Lecture 11
- Reefer Market
Section 1  Reefer Technology
Section 2  Reefer Market
Section 3  Reefer Cargo
Section 4  UK Case Study
Sailing ship Dunedin
- New Zealand – London
- 98 day voyage
- 1882

Frozen cargo
- 4331 mutton carcasses
- 598 lamb carcasses
- 22 pig carcasses
- 246 kegs of butter
- Hare
- Pheasant
- Turkey
- Chicken
- 2,226 sheep tongues

REEFER TECHNOLOGY
FIRST REFRIGERATED SHIPS
Transport cargo at temperatures below ambient (surrounding) temperature

Typically described in terms of cubic capacity
- Other ships by tonnage (dwt)

Reefer ship holds
- Lined with insulation materials (reduce capacity)
- Hold floor is double skinned to allow for even circulation of cooling air
  - Wooden gratings allow air passage through cargo

Suited to frozen or cooled cargo
- -30°C to +12°C
  - Separate compartments for different temperature conditions
- Defrosting capability also required
Important both in shipping and pre-sale storage

- Increases the shelf life of goods
  - Bananas from 2-4 weeks to 4-6 weeks
  - Apples 6 months to 10-24 months

- Controlled atmosphere technology manipulates oxygen and carbon dioxide levels
  - Nitrogen typically introduced
Continuous monitoring of hold conditions
- Remote technology available

Cargo carried in
- Bins (loose)
- Individual boxes
- Pallets
- On deck in containers

Speed
- Higher typical speeds 18 – 23 knots
  - Reduce transit times
  - Increase operational flexibility
  - Decrease turnaround times
REEFER TECHNOLOGY
SIDE DOOR REEFER VESSEL

- Allow fast, careful and economical loading
  - In bad weather conditions
  - Minimises temperature losses through open hatches
- Elevators allow loading and discharge independent of tidal variation
REEFER TECHNOLOGY
PALLETT VESSELS

- 3,500 pallets + 30 containers
REEFER TECHNOLOGY
PALLETS & CONTAINER VESSELS

- 5,000 pallets + 150 containers
Specialised Reefer Fleet (vessels greater than 100,000 cu. ft.)

- 774 specialised reefer (non-freezer) vessels above 100,000 cu. ft. (2008)

Source: Sextant Consultancy Ltd
REEFER TECHNOLOGY
FLEET AGE PROFILE (JAN-2008)

Source: Sextant Consultancy Ltd
Specialized vessels greater than 100,000 cubic feet

Source: Sextant Consultancy Ltd
Vessels greater than 100,000 cubic feet

Source: Sextant Consultancy Ltd
REEFER TECHNOLOGY
NEW BUILDINGS (MID-2008)

Source: Sextant Consultancy Ltd

![Bar Chart showing Specialised Reefers and Container Vessels from 2008 to 2012.](chart.png)
REEFER TECHNOLOGY
REEFER FLEET (1996 - 2010)

Bulk reefer fleet capacity in million cubic feet

### REEFER TECHNOLOGY
### REEFER VESSEL OWNERS

<table>
<thead>
<tr>
<th>Operator</th>
<th>Number of Vessels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seatrade</td>
<td>145</td>
</tr>
<tr>
<td>NYK Cool</td>
<td>70</td>
</tr>
<tr>
<td>Green Reefer</td>
<td>30</td>
</tr>
<tr>
<td>Star Reefers</td>
<td>38</td>
</tr>
</tbody>
</table>

**Banana Companies**

<table>
<thead>
<tr>
<th>Company</th>
<th>Number of Vessels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Del Monte</td>
<td>41</td>
</tr>
<tr>
<td>Dole</td>
<td>15</td>
</tr>
<tr>
<td>Chiquita</td>
<td>15</td>
</tr>
<tr>
<td>(Great White Fleet)</td>
<td></td>
</tr>
</tbody>
</table>
REEFER TECHNOLOGY
PRODUCT LIFE CYCLE – REEFER SHIPS

<table>
<thead>
<tr>
<th>Hamburg Süd</th>
<th>CAP SAN NICOLAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialist carrier on north south trade</td>
<td>World’s largest reefer container vessel</td>
</tr>
<tr>
<td>10 x 9,669 teu container vessel</td>
<td>Deployed on Far East to ECSA service</td>
</tr>
<tr>
<td>333.20m LOA</td>
<td>ASAS joint service with Maersk Line</td>
</tr>
<tr>
<td>Space for power units</td>
<td></td>
</tr>
<tr>
<td>More bunker fuel</td>
<td></td>
</tr>
<tr>
<td>14m draft (relatively shallow)</td>
<td></td>
</tr>
<tr>
<td>48.20m (19 rows) wide</td>
<td></td>
</tr>
<tr>
<td>2,100 reefers plugs (4,200 TEU)</td>
<td></td>
</tr>
</tbody>
</table>
Three primary functions

- **Control temperature**
  - To -35°C for products such as ice-cream and fish
  - Multi-temperature control
    - Allows changing temperatures during voyage (potatoes, tomatoes)
    - Can be programmed in at the start for one voyage

- **Control atmosphere**
  - Modify oxygen and carbon dioxide levels
  - Lengthen storage period

- **Control humidity**
  - Reduction in moisture in container
  - Maintain moisture for fresh produce

**Operation**

- Circulate chilled air within container
  - Must be consistent and uniform
- Provide ventilation
  - To remove unwanted gasses and moisture from container as goods respire
REEFER TECHNOLOGY
KEY REEFER CONSIDERATIONS

- Pre-trip inspections (PTI) of container
  - Detailed inspection to ensure container is
    - Clean
    - No odours
    - Systems are in working order

- Pre-cooling cargo
  - All refrigerated goods should be pre-cooled prior to loading
    - To the temperature required during their transport
  - Reefer containers are designed to maintain temperature
    - Not to lower it

- Container is not pre-cooled
  - To avoid condensation when doors are opened and goods loaded
  - Only possible if there is a suitable cold store available for packing
Packaging
- Designed to ensure optimal protection of goods
- Withstand
  - Handling & use in cold environments
  - Vertical pressures of stacking
  - Tolerate humidity (waxed)

Chilled goods
- Air forced through goods to remove heat
- No space between cartons or walls of container
  - So air has to go through goods
  - Open floor space must be covered to ensure correct air flow
- Cartons should be stored in a block
- Ventilation holes in boxes aligned
  - Promote air flow through goods

Source: Hamburg-Sud, Stay cool we care
REEFER TECHNOLOGY
LOADING CONSIDERATIONS

**Frozen goods**
- Cartons to be stored in a block
- No space between cartons or walls of container
- Avoid heat from outside coming in contact with the cargo
  - Cargo does not generate heat
Prevents proper air flow
- Increases temperature variations
- May cause cargo damage

Loading height should not exceed max
- Ensure proper air circulation

Source: Maersk Line, Cool facts
Electrically powered motors
- Ship
- Port
- Truck

Environmental considerations
- Adoption of low-energy motors
  - Reduce fuel consumption by up to three times per voyage
  - Reduce carbon emissions
- Energy use management software
  - Detailed management of temperatures to reduce electricity consumed
Attached to reefer container where no power source is available
REEFER TECHNOLOGY
CONTAINERIZED REEFER - DATA
REEFER TECHNOLOGY
AIR REEFERS

The PharmaPort™ 360 container is designed for safe, 5°C door-to-door transportation of temperature-sensitive pharmaceuticals and other life science products.

- Precise 5°C Temperature Control
- Energy Efficient, Internally Powered in Transport
- Advanced Monitoring and Tracking

The PharmaPort™ 360 Model 762S
fits a standard 40” x 45” pallet (101.6 x 122 cm)
REEFER TECHNOLOGY
LAST MILE REEFER CHALLENGES

- **Technical**
  - Different temperature requirement of products
  - Certain products cannot be mixed together

- **Human**
  - Mis-handling of equipment / load securing
  - Drivers shut down refrigeration units to save fuel costs
  - Doors are left open too long during deliveries

A cold chain has been defined as the transportation of temperature-sensitive products along a supply chain through thermal and refrigerated methods and the logistical planning to protect the integrity of these shipments.

Therefore, the major challenge of the reefer transport industry is to ensure a continuous cold chain from the producer to the consumer in order to guarantee the prime condition of the goods received.

<table>
<thead>
<tr>
<th>Section</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 1</td>
<td>Reefer Technology</td>
</tr>
<tr>
<td>Section 2</td>
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<tr>
<td>Section 3</td>
<td>Reefer Cargo</td>
</tr>
<tr>
<td>Section 4</td>
<td>UK Case Study</td>
</tr>
</tbody>
</table>
REEFER MARKET
MAJOR REEFER COMMODITIES (2011)

Reefer seaborne trade by commodity and mode

REEFER MARKET
GROWING GLOBAL MARKET

Source: Sextant Consultancy Ltd
**REEFER MARKET**

**INDUSTRY TRENDS**

- Continued reduction in specialised reefer vessels
- Reduced market share
- Real reduction in tonnage carried
- Pressure on rate due to
  - Reefer container industry competition
  - Climatic conditions
  - Global economy
  - Carbon footprint

### Specialist reefer vessels

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total reefer market (milion tonnes)</td>
<td>77.2</td>
<td>86.5</td>
<td>108.8</td>
</tr>
<tr>
<td>Number of specialist reefer vessels</td>
<td>803</td>
<td>747</td>
<td>642</td>
</tr>
<tr>
<td>Specialist cargo volume (million tonnes)</td>
<td>35.5</td>
<td>35.0</td>
<td>32.0</td>
</tr>
<tr>
<td>Market share (%)</td>
<td>46.0</td>
<td>40.3</td>
<td>29.3</td>
</tr>
</tbody>
</table>

Source: Sextant Consultancy Ltd
Maersk has 30% market share of the containerized refrigerated trade

Reefers generate 20% of Maersk Line’s operating yield from 11% of the volume

Operating yield = revenue per tonne mile / KM

<table>
<thead>
<tr>
<th>Container Carriers – Reefer Fleet</th>
<th>Units</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maersk Line</td>
<td>204,000</td>
<td>30.8%</td>
</tr>
<tr>
<td>MSC</td>
<td>32,800</td>
<td>5.0%</td>
</tr>
<tr>
<td>Hamburg Sud</td>
<td>29,200</td>
<td>4.4%</td>
</tr>
<tr>
<td>OOCL</td>
<td>26,600</td>
<td>4.0%</td>
</tr>
<tr>
<td>COSCO</td>
<td>26,000</td>
<td>3.9%</td>
</tr>
<tr>
<td>CMA-CGM</td>
<td>26,000</td>
<td>3.9%</td>
</tr>
<tr>
<td>Evergreen</td>
<td>25,200</td>
<td>3.8%</td>
</tr>
<tr>
<td>NYK</td>
<td>25,000</td>
<td>3.8%</td>
</tr>
<tr>
<td>CSAV</td>
<td>24,000</td>
<td>3.6%</td>
</tr>
<tr>
<td>Other (Including lease companies)</td>
<td>211,800</td>
<td>32.0%</td>
</tr>
<tr>
<td>Total</td>
<td>662,000</td>
<td>100%</td>
</tr>
</tbody>
</table>
### Table 2: South African citrus production (2000-2010)

<table>
<thead>
<tr>
<th>Product</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grapefruit</td>
<td>12.9</td>
<td>10.4</td>
<td>13.1</td>
<td>13.6</td>
<td>14.5</td>
<td>17.9</td>
<td>10.0</td>
<td>14.3</td>
<td>16.5</td>
<td>16.9</td>
<td>17.0</td>
</tr>
<tr>
<td>Lemons</td>
<td>3.7</td>
<td>4.2</td>
<td>4.6</td>
<td>5.8</td>
<td>6.8</td>
<td>6.8</td>
<td>6.7</td>
<td>6.6</td>
<td>9.7</td>
<td>10.4</td>
<td>10.8</td>
</tr>
<tr>
<td>Oranges</td>
<td>37.6</td>
<td>38.1</td>
<td>40.7</td>
<td>51.2</td>
<td>50.1</td>
<td>51.1</td>
<td>48.4</td>
<td>60.9</td>
<td>62.9</td>
<td>66.7</td>
<td>70.5</td>
</tr>
<tr>
<td>Soft citrus</td>
<td>5.4</td>
<td>4.0</td>
<td>5.3</td>
<td>6.4</td>
<td>5.9</td>
<td>5.3</td>
<td>6.3</td>
<td>8.8</td>
<td>9.5</td>
<td>9.8</td>
<td></td>
</tr>
<tr>
<td>Total citrus</td>
<td>61.9</td>
<td>73.5</td>
<td>74.0</td>
<td>73.5</td>
<td>76.0</td>
<td>79.3</td>
<td>74.8</td>
<td>90.5</td>
<td>97.9</td>
<td>103.4</td>
<td>108.1</td>
</tr>
</tbody>
</table>

Note: All figures in ,000 tonnes  
Source: SA Citrus Growers Association

### Table 3: Percentage use of reefer containers for South Africa’s fruit exports

<table>
<thead>
<tr>
<th>Year</th>
<th>Citrus</th>
<th>Deciduous</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>15.2</td>
<td>34.0</td>
</tr>
<tr>
<td>1999</td>
<td>19.6</td>
<td>37.4</td>
</tr>
<tr>
<td>2000</td>
<td>19.7</td>
<td>41.2</td>
</tr>
<tr>
<td>2001</td>
<td>25.9</td>
<td>48.2</td>
</tr>
<tr>
<td>2002</td>
<td>28.4</td>
<td>55.8</td>
</tr>
<tr>
<td>2003</td>
<td>31.4</td>
<td>60.1</td>
</tr>
<tr>
<td>2004</td>
<td>31.2</td>
<td>63.0</td>
</tr>
<tr>
<td>2005</td>
<td>38.4</td>
<td>72.4</td>
</tr>
<tr>
<td>2006</td>
<td>47.0</td>
<td>78.0</td>
</tr>
<tr>
<td>2007</td>
<td>52.0</td>
<td>83.0</td>
</tr>
</tbody>
</table>

Source: SA Citrus Growers Association
REEFER MARKET
EMPTY CONTAINER MOVES

Major 40’ empty flows.
REEFER MARKET
TRADITIONAL VS CONTAINER

Conventional reefer ship
- Tailor-made service
- Short transit time
  - Point to point shipping
- Fixed schedules
- Improved control
  - Temperature
  - Atmosphere
- Constant monitoring

Reefer container
- Cheaper
- Smaller shipment sizes
- Large number of reefer slots available
  - 15% modern container ships
- Products shipped in smaller quantities
  - Specific temperature & humidity requirements
- Easier intermodal transfer in port
- Greater flexibility
Section 1  Reefer Technology
Section 2  Reefer Market
Section 3  Reefer Cargo
Section 4  UK Case Study
Total reefer market 83 million tons (2008)

Other commodities carried include:
- Daily products
- Flowers
- Photographic material
- Pharmaceuticals

Source: Drewry (2008)
REEFER CARGO
SEABORNE REEFER CARGOES

Source: Sextant Consultancy, Drewry Reefer Shipping Market Review 2009/2010
REEFER CARGO
REGIONAL DIFFERENCES

REEFER CARGO
SEASONALITY OF TRADES
REEFER CARGO
TEMPERATURE CONTROL

- Multi-temperature mode
  - Different temperature levels can be defined to be run throughout the transit period as required by the cargo
    - Used to prevent infestations of fruit fly
    - Avoid need for fumigation

- Ambient Air control
  - Control / modification of the atmosphere in the container is used to preserve the cargo quality and slowing down the deterioration of fruit and vegetables.

![Ambient Air Diagram]

- Oxygen (O₂) 21%
- Nitrogen (N₂) 79%
- Carbon dioxide (CO₂) 0.03%
- Inert gases 1%

Water (H₂O)
- Transpiration
  - Dehydration
- Growth of aerobic microorganisms
  - Decay

Carbon dioxide (CO₂)
- + Water (H₂O)
- + Heat
- Respiration
  - Ripening/aging

Ethylene (C₂H₄)
- Ethylene production
  - Ripening/Aging

Decomposition of volatile ingredients

[Diagram showing the relationship between different processes affecting fruit and vegetables]
Section 1  Reefer Technology
Section 2  Reefer Market
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Section 4  UK Case Study
UK TOP 10 ORIGIN COUNTRIES

- Costa Rica: 19%
- South Africa: 14%
- New Zealand: 13%
- Chile: 10%
- Thailand: 6%
- Brazil: 5%
- Egypt: 5%
- India: 3%
- Israel: 3%
- Other: 22%
UK CASE STUDY
UK SEASONALITY

- UK retail market for fresh fruit and vegetables has retail value of £8.34bn (2009)
- Despite a strong domestic agricultural sector
  - 90% of fruit imported
  - 70% of specialist vegetables imported
