INSTITUT INTERNATIONAL DU FROID
Organisation intergouvernementale pour le développement du froid

INTERNATIONAL INSTITUTE OF REFRIGERATION
Intergovernmental organization for the development of refrigeration

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IIR Working Party

Life Cycle Climate Performance Evaluation

Meeting Minute

First Meeting at TU Delft, The Netherlands on June 28 2012

1. Overview by Yunho Hwang

- Introduction, Scope, Objectives, Membership, Deliverables, Timescale

- LCCP = TEWI + Indirect (production, transport, manufacturing, EOL) + Direct (chemical emissions, atmospheric reaction, manufacturing leakage, EOL)

- Scope WP - assess merits of different methods for evaluating environmental impact.

- Objectives:
  - Collect info on direct, indirect emissions
  - Member states form similar Working Party Groups
  - Establish LCCP evaluation methodology for HVAC&R
  - Assemble and disseminate information.
  - Booklet on Methodology, Fridoc
  - Promote collaboration
- Working phase - 2013 to 2015, with at least 1 meeting per year.

2. Presentations

2.1 Dr. Kostas Kontomaris, DuPont Chemicals

- Conventional Wisdom: Unsaturated fluorocarbons are not stable enough to be used as refrigerants
- Paradigm Shift: Unsaturated fluorocarbon refrigerants decompose rapidly in the atmosphere, but can remain stable in a system!!
- Tradeoffs - Cost vs. Performance vs. Safety
- Centrifugal Chiller - since Montreal Protocol, R123 (high ODP), and R134a (high GWP)
- Replacement Fluids for R134a (automotive) - R1234yf, primarily to meeting the F-gas regulation
  - XP10 - Azeotrope, (non-flammable), GWP = 600, (blend that contains 1234yf), Tc = 97.5°C, Pc = 3.85MPa, Tb = -29.2°C
  - DR-14: Azeotrope, GWP = 380, Tc = 111.6°C, Pc = 3.96MPa, Tb = -20.5°C

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  - DR-2 (replacement for R123) - GWP = < 10, Tc = 171.3°C, Pc = 2.9 MPa, Tb = 33.4°C (normal boiling point)
- For Chillers: Theoretical efficiency -2.5% (R134a), Capacity (1.5%), near drop in; compared to DR14
  - XP10 - no major equipment or safety code modifications and it could be adopted earlier.
- Fluid with lower GWP does not necessarily mean that it will have lower total LCCP or TEWI. DR2 has lesser TEWI than R1234yf and other fluids. This is true when the electricity emissions are high (China, US).
- But when electricity emissions are lower (Switzerland) - the GWP value directly translates to TEWI, i.e., low GWP is low TEWI
- Refrigerant selection should consider application impact and not just refrigerant attributes such as GWP.
- Need flexible climate protection regulation to allow acceptance of optimum refrigerants/trade-off

2.2 Xiuping Zhang, Hefei

- Discussion on environmental impact evaluation method of cooling and heating in mechanical refrigeration
- Various Environmental Impact Indicators: TEWI, LCCP, LEED-NC Standard
- Look into the formula used by the author. This appears different than other publications
  - Life Cycle Direct Global Warming Potential Index (comes from LEED-NC Standard)
  - Naturalness - degree of impact on environment vs. humans
  - CO_2 Reduction Rate Y
  - LCA - ISO method, environmental impact caused by all input and output of a product or service.
- Challenges: how comprehensive it should be; simplifications if any; where to get the raw data required for the calculations; should put security, safety and economic indicator into the system
- Objective:
  - Study and propose scientific, rational and complete evaluation methods and indicators and measurements methods.
  - Evaluation requirements for different category of products
  - Comparative analysis of existing indicators and provision

2.3 Dr. Vikrant Aute, University of Maryland

- Developed Life Cycle Climate Performance Model for Residential Heat Pump Systems sponsored by AHRTI.
  - Excel-based simulation tool for calculating the direct and indirect emissions for residential heat pump systems
  - Available from http://www.ahrinet.org/technical+results.aspx
- Developing LCCP model for Supermarket systems with ORNL

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- Simplified application for evaluating LCCP of supermarket refrigeration systems in web version is available from http://lccp.umd.edu/ornllccp/.
- Need to account for system performance degradation due to charge leak over years, because nobody replaces 5% charge.
- There were many questions during the presentation and so only web version was demonstrated and not the desktop version due to time limit.

2.4 Dr. Bachir Bella, Emerson Climate Technologies

- Shared Emerson's experience on LCCP analysis of systems.
- Emerson uses a simple version of LCCP calculation
- Presented sample supermarket analysis in North EU and US
- Lower GWP does not always translate to lower energy consumption
- A common method of calculating LCCP is recommended.

2.5: Mr. Martin Dieryckx., Daikin Europe

- EU policies 20-20-20: 20% less primary energy use (by 2020), 20% of share should be renewable; 20% reduction in CO_2 by 2020.
- Considering global warming, security of energy and economy essentially focused on energy issue.
- According to 2050 emission estimation, 76% of all HFC emission is coming from developing countries.
- By 2050, commercial refrigeration will contribute to 50% of total GHG.
- Macro-economical evaluation - cost of putting power plants, to meet peak load
- From Jan 2013, 70% AC units from market will be banned in EU, due to new emission and charge regulations
- SEER comparison for room AC and HPs in 3.5 kW capacity shows that CO_2 is worst, but everything else is equivalent to R410A.
- In conclusion, R32 is most balanced. Better energy efficiency, small LCCP, small conversion cost.

2.6 Mr. Dan Bibalou, London SouthBank University

- LCA of refrigerated display cabinets
- LCA standard - ISO 14040
- Sustainability: Social, Economic, Environmental
- Challenges: data collection, scarce literature of cradle to grave (full LCA) for refrigerant itself; GWP is just one aspect.
- Full LCA, LCC and SLCA of refrigerated display cabinets

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3. Discussions

3.1 Membership

- Recommended to involve policy makers.
- Leadership: Elected Dr. Ferreira and Dr. Piao as Vice Chairs and Dr. Aute as secretary.

3.2 Scope Review

- Interact with other organizations acting on refrigerant charge reduction and carbon mitigation groups for synergy effect.
- Need international inputs
- Need to search for other organizations already having methodology on LCCP.
- Need to search for other related standards (EN378-1 for TEWI)
- China - several universities are working on LCCPs.
- Piao: cc on China - Hefei has most recent analysis on commercial systems;
- Need to engage developing countries; China, India, Middle East, Brazil, etc; emotional barrier.
- Approach IIR rosters for Member States to find representatives from developing countries.
- China is focusing on R32 and 290.
- Need to invite Chinese Refrigeration Association (hosting next GL); 2 associations are individually working on R32 and R290.
- Work with other WPs to get leakage emission data, location, countries, applications; Reports in EU and Netherlands
- Recovery organizations - old vs. new refrigerants;
- UK Concern: Need a careful media interaction. Refrigeration industry has very high leakage - can produce negative public impression; obligation to support industry.

3.3 Purpose

- Harmonize LCCP Methodology
- Mitigation of misuse of LCCP should NOT be the objective of this WP; Work towards having a transparent methodology
- Need clear goal of LCCP methodology development
- Need to be used for policy making
- Avg. emission values are used
- Focus on Obj-1 needs to be an impartial group for input to policy makers; based on this input focus on the factors that are important (thus distinguishing our efforts);
- LCCP evaluation should be project basis
- Local emission values are to be used (10 g for renewable power, vs. 385g for regional average)
- LCCP Inclusions
- Standby power (20% for some applications) to be considered; BS exists that includes this

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- Embodied energy/emissions, e.g., replacing display cabinets every 3 years; would be project basis; significant effort required for initial data set; can be scaled later
- YH: suggest to include LCA related input in later phase
- Library/summary of methods, for reference
- Regular/preventive inspections and maintenance cases have much smaller emissions.
- Degradation of component performance should be considered.
- Could be subjective
- Feedback on actual energy consumption (after project) is needed; compare actual vs. predicted performance
- Maintenance contracts may not include efficiency aspects, may be just system on/down
- Manufacturing, component selection checklist, e.g., component durability, leak tightness, to reduce emission; e.g., use of flare vs. brazed joints
- There is new ISO standard on durability testing of components
- Are components tested based on durability standard?
- Standard for energy consumption calculation, information
- Standardization of leakage parameters is needed; sensitivity analysis
- Initial LCA focus was on energy flows; we are looking at CO_2 footprint; need to be clear on terminology
- Need to clearly differentiate between LCCP (focus here) vs. LCA
- Refrigerant drop-in aspects: save on equipment replacement/recycle/transport /decomission
- Include use of materials, e.g., magnetic refrigeration?; Fair comparison of different technologies such as heat activated systems
- How to define the minimum amount of information required?

3.4 Next Meetings

Our next meeting is suggested in conjunction with following events:

- The ASHRAE/NIST 2012 Refrigerants Conference: “Moving toward Sustainability” takes place October 29 - 30, 2012, at NIST in Gaithersburg, Md.
- ASHRAE Winter Meeting: January 26 – 30, 2013, Dallas TX
- IIR April 2-3, 2013; Paris
- ASHRAE Denver June 22 - 26, 2013

Yunho Hwang will send out survey email for next meeting among the events above.