Design of a new cloud-based standardised container preservation system for moving vehicles

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Abstract. Since the beginning of the 20th century, advanced business enterprises have focused on strengthening logistics management as a "third source of profit". In this context, that is, since the 1950s, the beginning of container sea transport, the superiority of container transport has been recognised worldwide, and become the main form of transport in domestic and foreign trade, the containerisation of such goods transport has become an irreversible direction of development. In the domestic occupy the transport of the mainstream of the car logistics is a greater demand for containers, in particular, can self-adjust the temperature of the container to achieve fresh demand, and the emergence of cloud servers and the Internet of things for this container design provides the possibility.

Keywords: logistics management, moving containers, Internet of Things

1. Design background
Among the existing modes of transport, air transport is expensive, ship transport has a small scope of application, car transport is inefficient and slow, each mode of transport has limitations and deficiencies and does not meet the needs of contemporary development, so we put forward the concept of "centralised high speed rail transport of goods" in response to the above situation, however, due to the passenger carriages, it is not possible to provide a centralised high speed rail transport. As there are no special goods trains and loading containers, loading and unloading of goods will cause serious interference with passenger flow. The task of a quality, standardised freight car container is imminent.

Figure 1. Conventional containers
Thus, a high speed rail transport with standardised containers can effectively solve all the problems of today's transport methods, facilitate the mechanisation of the workforce and increase the efficiency of combined multi-modal transport. The pathway environment, the autonomous regulation of the container's internal environment, has become a necessity for the logistics industry.

2. **Overall design**

In the process of moving container transport, a wide variety of goods need to be transported, not only to transport some room temperature goods, but also fruits and vegetables and seafood and other goods that need to be kept fresh, fruits and vegetables and perishable food such as aquatic products, due to the seasonal and regional production, the perishability of the product and the demand for annual reasons, the freshness of the product at room temperature decreases quickly, spoilage is rapid, and the loss of nutrients is serious.

Compared to about 5% of food cold chain logistics losses in developed countries, China's cold storage and preservation technology is relatively backward and inefficient, resulting in an annual turnover loss of more than 20% of fruit, vegetables, meat products and aquatic products, and an alarming loss and waste. Therefore, it is necessary to combine the standardised loading and unloading process, at the same time, the use of efficient and feasible refrigerated fresh transport to solve the problems caused by temperature changes in the transport process due to product spoilage and corruption, so as to effectively ensure the freshness of the product, food value and nutritional value, this paper designed a new type of cloud computing based on the dynamic vehicle standard container, the overall workflow is shown below.

![Workflow diagram](image)

Figure 2. Workflow diagram

3. **Performance analysis and optimisation of freshness containers**

3.1. **Refrigeration analysis of freshness containers**

3.1.1. **Boundary condition setting and parameter setting.** The internal state of the system is modelled and simulated in order to determine its insurance capacity. First of all, the interior of the freshness container is air, so the material type is set to fluid and the other parameters are default; the outer wall is aluminium-PU foam layer-aluminium, three materials in one, density 40kg/cm³, specific heat 1.38J/(kg°C), thermal conductivity experimentally measured at 0.022W/(m·K), so the material type is set to solid; the surface heat transfer coefficient of the wall is set to 1W/(m·K); the heat transfer coefficient of the wall is set to 1W/(m·K), so the material type is set to solid. (m²·K), free stream temperature is set to 313.15K according to the external temperature of 40°C. The thermal conductivity of the cooling surface is 0.022W/(m·K) and the heat flux is -1001W/m² where the heat flux is calculated...
from the parameters of the compressor used and the area of the cooling surface and is set to a constant value. 60s

3.1.2. Cooling effect. The resulting cooling curve is shown in Figure 3.

![Figure 3. Empty container cooling curve for fresh containers](image)

The calculated parameters set in FLUENT resulted in a cooling curve, concluding that when the freshness container is cooled down by an Embraco NT2192GK compressor, it takes approximately 3 hours for the empty container to cool down from 40°C to 0°C. The cooling rate is fast and meets the basic requirements of a dynamic freight container.

3.2. Insulation analysis of fresh containers

3.2.1. Boundary condition setting and parameter setting. The holding temperature is set from 0°C to 4°C, 600kg to 800kg of water as medium; the ambient temperature is set to 35°C, the internal starting temperature to 0°C, the setting time step is 60s and the number of time steps is 90. The total time step is 5400s or one and a half hours. The holding time is calculated under the above conditions.

Add the convection module Convection to select the heat transfer surface (yellow area) for the overall cabinet, as shown in the yellow area below. Set the constant convective heat transfer coefficient to 30 W/(m²·°C), as shown in figure 4.

![Figure 4. Parameter setting model](image)
3.2.2. Insulation effect. The overall temperature cloud diagram is shown in figure 5. The air has a high thermal conductivity and therefore rises in temperature quickly. After an hour and a half most of the air in the upper part has risen to 35 degrees Celsius. The water has a poor thermal conductivity, so the temperature is not evenly distributed.

![Overall temperature cloud map](image1)

**Figure 5.** Overall temperature cloud map

The maximum temperature of the 5400s is 4.1463°C. The minimum temperature is -0.037734°C, as shown in Figure 6. The lowest temperature is -0.037734 degrees Celsius, as shown in Figure 6.

![Water temperature cloud map](image2)

**Figure 6.** Water temperature cloud map

A graph of the maximum temperature change of the water, from which it is easy to see that the rate of increase of the water temperature gradually slows down with time and finally the temperature
approaches a certain value, which is obtained from the data in the table at 4920s when the maximum water temperature reaches 4.004°C. This is shown in figure 7.

Figure 7. Water temperature curve

Conclusion: In the absence of a chiller in conjunction with an outside temperature of 35°C, the maximum temperature inside the water after 1.5 hours of water at 0°C is 4.1463°C and the minimum temperature is -0.037734°C, and the water temperature rises more and more slowly, i.e. the container has an insulating time of more than 1.5 hours, so the container's insulating performance can achieve the expected results for moving freight.

3.3. Optimised design of insulated containers
The performance of the insulated containers is within the desired range, but there are still some irrational aspects of the structure and layout which have been optimised in the following areas.

1) The door width and height of the insulated container are adjusted from 600mm*1500mm to 800mm*1600mm, which is more convenient for loading and unloading of goods.

2) Adding a condensate atomisation device to atomise the condensate produced during the operation of the thermal insulation collector, eliminating the collection device and saving part of the space.

3) Adjusting the compressor unit piece to the sides of the cabinet increased the use of space inside the cabinet by 10%.

4. Collector performance testing experiments
The simulation model of the container has been analysed on a computer using finite element analysis (FEA) to determine the strength and thermal insulation properties under various operating conditions and to optimise the design accordingly, but there are some differences between the simulation model and the actual physical model.

The strength loading test of the metal container is shown in Figure 8, as shown in Figure 9, and the freshness test of the container is shown in Figure 10.
5. Conclusion
As there are certain differences between the simulation model and the actual physical model, a real container is made according to the simulation results and tested in the field, and the strength and thermal insulation of the container reach the expected target in the experiment, which is in line with the corresponding standards of the new standard container. Therefore, the system designed in this paper is not only standardised to facilitate mechanical loading and unloading, but also meets the transport conditions for various types of goods in terms of strength, cooling performance and thermal insulation performance. The container is able to achieve the goal of transporting goods in high-speed carriages, effectively compensating for the shortcomings of current transport methods.

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