IceBook

A new approach to ammonia/water absorption refrigeration

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March 2014
Content

• Brief background to the IceBook project
• Basic Principals in ammonia absorption cooling
• Shortcomings of existing technology
• “IceBook Concept” - Efficient, scalable, modular cooling
• How it Works - Key Elements
• Practical Challenges
• Future Roadmap
Project Background

• 1996: Dr Gerhard Kunze, Professor of Physics (Vienna) heads up an Aid project in Tanzania to create dairy solar cooler.
• Dr Kunze continues the development of these concepts, working with the Group for Appropriate Technology (GrAT).
• 2001: SolarFrost Research formed to further the development of absorption chillers suitable for use with Solar Energy.
• 2010: SolarFrost Research partners with New World Machines to develop and commercialise high efficiency, compact, scalable and modular absorption chillers.
• 2014: Release of “IceBook”, Version 6, a modular, high efficiency absorption chiller, co-invented by Gerhard Kunze and Marshal Rubinstein. The chiller includes novel electronic optimisation techniques.
How can we cool with heating?
The simplest example: Crosley IcyBalls

Source: crosleyicyball.com
Icy-Ball

(NH₃) + H₂O

(NH₃)
NH₃ Absorption Machine

Condensor (P ~10 Bar) → Liquid NH₃ → Evaporator (P ~3 Bar)

NH₃ Gas

Generator (P ~10 Bar) → Weak Solution → Absorber (P ~3 Bar)

Strong Solution
Absorption Chiller Challenges

- Poor performance at high back-cooling temperatures
- Don’t scale well to small, low powered units
- Expensive
- High volume / kW cooling
- Typically have low efficiency (heat exchanger $\Delta T$ is high)
The IceBook

• Operates at high back cooling temps.
• High Efficiency
• Compact and Scalable
• No ammonia pumps
• Minimal moving parts
• Economical to mass produce
• Can scale to both very small and large sizes because of modular design.
Key Elements

- Novel Layered Architecture
- Special Heat Exchangers
- Pressure Injection mechanism
- Novel refrigeration cycle
- Adjustable Cooling temperature
- Electronic performance control
Novel Layered Architecture
Ideal Cooling Cycle

- **Condensation Pressure**: Defined by backcooling temperature.
- **Absorption Pressure**: Defined by cooling temperature.
- **Boiling**: Indicates the point of boiling temperature.
- **Pre-heating**: Shows the temperature before precooling.
- **Precooling**: Represents the temperature after preheating.

Temperature (°C):
- Cooling T=0°C
- Backcooling T=40°C
- Heating T=146°C defines concentration change.

Pressure (bar):
- K100%
- K60%
- K50%
- K40%
- K30%
- K20%
Real Cooling Cycle with Heat-Exchanger Temperature Drop of DeltaT = 10°C

condensation pressure defined by achieved backcooling temperature

evaporation pressure defined by necessary cooling temperature

necessary real cooling T = -10°C
achieved cooling T = 0°C
backcooling medium T = 40°C
backcooling achieved T = 50°C
max. achieved heat T = 135°C
heating medium T = 146°C

boiling
preheating
precooling
absorption

Pressure (bar)
The Challenges

• Building absorption chillers is really hard!
• High Pressures
• Corrosive and Toxic Ammonia
• High Temperatures
• Critical design parameters (complex thermodynamic calculations)
• Time consuming design iteration loop
• Expert work, no existing workforce skilled in this area.
Making IceBook Pages
Prototype Assembly
Test Bench
COP for Different Backcooling and Heating Temperatures

- **Calculated COP**
  - Y-axis: 0 to 1.4
- **Backcooling Temperature (°C)**
  - X-axis: 25 to 40

**Heating Temperatures:**
- Blue line: COP (100°C)
- Pink line: COP (120°C)
Roadmap forward

- Completion of Version 7 IceBook, 3.5kW Cooling
- Independent Testing at Oak Ridge National Lab (USA)
- Completion of Version 8 IceBook, 17.5 kW Cooling
- 2 Pilot Installations scheduled in USA
- Move to Mass production
- IceBooks for solar powered refrigerated food storage
- Third world humanitarian impact (OneFridge)
Thank You

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