger area in an effective space[8].

This article uses a modeling approach, and ultimately, in the next generation of communication satellites, a wide range of pipeline cooling systems will be used to eliminate the heat emitted by satellites in space.

The analysis using this system requires the use of mathematical modeling tools. For example, when some liquid flows out of a pipeline, evaporators with fine holes are used on both sides to allow the liquid to enter and saturate these porous evaporators. Ultimately, when these evaporators saturate, due to the surface tension support, their pressure is higher than the outside world, so they will evaporate faster than a simple flow rate. Although this is not the fastest way to solve the heat transfer caused by the evaporation rate. However, through this method, rapid evaporation can be achieved, limiting the liquid to a very small space, which provides opportunities for the use and development of this technology on satellites. However, correspondingly, if this system is to be applied to buildings, it is very "energy unfriendly"[8]. Because of this method, there is a significant pressure reduction when the liquid flows in a porous medium. This method will also prevent a portion of the steam flow. Therefore, a device is needed to store heat, any form of substance can enter, such as liquid or vapor, but ultimately only liquid can be separated by pressure, by doing so, the vapor in the liquid will be separated. This is a very clever way for pipeline systems.

2.2. Using in Buildings

If this technology is applied in buildings, it will greatly save the impact of pipe networks on wall thickness. This allows people to have more living space under the same building area, as the reduction in wall thickness and the use of pipes do not take up too much space. Because this can make the original water flow faster without worrying about the heat not dissipating. However, in the case of limited energy, whether this system can be applied to buildings is a significant challenge.

Diamant writes about collective heating in housing, where only one heating system is used in a community and hot water is provided by the same heating system during winter. Similar to capillary systems, central heating has different effects on each room to distribute hot water and warm the entire community. And it also greatly helps with billing. He proposed two billing methods. The first one is to use a time-based billing method, which means that at the same time, all communities pay based on their building area multiplied by their usage time. Another approach is to investigate the difference in heat between the water flowing out of the pipeline and the water entering the pipeline, to make payment judgments. Because the first type is a fixed cost, So, this has led to many people not cherishing heat[1].

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2.3. Why Need to Pay

Most of the central heating in the UK is provided by the National Coal Board, but this does not mean that they will boil water separately for heating. This is usually done by connecting the water used by the power station to the surrounding community, which greatly reduces the cost of use. However, because pipeline construction and hot water heating both require money, heating is not considered a cost borne by the public. Generators usually use very high temperatures for power generation, and warm water is cooled from the cooling tower. However, a lot of heat is lost during the cooling process. If this heat is provided to residents, it can greatly reduce the loss of this heat[1].

In Germany, the demand for heating and electricity at night is relatively low, during this period, a lot of heat is stored in the circulating water. And stored in special weak containers, these heat are turned off when there is a high demand for electricity in the morning or afternoon. And the source of heat has shifted from the factory to water produced at night[1].

Tao Pengfei and Liu Jun Introduced the cooling system in a specific office building in Xi'an, among them, the unique cooling system represents their pipeline network, which is only arranged on the ceiling and floor, not in the walls, and a mixture of traditional air conditioning and capillary pipe network is provided to achieve maximum cooling effect. And it provides a unique distribution of the pipeline network to prevent dewdrops from appearing on it. Because dewdrops cause significant damage to the wall. Just like in recent years, the environment has been rapidly greenhouse warming and warming up[9].

2.4. Specific Design

It is believed that capillary network refrigeration is a simulation method used to simulate the subcutaneous blood vessels or transportation systems of plants and humans in nature. The special design adopted in this article is to maintain both the air-conditioned area and the use of air-conditioned areas in the pipeline system for cooling in large spaces. At the end of the room, using a capillary pipe network refrigeration system ensures no blowing. It can greatly improve comfort and optimize energy use. Based on the insulation materials of the building, different types of refrigeration scheme designs are provided, and regional differences also affect the local refrigeration conditions[9].

This gave me great inspiration because it means that air conditioning and capillary networks are not two opposing properties. They can be cleverly combined to create a more complex refrigeration method, greatly improving indoor comfort and application of energy level[9].

Knowing that refrigeration systems are not singular, they are closely related to the insulation and structure of buildings. And the region where it is located also affects the refrigeration effect, in a significant way.

Introduced the use of solar energy in capillary networks in office buildings, these studies provide another source of energy besides electric fields, water energy, and groundwater, solar energy, this article also introduces the return and recycling of water in capillary network systems, which can make the system more environmentally friendly. And it can effectively reduce electricity consumption[5].

Data of the system from this article, and then some new data will be used for the research. Introduced that embedded water pipes in concrete can have a certain impact on the concrete, and different heating and cooling methods may cause concrete to crack. There is a problem with a link in the pipeline water cooling system that needs to be repaired in concrete, which is very difficult. In extremely harsh weather conditions, there is a clear relationship between the cracking of concrete and the number of pipelines.

2.5. Application of Analytic Hierarchy Process

AHP is an evaluation model developed by Thomas L.Saaty in the 1970s[2].This model is divided into three layers: the target layer, the criterion layer, and the evaluation layer. For example, if we want to study a big problem, we will first divide it into several small problems, analyze them independently, and finally give them a score, the scoring of each small question may also be determined through many questionnaires and ultimately analyzed. By scoring a few small questions, we can ultimately determine which part is important and which part is not important. For example, through analysis, We can explore two aspects: a and b. It can be concluded that people may prefer an over b. And with the evaluation layer, we can ultimately determine whether Product 1 is better or Product 2 is better, and evaluate them through many aspects of them. This is an aspect to simulate the human brain for evaluation, So it should be noted that this evaluation may not be the most "accurate". But it helps us find the most suitable one for a person

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or group of people.

As an evaluation model, word analysis can be used to evaluate which aspect of a pipeline system is considered important and which patients consider unimportant. Through social surveys and various methods, the AHP model can effectively explore which aspect of the cooling system people value more. However, the AHP model also has some drawbacks, such as strong subjectivity. Therefore, the response method needs to be mixed with survey personnel in different populations to make the exploration report more reasonable. Finally, the Analytic Hierarchy Process model is used to evaluate which cooling system is more popular. However, the problem is that it is not easy to study the specific evaluation and criterion layers involved. Therefore, a good questionnaire to get the results of people's views on new refrigeration systems

A new cooling system has emerged, but there is a lack of scientific evaluation to determine its practicality. There are still doubts about whether the capillary network cooling system meets people's needs and is effective. Further research and evaluation are needed to address this issue.

3. Hierarchical Analysis Method Establishment and Structure

Before first using it, we need to understand the three layers and sources of AHP. Firstly the objective level is derived from the problem we need to solve. Secondly, the criterion level is planned by means of a questionnaire in which the weights of the eight valid factors are given[6]. Finally, the criterion layer is derived from real quotes and data published by companies.

3.1. Criteria Level of Hierarchical Analysis

Firstly, we need to construct the assessment matrix and before building the matrix, the data needs to be processed.

In the first step, Min- max normalization was done to normalize. The scores of all the people are planned into the interval of 0 to 1, which is convenient for calculation.

In the second step, the scoring habits of different people are taken into account. For example, some people like to give high scores, while some people like to give only low scores. Therefore, we control the total score of each person's scoring to 100.

At the end of the process, the data are summed vertically to give a final score ratio. And the specific weight of each individual value for each item is calculated[7]. The figure below shows the data after processing the first two steps. Each horizontal row represents a person's scoring. And the vertical columns represent different eight weights.

```
[8 rows x 8 columns]
[[0.68268456 0.59641217 0.69058291 0.94869528 0.         1.07110792
  0.25104092 0.        ]
 [0.26466739 1.14305971 0.6151686  0.32382805 0.0174912  1.19007032
  0.53128139 0.15495707]
 [0.04727644 0.86043199 0.53210921 0.         0.86043199 0.75718015
  0.322662   0.86043199]
 [0.48417445 0.07510233 0.59422952 0.51927809 1.01990561 0.80776481
  0.         0.74006895]
 [0.         0.         0.         1.08843383 0.01808936 0.54700739
  1.30494346 1.28204971]]
```

Figure 1: Processing data after the first two steps

3.2. Noise Model

The following is one of the social cost, noise models. This model was used to assist in calculating the impact of noise. As no direct data is available for this project, more analysis is required.

It is important to understand how noise works. Noise is defined as unwanted sound or excessive sound. Sound becomes unwanted when it interferes with normal activities such as sleep, work, speech, or recreation. Ten times the ordinary logarithm of the power ratio is 1 dB. Therefore, based on the assumptions, I first introduce a distance-dependent factor, since the sound level decreases naturally as the distance between the source and the receptor increases.

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$$K1 = 10 \cdot \log\left(\frac{d0^2}{d1^2}\right) K0$$

Where k1 is the noise level of the human place. d0 is the distance from the test point to the cooling system. d1 is the distance from the test point. K0 is the noise level of the test point. This is clearly this is insufficient and if a specific impact needs to be calculated, this result needs to be integrated based on time. If the refrigeration system runs 24/7. There is no need to consider the effect of the length of time of operation on noise.

3.3. Economic Profit Growth Model

For the economic model, one is the cooling system, if there is a lower price, then it will have an advantage compared to a higher price. And for air conditioners. The space will be labelled when the air conditioner is sold. Therefore, I think the price should be calculated using the unit of yuan/sqm. For a example, '[Midea variable frequency split air conditioner MVC-J36HA/MVS-J36HA]' is 19618 yuan. So put it in 2802.57yuan/sqm.

Results

$$eigenvalue = \frac{(A \cdot w)_1}{w_1} + \frac{(A \cdot w)_2}{w_2} + \frac{(A \cdot w)_3}{w_3} + \ldots + \frac{(A \cdot w)_8}{w_8}$$

where AW is the product of the judgement matrix and the weights (real data).

$$W = \sum_{i=1}^{n} w_i \cdot x_i$$

W: Composite weight or score. This is the final value obtained by weighted average of the factors or indicators. Decide whether to use this

n: number of factors or indicators. The formula has

n factors or indicators. In this case it is 8

w_i: is the weight of the first evaluation direction (e.g. appearance is the first)

x_i: is the score of the first evaluation direction

A is the matrix w is the weights. For the existing questionnaire if the code is not wrong. Air conditioning is more recommended than capillary network cooling systems. Air conditioning is recommended 0.583. Capillary network cooling is recommended 0.189.

3.4. Suggestions and Shortcomings for Model Improvement

This AHP model is not comprehensive, which is missing the calculation of the one-time indicator (CL). Therefore it does not. It is guaranteed that the one-time ratio (CR) is small enough that the consistency of the matrix is acceptable. However, specific maximised eigenvalues have been calculated, and based on the maximised eigenvalues, it is possible to estimate that this result has some reliability[8].

4. Discussion

Even in the current situation the new cooling systems are not as good as the old ones. The results of systematic evaluation of a system of pipeline cooling systems are not as good as air conditioning and heating[9].

5. Conclusion

5.1. Systematic Conclusions vs. Systematic Evaluation

Based on the systematic evaluation. It is not recommended that people who are in dire need of a cooling system right now buy a capillary network cooling system. This is because it is slightly lower than air conditioning in overall weighting. If the user has a higher unique need in which the temperature difference fraction. Capillary network cooling system is still an option[10,11].

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5.2. Subjective Conclusions & Subjective Evaluation

In terms of subjective evaluation, according to literature review, it can be found that capillary network refrigeration systems have recently undergone significant improvements and are showing an upward trend. Therefore, I am still optimistic about the future of refrigeration systems and would like to systematically predict the future development in conjunction with predictive modelling[12].

This thesis is also intended as a guideline, as there are many factors in real life choices that are not assumed in the problem. Therefore, more situation-specific analyses are needed.

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