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Cutting Costs and Emissions in Reefer Container Use

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Summary

Refrigerated or reefer containers have been around since the 1970s. By 2021, there were approximately 3.5m TEUs (20-foot equivalent unit) reefer containers worldwide and this figure is expected to reach 4m TEUs in 2026. With integrated refrigeration units and climate control capabilities, reefer containers are crucial components in cold chain logistics of temperature-sensitive products such as food, flowers, and plants. Based on takeaways from the 2022 CoolTech conference in Rotterdam, this article outlines three key topics that can help F&A companies identify opportunities for cutting supply chain costs and emissions: reefer design innovations, important aspects in using reefer containers, and tracking and tracing data in reefer chains.

Demand for Radical Reefer Design Innovations

Depending on operating conditions and specifications, a reefer container manufactured in 2022 will last 10 to 20 years, so until around 2030-2040. If the reefer shipping industry is to be carbon neutral by 2040-2050, radical design changes that enable major reductions in energy consumption should already be implemented in the reefer manufacturing process in the next few years. In fact, reefer design has not significantly changed for the last 25 years. Insulation and coating show the most potential for efficiency improvement. Furthermore, switching to refrigerants with low global warming potential (GWP) is desired, yet it should be carefully calculated, as such refrigerants[1] are more flammable (causing potential safety issues) and less energy efficient compared to the high GWP counterparts.

Stakeholders in reefer logistics, including F&A companies (as shippers), container leasing companies, and ocean carriers should encourage reefer manufacturers to invest in R&D for next-generation reefer designs. This does come with challenges, because the reefer manufacturing industry is highly consolidated, with the top four companies (all based in China) holding more than 90% of the market share. This gives them dominant control over innovation and development in the industry.

F&A Companies' Can-dos With Reefer Containers

Although the influence of F&A companies on the technical development of reefer containers seems limited, there are low- and high-hanging fruits within their reach by making better use of reefer containers in cold chains. This article focuses on technical and usage aspects of reefer containers. Please see our recent publication for an outlook on reefer container rates as well as global ocean freight.

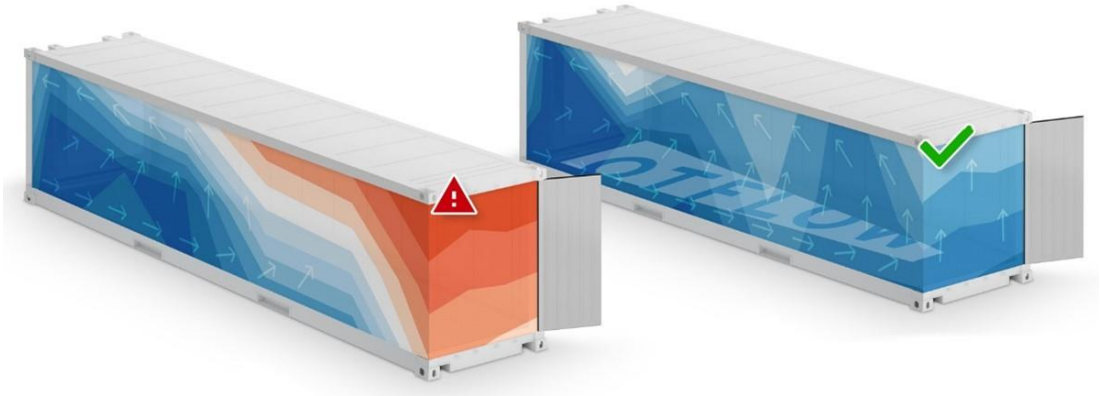
[1] Chemical substances used for refrigeration

Packaging and Stacking Matters

Different product categories pose different requirements for packaging. Taking fresh produce (e.g. fruits, vegetables) as an example, corrugated fiberboard cartons or corrugated cardboard (CFC) and reusable plastic containers (RPC) are the most frequently used packaging materials. These two materials differ in terms of weight, recyclability, biodegradability, ease of handling, mechanical strength, and moisture control. When it comes to packaging design, parameters such as the total area of vents[2] on packages, vent shapes, and vent positions determine how well cooling air can circulate around products and in the reefer container. These parameters therefore directly impact product quality and energy-saving opportunities. RPC can accommodate designs with numerous vents that may not be feasible in CFC. Nevertheless, the adoption of RPC requires a thorough planning of return logistics with regard to costs and environmental impact.

Besides packaging, the methods of stacking packages in reefer containers also have a great impact on airflow. For example, in palletized cargoes, cooling air is often not well distributed due to short circuits of airflow near the cooling unit. This creates heterogeneous (too cold or too hot) temperature zones inside reefer containers and consequently lowers product quality and shelf life (*see Figure 1*). At the CoolTech conference, Otflow presented their innovative product – a floor cover for 40ft reefer containers - which was the outcome of a collaboration with Wageningen Food & Biobased Research. It is a minimal add-on in terms of costs and operation, but can bring significant cooling energy saving, better food quality, and less food waste.

Figure 1: Otflow's floor cover for optimal airflow in 40ft reefer containers



Source: Otflow

Logistics Coordination and Reefer Cargo Monitoring

The main reasons for high temperature issues during reefer logistics processes include machinery failure (e.g. reefer unit malfunction), human failure (e.g. incorrect temperature settings, failure to plug in reefer during transfer from one party to another), and cold treatment failure (e.g. failure to cool products before loading, known as hot/warm loading). Such failures may not lead to cargo loss if detected on time. However, detecting and follow-up actions require regular coordination and communication efforts between F&A companies and logistics service providers. Using available tracking and tracing technologies, F&A companies can follow two approaches (*see Table 1*). The first approach (using offline data) is passive and low-cost, while the second approach (using real-time data) is active but may be costly. Nevertheless, a substantial reduction in food waste can be achieved even with the first approach.

[2] Vent is an opening that allows air to pass out of or into a package

Table 1: Practical approaches to reefer cargo monitoring

	How does it work?	*Examples from the conference*
Offline data approach	Temperature/humidity/shock/light loggers are packed along with the products. Analysing logger data from numerous tests (in combination with other available data) can reveal where disruptions occur in the reefer chains.	Applying this, AgroFair can determine if bananas from different origins need reefer or ambient transport. This saves costs of unnecessary reefer containers and supply chain emissions.
Real-time data approach	Live data from sensors installed in reefer containers help to detect issues immediately and allow timely actions to be taken (e.g. prioritize reefer containers with temperature issues). This requires mobile infrastructure for communication and data capture/transmit.	Hardware-based companies, such as Tive and Emerson, provide tracking devices and cloud platforms. Non-hardware companies, such as Dockflow, provide AI-enabled live reefer monitoring and alerts to reduce human effort.

Source: Rabobank 2022

Leadership To Boost Data Sharing

Throughout the conference, participants repeatedly mentioned the huge gaps in chain-wide data sharing, despite the fact that the technologies have been available for decades. One of the factors hindering data sharing is the use of tracking and tracing data in insurance claims (i.e. data to show what went wrong with the reefer cargoes). Parties in reefer chains are therefore not motivated to share such available data (if not contractually bound to do so) to protect themselves from liability. Two other major factors are technology standardization and cost sharing. Regarding standardization, we see hardware with different technologies that do not communicate with each other. Moreover, most hardware-based companies develop their own siloed cloud platforms that are not interoperable or that require interfaces for linking with each other. Regarding cost sharing, it is often the case that cost and benefit are not well distributed between upstream and downstream parties, removing the incentive for data sharing. For example, food exporters bear the costs of sensors and place them in product packages, yet receive limited benefit in return. Logistics service providers install monitoring systems to show that their services are correctly operated, yet bear the risks when problems arise. Retailers, without making any investment, seem to receive the most benefit from quality, well-maintained products.

To overcome those challenges in data sharing, the reefer logistics sector needs strong leadership from the ocean carriers. With high profits in 2020 and 2021, they have the necessary capital to invest in smart reefer containers (i.e. with the necessary standardized sensors and telematics so that no extra devices are required from shippers) and enough incentives to capture the data (to improve their operational efficiency) and sell customized data as 'data-as-a-service' to shippers. Maersk's 'Captain Peter' service, which provides live reefer visibility (temperature, humidity, O2/CO2 levels) to shippers, is an example of this vision. Furthermore, with ambitions to grow towards providing end-to-end service provision, ocean carriers are in the right position to work with maritime and hinterland ports for investment in interoperable communication infrastructures.

Conclusion

Reefer containers are not just giant metal boxes that demand no attention. Packaging and stacking in reefer logistics are examples of complex but important aspects that contribute to reduction of costs, emissions, and food waste. Experimental research (e.g. in collaboration with contract-research institutes) should be conducted to identify the optimal packaging, stacking and way of handling for each specific product.

Regarding reefer cargo monitoring and data sharing, F&A companies should work closely with logistics service providers to define their data needs. The process starts by taking some important decisions (i.e. what do we want to improve), then moves to connecting the decisions to data (i.e. which type of data is relevant), and finally defining the desired data characteristics (e.g. how frequently do we need to receive data and what is the acceptable range of data error?).

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