Energy optimization of refrigerating containers

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INTRODUCTION

Refrigerated (reefer) containers are used for transportation and temporary storage of food and other temperature sensitive products. During the period of Roskilde Festival more than 100 food stalls prepare and serve food for hungry festival participants. To secure the hygienic standards most of the food stalls utilize refrigerated containers as large refrigerators. These containers consume large amounts of precious energy. This project aims at optimizing the energy consumption of these containers, hereby making them more environmentally friendly and sustainable. An experimental study will be conducted in collaboration with Roskilde Festival.

THEORY

Refrigerated containers for outdoor venues are usually exposed to sunlight and a reasonably warm summer air. Even though reefer containers are well isolated, a heated surface will still increase the container's power consumption.

A thermodynamically system will strive for mechanical, thermal and chemical equilibrium. The container will therefore strive to obtain equilibrium by equalizing pressure, temperature and relative humidity with its surroundings. This can be exploited by applying water to the surface, where it will evaporate and extract energy from its surroundings whereby the temperature of surface decreases, much alike what sweating does for the human body. The evaporation process can be made even more efficient by the use of a hydrophilic surface. Water on a hydrophilic surface, such as TiO_2, will cause the angle of contact to decrease, hence causing the water to spread as a thin layer instead of forming droplets.

Cooling container with irrigation system

CONCLUSION

The theoretical results shows that by applying a continuous thin layer of water to the roof of the container will cause the energy flow from the surroundings into the system, to be reduced by up to 50% and reducing the power consumption by up to 75% on a summer day. The energy flow depends on the weather conditions such as the relative humidity, temperature, wind speed and the sun irradiance. Furthermore a thin layer of water will evaporate faster than droplets and thereby increase the potential of evaporation.

Utilizing a thin layer of water to reduce the absorbed heat can be used in other applications such as for buildings and high-rises in order to combat the urban heat island phenomenon.