WP2.4 refrigerated road transport (RRT)

Background

• UK primary food distribution by RRT uses 40% more energy than non-refrigerated vehicles

• Environmental Impact
  • Indirect emissions -
    • Transportation - 2 Mtonnes of indirect CO₂ emissions from the engine alone.
    • Refrigeration - ?????
  • Direct emissions -
    • RRT units leak up to 30% of their total refrigerant charge per year

• Cost

Deliverables

• Development of a model to investigate direct and indirect emissions
• Optimising system performance
Model Development

Sustainable Refrigerated Road Transport Vehicle

Indirect Carbon Emissions

Performance Model

Motive Work (i.e. Transport)

Direct Carbon Emissions

Refrigerant Leakage Analysis Tool

Refrigeration Work
Analyse maintenance and leakage records

A refrigerant leakage and analysis tool has been developed

- Itemizes and maps each fault to distinct categories and sub-components.
- A sample analysis of RRT service records showed that the bulk of the faults (i.e. 40%) were located in the condenser.
RRT System Performance Model Development

A model to predict the performance of a UK last-mile RRT systems has been developed.

- Preliminary steady state model.
- **Case study results** show that the refrigeration system account for 4% and 24% of the fuel consumed for motive work whereas field data suggested a range of 15-25% (Hutchins, 2007 cited in Tassou et al., 2009).

Future work to include:

- Revising the model assumptions based on actual data measurements.
- Developing PHASE 2 of the model to incorporate transient parameters.
## Measure Actual RRT Data

<table>
<thead>
<tr>
<th>Item No.</th>
<th>RRT Truck Part</th>
<th>Data Collection Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Refrigerated/insulated box</td>
<td>Euroscan X2-6 series Temperature Recorder</td>
</tr>
<tr>
<td>2</td>
<td>Refrigeration unit</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Transport vehicle</td>
<td>FleetBoard Telematics System</td>
</tr>
</tbody>
</table>

*Selected instruments comply with vehicle certificate agency automotive type approval for electromagnetic compatibility (VCA-EMC)*
Measure Actual RRT Data

For the refrigerated box

- Temperatures of various critical parameters are monitored with the Euroscan system including:
  - External Ambient
  - Chilled Compartment
  - Frozen Compartment
  - Internal Ambient

- The Euroscan system also uses sensors to monitor and register the events of
  - Fridge on/off cycle
  - Defrost on/off events
  - Rear door opening and closing
  - Side door opening and closing

Vehicle geographical position during delivery journey is also recorded
Measure Actual RRT Data

For the refrigeration unit
- Temperatures of various critical parameters are monitored with the Euroscan system
- The corresponding temperatures will then be mapped to a P-h chart

For the transport vehicle
- FleetBoard Telematics Software offers a variety of services for fleet management including:
  - Trip Records – overview of tour data such as moving and rest times
  - Performance analysis e.g. average speed, fuel consumption

Multi-evaporator system, single compressor and individual expansion valves
Project Plan flow chart

Conduct Prelim Study & Data Analysis I

Develop:
- a) Leakage Tool
- b) Steady State Model

Collect Data & Analyse

Develop Transient Model

Validate & Optimize Model

PhD Thesis

Report for Transport Industry
Project Schedule

- Instrument refrigerated compartment - Jul 2015
- Instrument transport refrigeration unit - Nov 2015
- Start data analysis – Jan 2016

WP 2.4 Deliverables

• Developed a steady state model and leakage analysis tool

• Developed a refrigerant leakage analysis tool

• Initiated methodology design to collect data from the RRT truck

• Initiated research survey and collection of operational data on RRT truck
Next immediate steps

- Continue to collect data from the RRT system
- Analyse data on the road performance of home delivery refrigerated vehicles