Updated Technology of Cold Chain Logistics in Korea

한국콜드체인물류의 신기술

prof. M.S.Chung (鄭明洙)
Mar. 03, 2017

Korea Food Cold Chain Association
We handle Temperature Controlled Supply Chain
Korea Food Cold Chain Association

Establishment
- 2007 Organized “Research of Low temperature Logistics for Agricultural products”
- Accredited by Ministry of Agricultural, fishery & Food, Korea
- Ex Minister DT Kim/MAFRA & Ex CEO of NH Mart/SY Lee led as chairman

Reform
- 2014 Renamed to Korea Food Cold Chain Association
- 2015 MOU with China Cold Chain Association
- Numerous Seminars/Forums held for maintaining Fresh Food & Technology

Development
- 2016 Cross Trade Activity for Cold Chain with China
- Standard of Cold Chain System under progress
- Recommending Good Operation Certificate for Good Cold Chain Enterprises
For China-Korea Cold Chain Business cooperation
Participation at Cold Chain Standard in Northeast Asia
Food Consuming Trend of Korea

Ref: Korea Rural Economics Institute, Seminar on Jan 18, 2017
## Cold Chain Industry in Korea

### Contents

<table>
<thead>
<tr>
<th>contents</th>
<th>percentage</th>
<th>remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerated share of food</td>
<td>22.4% out of Total Food</td>
<td>As for Distribution</td>
</tr>
<tr>
<td>Refrigerated Ware House &amp; Storages</td>
<td>General 337 Meat 400 Fishery 688 Hygienic Law 425 Agricultural storage 3,500</td>
<td>W/H registered As food Distribution</td>
</tr>
<tr>
<td>Refrigerated Trucks</td>
<td>120,000 trucks *business use 13,000 *private use 107,000</td>
<td>From 1 ton/2ton /5ton/10ton &amp; 14ton Capacity Truck</td>
</tr>
<tr>
<td>Refrigerated-Truck Molding Makers</td>
<td>Semi automatic 300</td>
<td>Small &amp; Medium Ind</td>
</tr>
</tbody>
</table>

*(Based on 2016)*
Major Technology in Cold Chain Industry

- Refrigerated Warehouse & Storages
- Refrigerated Vehicle - Cold & Cool
  - Insulation Material
  - Refrigerating Device
  - Mechanical Technique of Truck Container Molding
  - Mechanical Technique of Packaging
  - Temperature Real Time Monitoring System (Tracking/Tracing/Controlling)

Mechanical Development
Technology Contents

- Refrigerated Vehicle
- Insulation Material
- Monitoring Device
- IOT for Cold Chain Operation
- Green Facility
Side Door
- Door ...to be flat
- Clean Surface

Insulated Door Frame

Reinforced Floor
- Thickness
  70mm → 112mm
- X-mbr included

insulated molding door
assembled gasket
Compact sheet of Insulated wall of Truck

Manufacturer: Gold Van, Korea
## Comparison

Ref: based on Analysis of Gold Van

<table>
<thead>
<tr>
<th>KOREA (Gold Van)</th>
<th>specification</th>
<th>CIMC (china-reefer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9,500</td>
<td>Length, mm</td>
<td>9,500</td>
</tr>
<tr>
<td>2,280 (panel width: 80mm)</td>
<td>width, mm</td>
<td>2,300 (panel width: 80mm)</td>
</tr>
<tr>
<td>2,250 ~ 2,450</td>
<td>Heith , mm</td>
<td>2,250</td>
</tr>
<tr>
<td>3,400</td>
<td>Weight, kg</td>
<td>4,550</td>
</tr>
<tr>
<td>① outside – GRP whole, flat</td>
<td>Major specification</td>
<td>① outside – steel, uneven</td>
</tr>
<tr>
<td>② door frame – stainless</td>
<td></td>
<td>② door frame: steel</td>
</tr>
<tr>
<td>③ side door: flat</td>
<td></td>
<td>③ side door – uneven</td>
</tr>
<tr>
<td>④ floor – AL Floor + rail</td>
<td></td>
<td>④ floor – AL-T pallet + rail</td>
</tr>
<tr>
<td>US$ 25,000</td>
<td>Selling price</td>
<td>US$ 28,000</td>
</tr>
<tr>
<td>KOREA</td>
<td>origin</td>
<td>CHINA</td>
</tr>
<tr>
<td>Flexible adaption according to customer’s need. Convenient for advertising</td>
<td>Outer surface</td>
<td>less effectiveness in advertising</td>
</tr>
</tbody>
</table>
Technology of PCM (phase Change Material)

* Heat is absorbed or released when the material changes from solid to liquid and vice versa
* Capable of storing and releasing large amount of energy

Developed by FMS, EST & JinSung
PCM Truck in Indonesia by EST

PCM Modules
Freezer/Chiller/Multi-Temp.

Controller/Plug
380V 3PH

Condensing Unit
Electrical Compressor

06:00 - 14:00
Storage

20:00 - 06:00
Charging

Truck

06:00 - 14:00
Operation

06:00 - 20:00
Delivery

PCM COLD CAR
New Leader of Energy Solution Technology
Low Emission

green logistics
EST
**Actual Advantage on Cost**

Ref: Based on actual driving test, EST Analysis

<table>
<thead>
<tr>
<th>TRUCK</th>
<th>ELECTRICITY</th>
<th>DIESEL</th>
<th>COST</th>
<th>EMISSION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KWh</td>
<td>USD</td>
<td>Litre</td>
<td>USD</td>
</tr>
<tr>
<td>Normal Reefer Truck</td>
<td>-</td>
<td>-</td>
<td>190</td>
<td>77.37</td>
</tr>
<tr>
<td>PCM Reefer Truck</td>
<td>3.7</td>
<td>3.35</td>
<td>125</td>
<td>50.90</td>
</tr>
<tr>
<td><strong>COST SAVING</strong></td>
<td>65</td>
<td>26.47</td>
<td><strong>23.12</strong></td>
<td>237</td>
</tr>
</tbody>
</table>

34\%  30\%  34\%

*Jakarta between Surabaya Round Trip: 8 times/month, 96 times/year*

**Information**

- Truck Type: 6 Wheel Truck CDD120PS
- Destination: Surabaya - Jakarta
- Distance: 790 km
- Time: 27 hours
- Date: October 2012
- Electric Tariff: USD 0.11/kWh
- Diesel: USD 0.41/liter
- Charging Time: 8 hours

**SAVING COST per Return TRIP** = 46.25 USD

**SAVING COST per MONTH** = 369.92 USD

**SAVING COST per YEAR** = 4,439.09 USD
Activities in Indonesia

EUTECTIC 150 UNITS USING IN BEKASI

PT. SUKANDA DJAYA

EUTECTIC OVER 150 UNITS
JAKARTA & SURABAYA

WALLS USING EUTECTIC IN
THAILAND, MALAYSIA &
OTHERS
Insulation Material invented

Eco-Friendly

Water-Blown High-Insulation Polyurethane Foams

Entered 4th generation in technique
# Water PUR by Lead Power

## History of Agents

<table>
<thead>
<tr>
<th>Generation</th>
<th>Feature</th>
<th>Agent</th>
<th>Remark</th>
</tr>
</thead>
</table>
| 1st Gen    | Low thermal conductivity  
High ODP, High GWP                                                  | CFC-11       | -prohibited throughout the world                                      |
| 2nd Gen    | Low thermal conductivity  
Low ODP, Moderate GWP                                              | HCFC-141b    | -prohibited in develop countries  
-supposed to be prohibited soon in the other countries |
| 3rd Gen    | Moderate thermal conductivity  
Zero ODP, Moderate GWP                                              | HFC-245fa, HFC-365mfc, Pentanes | HFC usage is going down  
-Pentane is good for ODP but still not good in GWP, and has danger of explosion |
| 4th Gen    | Low thermal conductivity  
Zero ODP, Lowest GWP                                                 | Water        | -The most Safest  
- LP’s tech. is the best in the world in terms of Mech. Strength and Thermal Insulation. |

* ODP: Ozone Depletion Potential  
* GWP: Global Warming Potential  
* HCFC : Hydrogen Chloro Fluoro Carbon
# Usage and Feature of PUR

- **Insulation Materials with the Same Thermal Conductivity**
  (Comparison of Thickness)

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyurethane Foam</td>
<td>100mm</td>
</tr>
<tr>
<td>Expanded Polystyrene graphite</td>
<td>133mm</td>
</tr>
<tr>
<td>Expanded Polystyrene</td>
<td>146mm</td>
</tr>
<tr>
<td>Extruded Polystyrene</td>
<td>150mm</td>
</tr>
<tr>
<td>Mineral Wool</td>
<td>154mm</td>
</tr>
<tr>
<td>Wood Wool</td>
<td>167mm</td>
</tr>
</tbody>
</table>

![Image of insulation materials](image-url)
## Specification

**LEAD POWER (Water-blown) Rigid PUR Foams vs. Current (Blowing Agent) Rigid PUR Foams**

<table>
<thead>
<tr>
<th></th>
<th>LEAD POWER Water-blown</th>
<th>Other Blowing Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blowing Agent</strong></td>
<td>Water</td>
<td>HCFC, HFC, pentane</td>
</tr>
<tr>
<td><strong>ODP</strong></td>
<td></td>
<td>0.11 (HCFC)</td>
</tr>
<tr>
<td><strong>GWP</strong></td>
<td>1 (CO₂)</td>
<td>HCFC: 630</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HFC: 790~1,030</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C-pentane: 25</td>
</tr>
<tr>
<td><strong>Thermal Conductivity (W/m·K)</strong></td>
<td>0.021</td>
<td>0.020~0.023</td>
</tr>
<tr>
<td><strong>Flame Retardance (UL94)</strong></td>
<td>HF-1</td>
<td>Self-extinguishing</td>
</tr>
<tr>
<td><strong>Density (kg/m³)</strong></td>
<td>25~45</td>
<td>25~45</td>
</tr>
<tr>
<td><strong>Physical and Mechanical Properties</strong></td>
<td>Same as or Comparable with Blowing Agent</td>
<td></td>
</tr>
</tbody>
</table>

(Flowchart details not included in the text representation.)
manufacturer
Feature of Water PUR

Meet Environmental Regulations
- Montreal Protocol bans CFCs & HCFC
- Kyoto Protocol limits to use HFC

Non-Toxic
- No VOC (volatile Organic Compound)
- No Formaldehyde

Perfect Characteristics of Insulation
Mechanical Properties
Flame Retardant

Economic Process
due to economic cost
TEMPERATURE MONITORING SYSTEM

New Cloud Monitoring by RFID Tag

#Motion picture

RFID F2F fish.mp4
Monitoring Process for Multiple Transportation

Program by Triphos, Korea

Temperature Sensors installed

Map By GPS

RAW DATA AREA (CAR)

Sensor #1
Sensor #2
Other Sensors...
GPS Module
Car Data

Digital Data
DATA GETTER
3G MODEM

Gateway Server
DATA ANALYSIS
M/W CONNECTING

SERVER
GET
SAVE & ANALYSIS
VIEW

M/W
DATABASE CONNECTING

RAW DATA DB TABLES
PROCESSING DATA DB TABLES

WAS
JSP
JS, JQUERY
HTML5
GOOGLE MAPS
OTHER API
Scene 1

Scene 2 (Close-up)

Scene 3 (More close-up)

Showing Temperature 3.0°C ~ 4.5°C
Total Data recorded in detail for temperature

Car number/Temperature/Abnormal status

<table>
<thead>
<tr>
<th>영업증인</th>
<th>영업정보</th>
<th>영업자기장</th>
<th>장비변환</th>
<th>온도세트</th>
<th>온도장비</th>
<th>정비 AS</th>
<th>정비구성</th>
<th>정비관리</th>
<th>운행데이터</th>
<th>정비관리</th>
<th>정비관리</th>
<th>정비관리</th>
<th>정비관리</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>시험</td>
<td>서울82버스5159</td>
<td>8.407</td>
<td>2</td>
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<td>2</td>
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<tr>
<td>2</td>
<td>시험</td>
<td>경기82버스73</td>
<td>7.093</td>
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<td>2</td>
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<tr>
<td>3</td>
<td>시험</td>
<td>서울82버스874</td>
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<tr>
<td>4</td>
<td>시험</td>
<td>경기82버스414</td>
<td>6.979</td>
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<tr>
<td>5</td>
<td>시험</td>
<td>서울82버스873</td>
<td>6.902</td>
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<tr>
<td>6</td>
<td>시험</td>
<td>경기82버스930</td>
<td>6.217</td>
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<td>7</td>
<td>시험</td>
<td>경기82버스931</td>
<td>6.166</td>
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<tr>
<td>8</td>
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<td>경기82버스988</td>
<td>4.832</td>
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<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

| 영업내역 | 영업내역 | 영업내역 | 영업내역 | 영업내역 | 영업내역 | 영업내역 | 영업내역 | 영업내역 | 영업내역 | 영업내역 | 영업내역 | 영업내역 | 영업내역 |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1       | 2017-01-31 10:13:24 | 주행   | 85     | 0       | 4.000   | 5.000   |         |         |         |         |         |         |         |         |
| 2       | 2017-01-31 16:13:19 | 주행   | 85     | 0       | 4.000   | 5.000   |         |         |         |         |         |         |         |         |
| 3       | 2017-01-31 16:13:14 | 주행   | 85     | 0       | 4.000   | 5.000   |         |         |         |         |         |         |         |         |
| 4       | 2017-01-31 16:13:09 | 주행   | 84     | 0       | 4.000   | 5.000   |         |         |         |         |         |         |         |         |
| 5       | 2017-01-31 16:13:04 | 주행   | 84     | 0       | 4.000   | 5.000   |         |         |         |         |         |         |         |         |
| 6       | 2017-01-31 16:12:50 | 주행   | 84     | 0       | 4.000   | 5.000   |         |         |         |         |         |         |         |         |
| 7       | 2017-01-31 16:12:54 | 주행   | 84     | 0       | 4.000   | 5.000   |         |         |         |         |         |         |         |         |
| 8       | 2017-01-31 16:12:49 | 주행   | 83     | 0       | 4.000   | 5.000   |         |         |         |         |         |         |         |         |
| 9       | 2017-01-31 16:12:44 | 주행   | 82     | 0       | 4.000   | 5.000   |         |         |         |         |         |         |         |         |
app – push alert for specific case

Push notification


OK

Truck Number 89-7822
As of 04:14:22 dated Nov 01, 2014
Required Urgent checking of Temperature
**Innovative: Temperature RFID Tag**
*(No battery) by TKS Semicon*

**Powered by external RF waves wirelessly:**
Energy Harvesting

- WiFi
- Bluetooth
- LTE/3G
- RFID(900Mhz)
- NFC

**SoC semiconductor**
900Mhz Communication Module +
Temperature Sensor Module

**Real Passive Sensor**
*Works without a battery*
Proving temperature without opening up the box!

Packaging for Temperature Sensitive or Perishable Food

- Vaccines, Pharmaceuticals
- Blood, Blood based product
- Vegetables
- Chilled foods
- Fruits
- Meats
- Seafoods
- Wine

TKS Tag attached inside
Comparison of Temperature Tag

- **Battery**
- **Antenna**
- **Antenna 1**
- **SemiCon**
- **Antenna 2**

### SIZE

- **DHL tag**
- **TKS tag**

### COST

- **$ 50 or more**
- **$ 0.5 or less**

**VS**
Key Point #1: Prove Temperature inside of sealed cooler box without opening up

- Developed by TKS
- UHF RFID + TempSensor
- (System on Chip) TK5’s Passive T-Tag
- Cooler Package Attached Inside
- RFID/Bar-Code Reader with LTE module
- Retrieved Temperature & RFID ID
- Cloud

Key Point #2: Inexpensive (Temperature Authorization Service Solution for $1 or less)

- $0.5
Evolution!

# Motion picture

Video_Passive Temp Tag with caption.mp4
Recycled Sourcing Energy

Eugene Cryogenic evolutionally attempts to build Refrigerated Ware House & Low temperature distribution Center used recycled LNG cold energy.

LNG Liquid $\rightarrow$ Gas

-162°C

Cold Energy
TRANSFERRING COLD ENERGY FROM LNG

Basic Diagram in technique

Refrigerated storage

Waste to Sea

약 40~45%

LNG Tanker

Use in Refrigerated

약 55~60%
Logistics Complex Profile.

Photovoltaic power generation facilities: 120kw

Operation support facilities: 9,720 m²

Documents storage facilities: 14,114.7 m²

Low temperature storage: 38,690 m²
Automated warehouse: 4,725.0 m²
Loading dock: 8,924.6 m²

Processing plant: 3,675 m²

<table>
<thead>
<tr>
<th>Construction profile by Eugene cryogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Name</strong></td>
</tr>
<tr>
<td><strong>Location</strong></td>
</tr>
<tr>
<td><strong>Lot area</strong></td>
</tr>
<tr>
<td><strong>Gross floor area</strong></td>
</tr>
<tr>
<td><strong>Building to land ratio</strong></td>
</tr>
<tr>
<td><strong>Capacity ratio</strong></td>
</tr>
<tr>
<td><strong>Use district</strong></td>
</tr>
</tbody>
</table>
New recycling energy system

The most advanced Utility system of new Recycled energy

- Using LNG cold energy
- Low temperature distribution
- Using full arrangement
- Environment-friendly management technique

The lowest • high fresh/low carbon emissions and green Growth distribution center

- Using -162℃ cold energy
- Maintaining the cold temperature continuously
- Keeping the freshness
- Realize perfect cold chain

- Using LNG low temperature
- Energy saving system
- Non-pollution system

Distribution diagram of energy utilization

LNG base

Lowest temperature
- Cold
- Frozen

Low temperature Processing plant

A distribution center

B distribution center

C distribution center

Document storage center

Operation Support center

Constant Temp, Humidity controller

Convention center
Supplying sys of cold And hot water

Thermo
Cooling system using LNG cold energy

LNG: (Liquefied Natural Gas) cooling heating application

Indirect application

<table>
<thead>
<tr>
<th>°C</th>
<th>Direct LNG using</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(Freshen seawater)</td>
</tr>
<tr>
<td>-50</td>
<td>(skiing ground)</td>
</tr>
<tr>
<td>-100</td>
<td>Frozen warehouse</td>
</tr>
<tr>
<td>-150</td>
<td>Manufacturing liquefied carbonic acid</td>
</tr>
<tr>
<td>-200</td>
<td>Manufacturing dry ice</td>
</tr>
<tr>
<td>-250</td>
<td>Ethylene tablets</td>
</tr>
<tr>
<td>-300</td>
<td>Air liquefaction separate</td>
</tr>
<tr>
<td>-350</td>
<td>Liquefied hydrogen manufacturing</td>
</tr>
<tr>
<td>-400</td>
<td>Liquefied helium production</td>
</tr>
</tbody>
</table>

- High temp superconductor
- Frozen warehouse
- Manufacturing dry ice
- Ethylene tablets
- Air liquefaction separate
- Liquefied hydrogen manufacturing
- Liquefied helium production

Facility

Low temp superconductor

- Crush abolition of a car
- High temperature superconductor freezing method
- Low temp superconductor

Liquid nitrogen temperature

( ) is under consideration

Dry ice temperature

- Storage of frozen food
- Food grinding
- Serve zero treatment
- Food lyophilization
- High temp superconductor freezing method

High temp superconductor

- Crush abolition of a car
- High temperature superconductor freezing method
- Low temp superconductor
Benefit

- **Electricity Energy Saving up to 70% comparing than general refrigerated system**

  Applying a new frozen technology using the cold energy (-162°C) generated from LNG base, enabling save the electricity consumption up to 70%.

- **Green Operation by LNG: CO2 Emission, ODP 0 % And Supplement Supply by Solar Energy**

  For operation of refrigerating system by LNG, no any CO2 emission and harmful ingredients making pollution. Getting more electricity, applying additional photovoltaic (Solar) Power generation on the roof. It also carry out low carbon emissions and green Industrialization.

- **Efficient distribution center with cost reduction**

  It is the first energy saving distribution center in Korea. Through the lowest frozen system maintain freshness of products, necessary Processing system is established for distribution immediately. This distribution center is connected between abroad to domestic users directly. As the biggest one of low temperature ware houses in Asia, this center will be working on every day without any stopping.
Reference

Refrigerated Truck.................................Gold Van
Refrigerated PCM Truck .........................EST
Insulated Material Water PUR....................Lead Power
Wireless Monitoring System.....................TriPhos
Passive RFID Tag for Temperature ..........TKS Semicon
Green Refrigerated LNG ware House........Eugene Cryogenic

* Special Note

MOU between Cold Chain associate of Indonesia and Korea Food Cold Chain Association for Exchange of Engineering Know How, Technique And relevant Information will be concluded on March 04.
Thank You.

Korea Food Cold Chain Association