THE LINDE GROUP

FROSTCRUISE™

Cryogenic in-transit refrigeration system.

Introduction

Currently, the majority of the world's chilled and frozen food overland transport is done by refrigerated trucking, utilising mechanically refrigerated trucks and/or trailers. Mechanical refrigeration units use diesel to fuel a compressor that circulates a refrigerant.

Apart from diesel combustion, which creates air pollution and CO_2 emissions (i.e. "greenhouse" gases), these systems usually create noise levels of 80 dB and above, even if the truck's engine is off and the truck stands still during loading and unloading. Moreover, with these systems, refrigerant leakage can reach levels between 15 and 35 %, creating additional contamination and corresponding costs.

Solution

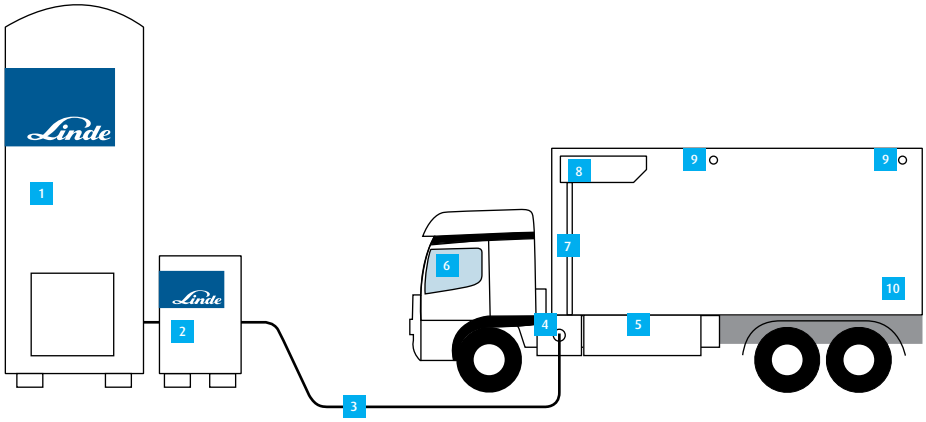
FROSTCRUISE™ is an efficient, economical, cryogenic replacement for mechanical, diesel-powered truck refrigeration systems. As an indirect cooling method, it provides an eco-friendly solution for the transportation of perishable chilled and frozen food, based on the use of liquid nitrogen (LIN) as the refrigerant. LIN, which is liquid at a temperature of -196 °C, is stored in an insulated on-board tank. In order to use its cooling energy, LIN is piped through a heat exchanger with a large surface area. The liquid nitrogen evaporates as high-velocity fans circulate the compartment air in the truck's container.

Details

Due to the system's very low noise emission, FROSTCRUISE™ can also be used at night or at early hours, even in urban areas where laws usually limit noise pollution to 60–65 dB after 10:00 p.m. and before 6:00 a.m. – a level which many diesel-operated refrigeration systems are unable to achieve. This represents a significant advantage for refrigerated trucking businesses, giving them the flexibility to make deliveries even at unusual times or to residential locations.

Advantages

- Very stable temperature control: rapid cool-down and recovery, multi-temperature compartments
- No diesel or refrigerant pollution at delivery locations, reduction of CO_2 emissions
- Very low operating noise (noise reduction at night/in residential areas)
- Elimination of hazardous refrigerants (e.g. R404A)
- Improvement of the system user's public image ("greener" image for companies)
- Less moving parts, less weight, less downtimes, less maintenance, less service costs
- Safe cryogenic filling and easy operation
- Higher system efficiency, reliability and durability (expected lifetime: 10 years)
- Inert, food-safe nature of nitrogen ensures high food quality
- Sustainability: Nitrogen is a natural component of air
- Very cost-efficient system



1 On-site LIN tank
2 LIN filling station
3 On-site LIN hose
4 Control and filling box (valve cabinet)
5 LIN tank
6 On-board control unit
7 Piping
8 Heat exchanger
9 Sensors
10 Container

Field trial results

46-m³ FROSTCRUISE™ truck, London

LIN tank volume	430 litres
Operating temperature	2 °C
Operating time	8 to 16 hours
LIN consumption	30 to 50 litres/hour depending on conditions
Cool-down time	10 minutes from 14 °C to 2 °C
Exhaust gas temperature	-5 °C to -10 °C
Mileage improvement	1–3 miles per gallon over typical air-cooled d iesel systems
Noise emission	60 to 65 dB
Expected system lifetime	10 years (as opposed to 5 years with mechanical systems)
Carbon footprint reduction	15-% expected in summer, 12-% reduction in winter*

*) Results based on trial customer conditions.

Service and know-how

As a global gases and engineering company, Linde offers innovative solutions to many business areas within the food industry – especially for chilling and freezing of perishable goods. Amongst others, the meat, poultry, seafood, bakery and prepared foods industries profit from our company's extensive gas application know-how for environmentally friendly, efficient and reliable freezing and chilling methods.

With FROSTCRUISE™, we present an eco-friendly alternative to diesel-powered refrigeration systems. The system's low noise emission and the use of liquid nitrogen as the refrigerant make FROSTCRUISE™ an especially sustainable and economical solution.

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