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SINTEF Energi AS SINTEF Energy Research

Address:

Cases Fish Industry





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Outline

- Fish industry research topics in CREATIV
 - RSW systems
 - Freezing tunnels
 - Drying tunnels
 - Waste heat utilizaton in refrigeration
- Summary





Topics related to fish industry

Торіс	Content	Status
CO2 RSW (Co-op. applied project)	Modeling, component design and control optimization	Demonstrator on fishing vessel in operation
Freezing tunnels	Ceiling design, product and tunnel modeling, fan control strategies	Ready for demonstration
Drying tunnels (Co-op. industry project)	Product and tunnel modeling, fan control strategies	Ready for lab-scale or industrial verification
Utilizing waste heat for refrig. system improvement	Ejector implementation in refrigeration systems	Laboratory testing and conceptual studies performed

Industry HREA Energy

Efficiency



Level of research







The "dream team"

Different activities and tasks but with mutually beneficial cooperation









From fundamentals to industrial prototype







Motivation

- Refrigerated Sea Water (RSW) refrigeration plants are used on fishing boats to cool and preserve the catch
- Replacement for current, environmentally hazardous fluid required
- NH3 (Ammonia) is an existing option, but has specific safety issues (toxicity) are challening for retrofit, and in smaller vessels in general
- CO2 systems have shown great performance in other applications, but require different solutions





CREATIV contribution

- Project was facing a design challenge
 - Common design criteria: capacity at 0°C (RSW tank)
 - But RSW operation is dynamic
- Analyse and improve dynamic operation
 - Develop methods and tools
 - Optimize operation and component design in a transient process
- => Possibility to run high-capacity, high-COP at start up If the system is designed for it!



Result of collaboration

 250kW prototype, installed on fishing vessel

Ongoing work:

- Data collection from prototype CO2 system and commercial NH3 systems during operation
- Compare CO2 and NH3 systems
- Compare operation data to simulation model
- Evaluate current control strategy – recommend improvements







Summary

- CREATIV and applied project "Fremtidens RSW anlegg på fiskebåt"* with co-operation on CO₂ RSW development
- Applied project designed and installed demonstrator on fishing vessel, currently in operation
- CREATIV supported with more fundamental basis;
 - Modeling of components and dynamic model of system
 - Steady state simulations to aid in novel heat exchanger design
 - Dynamic simulation of various operation modes and conditions to determine efficient and secure control of system

* Next-generation RSW systems on fishing vessels





Ongoing/further work

- CREATIV plans:
 - Together with industry project aquire logged data for CO2 prototype and commercial NH3 system in operation
 - Use logged operation data to verify models and suggest improvements



Freezing tunnels Improving operation based on advanced simulation models





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Motivation

- Freezing tunnels are energy demanding industrial processes
 - Energy use may be minor part of turn-over, but significant to margins
- Studies have shown great potential for improvement to energy efficiency
- The industry is generally aware of possibilities for improvements
 - Challenging and risky to test, disturbs core processes => sticks to "normal practice"
 - Still: Different solutions for improvement have been implemented by the industry, effect is largely un-documented
- CREATIV role: Methodic approach; evaluate existing solutions and suggest improvements.
 - Focus on fan power and control: Fan power is significant, and adds heat to the freezing tunnel air. Improvements have multiple effects on system power consumption





Model Freezing tunnel



Industry Energy

Efficiency

В



Scope

- Investigation of air flow in tunnels
- Optimization of ceiling design to improve air distribution and reduce fan work
- Investigate control strategies for fan control to reduce power consumption of fans and refrigeration system
- Industry-scale measurements and evaluation of different fan control strategies





Summary

- CREATIV sub-topics
 - Optimization of ceiling design to improve air distribution and reduce pressure drop
 - Equalize freezing times for products across tunnel
 - Reduce the significant energy consumption to fans and refrig. system
 - Investigate control strategies for fan control to reduce power consumption of fans and refrigeration system
 - Shown great potential for increasing energy efficiency







Ongoing/further work

- Desirable to evaluate fan control strategies in industrial environments:
 - Challenging due to risk of disturbance on core process
 - Coupled and complex systems
 - Requires instrumentation of refrigeration system and products
 - Several sites contacted; found interest, but systems unsuitable



Drying tunnels

Methodic approach towards knowledge and system improvement







Motivation

- Drying tunnels are energy demanding industrial processes
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 - Still: Different solutions for improvement have been implemented by the industry, but effect is largely un-documented
- CREATIV role: Methodic approach; evaluate existing solutions and suggest improvements.
 - Focus on fan power and control
- two approaches:
 - Improvement of existing drying technology (HPD)
 - Fundamental research on hybrid drying technology (ultrasound and microwave





Existing heat pump drying

- Determination of performance
 - Energy
 - Drying
- Develop dynamic process simulation tools
- Verification
- → New drying concepts
 → Storage drying for clipfish
 → New design of tunnel
 → Controlled volume flow







Fundamental research



Fundamental research

 Microwave drying
 →Drying time reductions of 90% possible







Interaction: new vs. existing technology









Summary

- Co-operation with industrial project "Rasjonell klippfisktørking"*
- Shares problems, solutions and methods that are analoge to freezing tunnel application
- CREATIV sub-topics
 - Dynamic modeling of the drying process
 - Product modeling; describe behaviour of product during drying (very complex)
 - System modeling; describe behaviour of refrigeration system and air circulation
 - Investigate control strategies for fan control to reduce power consumption of fans and refrigeration system

* Rational clip-fish drying

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Ongoing/further work

- Verification of models through lab/industry-scale measurements and evaluation of different fan control strategies
- CREATIV models and methods planned used in industry project tasks natural platform for bringing the results out to the industry



Utilizing refrigeration waste heat with ejector



Motivation and summary

- There are significant unused wast heat from refrigeration systems
- This energy can be used to improve system efficiency or converted to cooling using ejector cycles.
- MSc Student Øystein Hunseth investigated opportunities through conceptual studies and laboratory experiments
- Heat source: Screw compressor oil cooling (60-90°C)
- Gains in efficiency was found with current setup, no further activity







Level of research - Summary

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	Freezing tunnels				
	CO ₂				
			I	> Level	of research
Fundamental		Applied	Demonstr	ation	





Level of research - Summary







Summary and conclusions

- Topics with industry project co-operation experiences significant synergy
- Significant progress on important topics
- Work spans from near-fundamental level to demonstration and prototypes
- Some challenges to demonstrate concepts in industrial environments





Thank you for your attention!



