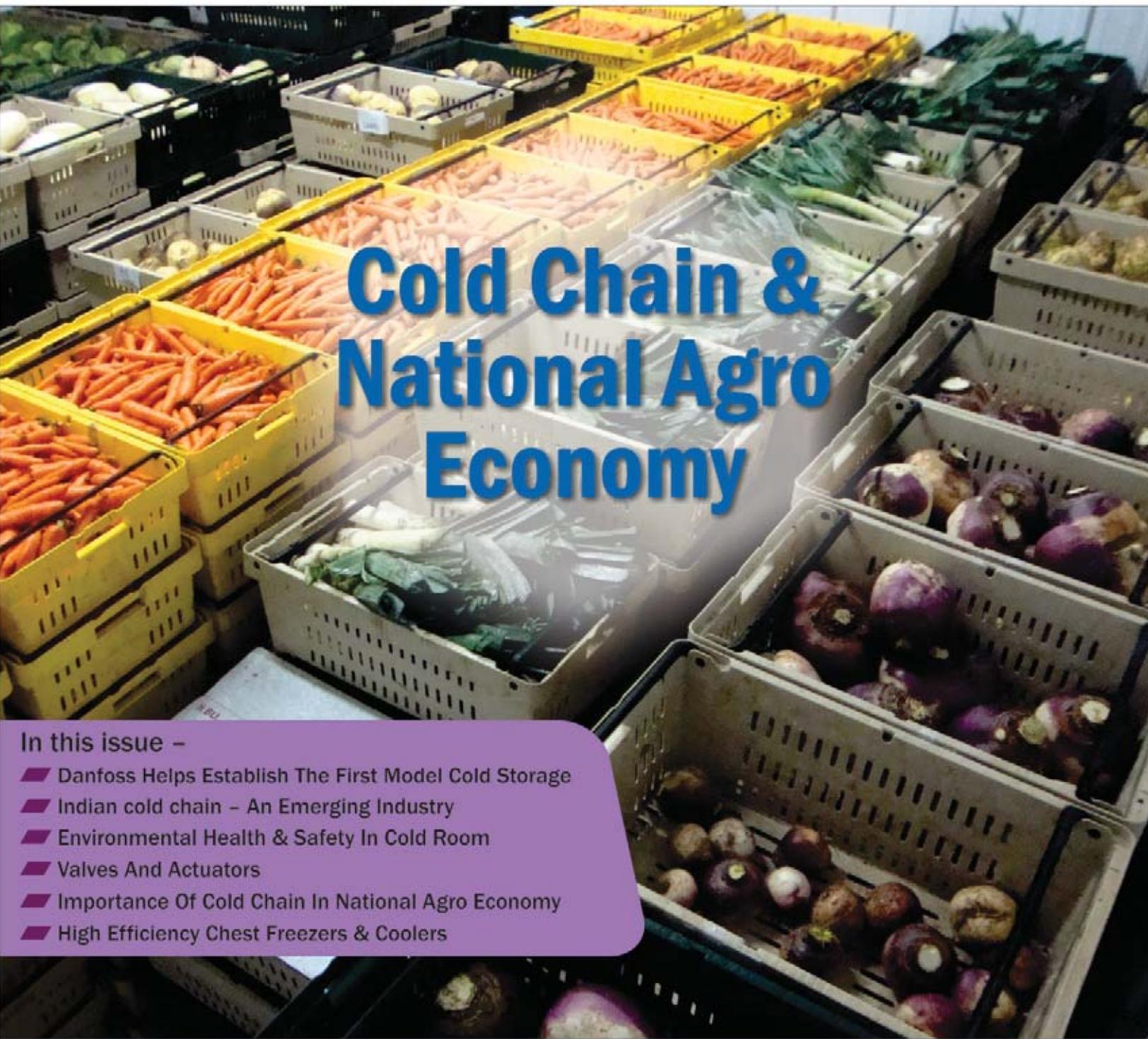


Cooling India

India's foremost Monthly dedicated to the growth of HVACR Industry



Cold Chain & National Agro Economy

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- Danfoss Helps Establish The First Model Cold Storage
- Indian cold chain – An Emerging Industry
- Environmental Health & Safety In Cold Room
- Valves And Actuators
- Importance Of Cold Chain In National Agro Economy
- High Efficiency Chest Freezers & Coolers



High Efficiency

Chest Freezers & Coolers

Experiments conducted suggest that there is at least an increase of 6 to 7% in the CoP (Coefficient of Performance) of any refrigeration system with the use of Phase Change Materials (PCM)...

World's increasing energy demand forces us to brainstorm for new and innovative methods, which allow us to save the precious earthly resources, while maintaining the performance parameters of any technology. The depleting coal resources have also given us the indication that the time is right for such endeavours. After understanding the gravity of the above-mentioned situation, an important question to ask would be "what are Phase Changing Materials (PCM)?" This question beholds a significant understanding of energy saving and appropriate energy utilization. Analogous to the battery, where a constant voltage is supplied in the absence of the electrical supply, the Phase change materials provide constant temperature application in the absence of thermal source or sink depending upon the scope of application.

A phase change material absorbs energy, stores it in the form of latent heat and utilizes wherever necessary.

They maintain constant temperature while changing their physical form i.e. from liquid to solid or vice versa (figure 2). Phase changing being a reversible process, the high energy density (figure 1) behaves as a thermal reservoir which can be used repeatedly.

"The food wastage & cold storage infrastructure relationship in India" – a report published by Emerson Climate Technologies clearly states that "India, the world's largest producer of milk and the second-



largest producer of fruits and vegetables, is also one of the biggest food wasters in the world –wasting INR 440 billion worth of fruits, vegetables and grains every year. India definitely needs a proper cold storage infrastructure. The rest part of the article will try to explain the importance of PCM in freezers, which forms an integral part of the cold storage industry.

Market Scope of PCM

Increasing demand for energy saving and innovation for green technologies is driving the scope for growth of PCM market. With the leaders of all the countries going green after the historical event of 2015

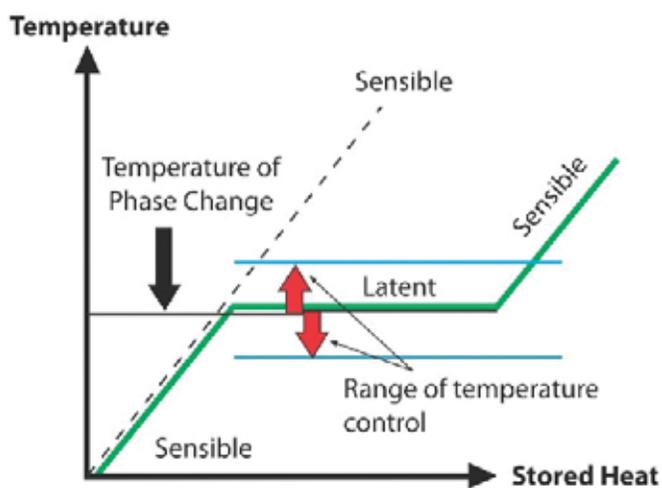


Figure 1: Sensible heat vs Latent Heat...



Figure 2: Concept of heat storage...



Figure 3: PCM based Chest freezer...

“United Nation Climate change conference, setting a maximum temperature for global warming at 1.5°C and reducing the emission to 40% by 2030. Achieving these parameters requires a need to revolutionize our current technologies.

The major application driving the PCM market is the building and construction with an annual revenue of \$415.5 Million(2015) which is then followed by commercial refrigeration with a revenue of \$286 Million(2015) with a CAGR of 36% and 30% from 2008 to 2015 respectively [Market-Global Forecast (2010-2015)].

In 2015, the commercial refrigeration constitutes for 20% of total PCM market which shows no significant improvement from 19% in 2008. Studying for such parameters increases the curiosity for exploring our interest in the commercial refrigerators, mainly in the form of deep freezers. A lot of innovation can change the way we look at the refrigeration now, like frictionless compressors, magnetically driven compressor, PCM or even the Peltier effect. Out of all, PCM is the only technology currently available and can be utilized in replacing Glycol-water mixture for higher retention time.

In the last 4 years since 2013, more than 30,000 PCM-based Chest freezers and coolers were have been launched in the market by major OEMs in the refrigeration space. Each PCM based freezer/cooler provides over 5000 hours of temperature control during the power outage annually. These numbers are only a miniscule in comparison to the total market size of chest freezers and coolers and hence the potential for this segment to grow is very large. Proper Initiatives in research & development, strategic scheduling and marketing can easily broaden the horizons for Phase change materials.

Design and Evaluation of the PCM based Deep Freezers

Experiments conducted suggest that there is at least an increase of 6 to 7% in the COP (Coefficient of performance) of any refrigeration system with the use of Phase Change Materials (PCM) [performance improvement of a domestic refrigerator by using phase change material].

The use of PCM pouches perfectly wrapped around the evaporator coils increases the evaporator temperature and hence the energy efficiency is increased. The energy stored in the PCM is utilized after the compressor cuts-off therefore maintaining a long retention time. Glycol-water mixture based deep freezers have ruled over the entire market for years. They readily give the retention period of 4-5 hours but do not maintain the precise temperature during this retention period.

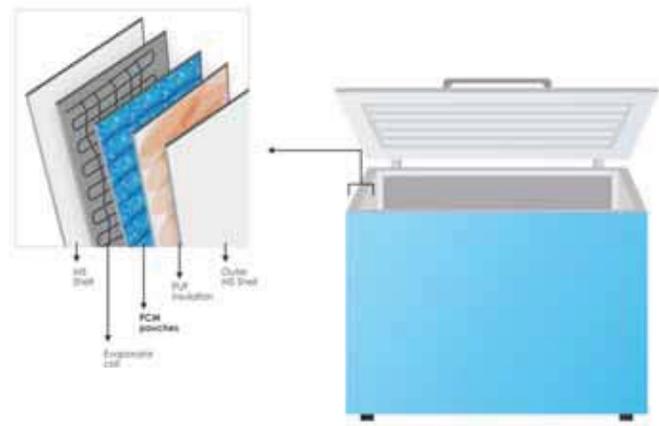


Figure 4: Pouch installation in deep freezer...

Depending on the evaporator coil temperatures and required temperature inside the chamber an appropriate phase change material is chosen. The encapsulation and integration within the freezer and cooler need to be evaluated based on the type of system and limitations in the manufacturing processes of the OEM.

Key Advantages

- Annual electricity saving of 25% or more due to longer compressor cut-off period.
- Reduces weight of 10% or more, when compare to similar Glycol-water base Deep Freezer.
- Longer retention time; suitable in longer power outages of upto 16 hours.
- Precise temperature control of $\pm 20^{\circ}\text{C}$.
- Larger shelf life, 3000 thermal stability (cycles) guaranteed, which translates to a period of 8-9 years.
- Lowers the risk of transportation – PCM encapsulated in modules.
- The yearly saving per 1100 Liter machine is around 10,000 INR with a payback period of less than 2 years.
- Considerable reduction in greenhouse effect.

Conclusion

Increasing demand for an effective and clean technology should be properly handled by taking initiatives which can cater to industries and the people using it at large. Government enterprises and the private players should together implement ideas for the development of PCM based refrigeration systems. Awareness is the key, proper knowledge session by making people literate about the technology should be included in the cold storages or refrigeration conferences/summits nationally. ■

Vishnu Sasidharan
Vice President
New product Initiatives
Pluss Advanced Technologies Pvt. Ltd.



Devakar Dhingra
Associate - Business Development
Phase change Materials
Pluss Advanced Technologies Pvt. Ltd.

