EKA, 2022

THESIS PROJECT:

TECHNO ECONOMICAL ANALYSIS OF LARGE REFRIGERATION SYSTEMS - OPERATIONAL AND MAINTENANCE STRATEGIES

Project summary

Large refrigeration systems such as marine HVAC solutions or industrial process refrigeration systems use vast amounts of energy. Even small improvements in system efficiency may have considerable impacts on the cost of operation and not the least on the environmental impact footprint. There are often monitoring systems available, but the practical analysis and interpretation of the actual performance and efficiency may lack.

This proposed work includes practical analysis of field data of real refrigeration systems and especially the compressor performance. One key task the evaluation and techno economic analysis of compressor renovations of large size compressors. Due to the large cooling capacities, the compressor efficiency will have a significant impact on the input power and associated energy.

The target is to find means and measures to evaluate the relevant efficiencies and to determine the techno economic optimum for renovations or other related measures to improve the efficiency and lower the cost of operation and environmental footprint.

The work will include analysing data from field measurements combined with literature studies, experimental work and calculation/modelling. EKA has access to field data where systems can be evaluated from a functional and performance point of view. The consortium behind this thesis task is a cooperation between EKA, Kompressorteknik and KTH.

Involved parties

- EKA provide services within the industrial refrigeration business such as energy and technology inventories, energy saving counselling, design and specification of new energy systems as well as procurement support. To provide energy calculations and to give best possible support to the customers EKA need to have a leading knowledge and command of all aspects of refrigeration systems. In this case this implies the strategies for operation and maintenance such as system optimisation, monitoring tools and predictive maintenance and service with its effect on investment as well as life cycle cost.
- Kompressorteknik are industry compressor specialists with a focus on renovation, repair and servicing of compressors. They have a deep knowledge of many brands and solid experience of many different compressor types where the following can be mentioned; STAL, Sabroe, York, Frick, Gram, Howden, Daikin, Mycom, Trane, FES, VMY / Aerzen and Carrier and more.

Background on marine HVAC

On a cruise ship, the refrigeration systems are really business critical. A malfunction affects many important functions within a ship. Temperature and humidity on board shall be kept within a narrow range for the convenience of passengers. Furthermore, all food and drink must be handled in accordance with current regulations, there are large amounts of refrigerators and freezers on board. Finally, all technical equipment must be protected from elevated temperature and humidity via separate cooling units. It is thus not only a matter of convenience but also, to a very high degree, of safety.

The cruise industry therefore works a lot with preventive maintenance of compressors and units. Our offer to the cruise industry, partly with compressor renovations and partly with service on board, helps to minimize or eliminate operational disruptions.

With our own staff on board the ships, we work with preventive maintenance and perform function checks, so-called performance checks. We disassemble and reassemble compressors, renovated or new and carry out start-up.

For many compressor models, we offer replacement systems to minimize the time for a possible. downtime.

Well-functioning HVAC systems on large cruise ships are not just a matter of convenience. With thousands of people on board in tropical waters, it becomes business critical that all refrigeration systems on board work.

Preliminary tasks:

- Literature study:
  - Marine HVAC, industrial refrigeration system and other large applications
  - System solutions, typical components, commonly used compressors, …
  - Design criteria, capacities, energy usage, environmental impact
  - Compressor and heat exchangers modelling and performance indicators
  - Compressor renovation and potential efficiency improvements
- Field data analysis including complete systems and compressor cases:
  - Compile data from field application(s)
  - Evaluate and develop method(s) for analysis
  - Determine, performance, efficiencies, SEI, COP, heat exchangers, etc.
  - Present evaluation results for the system as well as the components
  - Find the weakest points and propose measures to improve the process
- Modelling:
  - Build a representative system model for a typical marine HVAC system
  - Run simulations/calculations to establish annual energy usage
  - Compare modelling results with field measurements, analyse the difference
- Environmental aspects:
  - New compressors vs renovation
  - Energy usage and related CO2 emissions
  - Refrigerant types and typical leakages in refrigeration system in general and the studied applications in particular (mainly applies to synthetic refrigerants)
- Techno Economical analysis:
  - HVAC - cost of operation
  - Impact of energy saving
  - Cost of replacing a compressor – new vs renovation, is the cost justified?
  - Cost of HVAC system means and measures
  - Visual models for optimisation (i.e. at what compressor efficiency should renovation take place)
- Expected results:
  - Technical, environmental and economic arguments for predictive maintenance and compressor renovation
  - Proposed monitoring systems including critical measurement points
  - Recommended methods for data analyses
  - A guideline for optimised HVAC system operation
- Report:
  - Document and visualise - results, information acquired, methods developed, output, …..
  - The collected knowledge will serve as guideline for the marine HVAC market; therefore, this work should be well documented in a report (English language).

Work plan

The work is supervised in close cooperation with EKA, Kompressorteknik and KTH.
Regular meetings are expected to keep good pace in the project.

Industrial supervisors

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The project is in academic collaboration with the Royal Institute of Technology, Energy Technology – Applied Thermodynamics and Refrigeration, KTH, Stockholm.

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