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Case Study

Conversion of Platelet Incubator to Hydrocarbon Refrigerant

Presented by:

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Helmer SCIENTIFIC

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Introduction

About Helmer Scientific

- Founded in 1977, Helmer designs and manufactures medical-grade cold storage equipment to help our customers deliver the highest standard of patient care.
- Based in Noblesville, Indiana, Helmer supports clients in hospital laboratories, pharmacies, and blood banks in more than 125 countries. Virtually every hospital in the U.S. has a Helmer product.

Motivation

- EU F-Gas regulation banning HFC refrigerants
- US EPA SNAP Regulation Rules 20 & 21 delisting HFC refrigerants
- Advantages of HC refrigerants
  - Environmentally friendly
  - Very low or zero efficiency penalty
  - Wide manufacturer and customer acceptance as well as supplier support

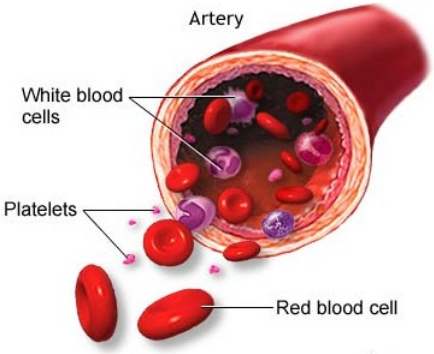
About Creative Thermal Solutions (CTS), located in Urbana, IL

- CTS was founded in 2004 as University of Illinois spin-off company to perform confidential R&D services for HVAC & R industries
- Closely linked to U of I's Air Conditioning and Refrigeration Center (ACRC)
- CTS offers product development, research, consulting, testing, modeling, training courses
  - Mobile and stationary heating and cooling applications
  - Sustainable, energy efficient solutions
- 40 full-time employees; specialists and experts with diverse technical backgrounds
- Cutting edge facilities with 100,000 sqft of lab and office space; 43 environmental chambers
- ISO 17025 accreditation

Platelet storage systems

Primary Function and Users

- To provide the controlled temperature environment and constant agitation required for the safe storage of platelet products
- Used by hospitals, transfusion centers, blood banks, and pharmaceutical labs

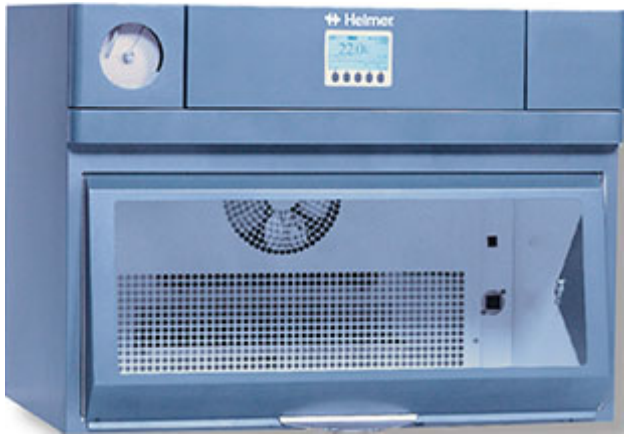


http://blog.inceptsaves.com/files/2012/02/platelets.jpg

Components

Incubator

- Houses one or more agitators
- Maintains a constant storage temperature



Agitator

- Placed inside an incubator
- Provides constant agitation

Specifications

- Storage capacities range from 15 to 396 platelet bags
- Controlled temperature range is 20-35°C; uniformity is ±1°C
- Indoor operating ambient temperature range is 15-35°C

Conversion of existing R134a incubator to R600a

- Only very minor system changes with some technical challenges:
- Hydrocarbon refrigerant charge limit of 150g to mitigate flammability risk
- Pressure drop and refrigerant velocity in existing lines and heat exchangers
- Compressor availability (high back pressure, small capacity, US voltage)
- Capillary tube and charge adjustment to match heat infiltration load
- Evaporation temperature above freezing

Initial hydrocarbon conversion assessment based on refrigerant properties:

- Hydrocarbon refrigerant charge based on HFC charge
- Compressor size
- Refrigerant pressure drop and velocity in tubes

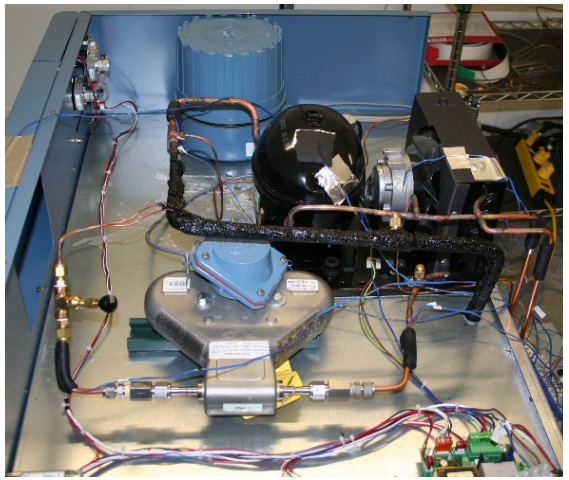
Refrigerant		R134a	R600a	R290
Name		1,1,1,2-Tetra-fluoro-ethane	isobutane	propane
Liquid density at 55°C	kg/m^3	1094	515	446
Density ratio HC/R134a	-		47%	41%
System charge (estimation)	g	142	67	58
Volumetric capacity	kJ/m^3	2668	1446	3413
Volumetric capacity ratio	-	100%	185%	78%
Compressor displacement (same capacity)	cm^3	4.5	8.3	3.5
Fluid ideal COP 10/55/20°C & 3K SC	-	4.95	5.15	4.83
		100%	104%	98%
Vapor velocity in suction line 3/8"	m/s	1.72	3.18	1.35
Pressure drop in 1 m of suction line	Pa	67	69	30
Liquid velocity in liquid line 1/4"	m/s	0.05	0.06	0.07

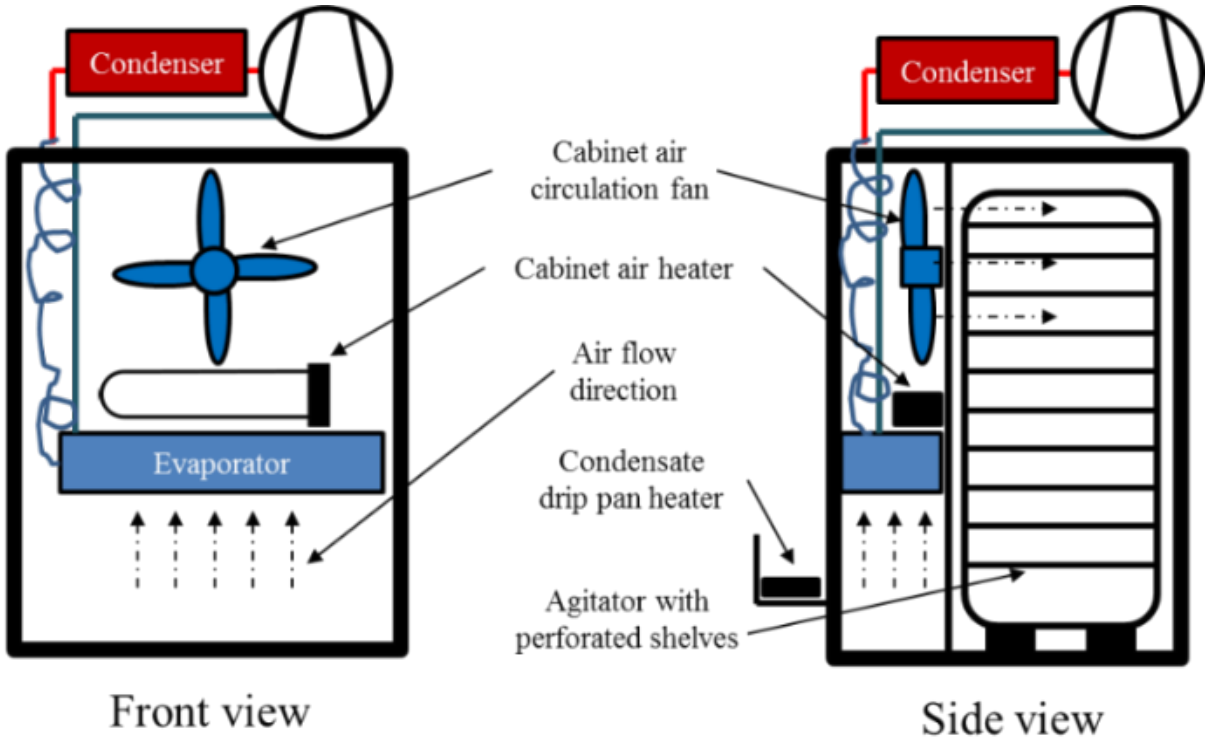
Unit preparation and modifications

- Platelet incubator principle of operation
- Instrumented system with TC, pressure transducers and mass flow meter

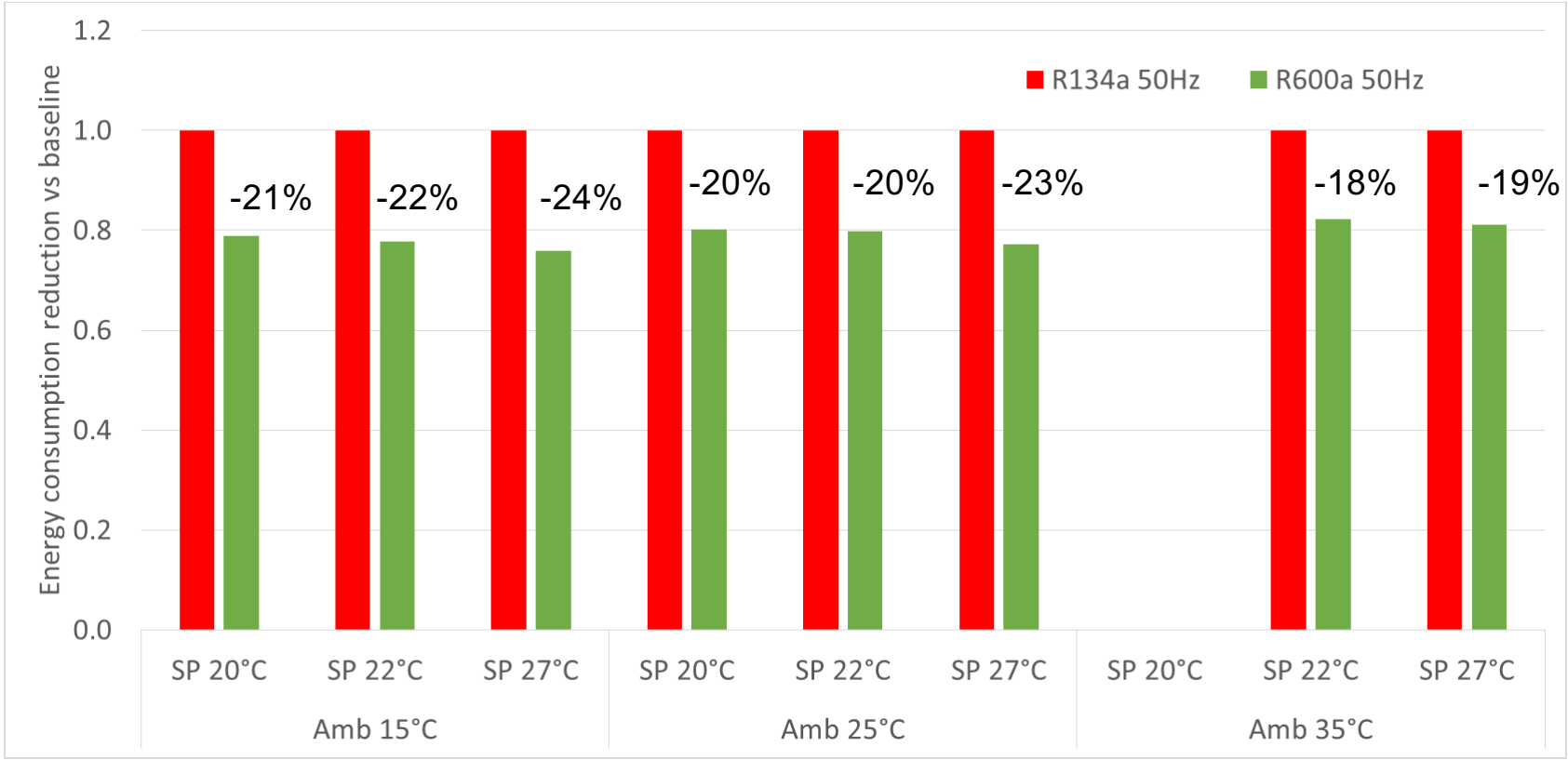
Implemented modifications:

- Compressor replaced
- Capillary tube adjusted
- Hot gas loop as condensate heater



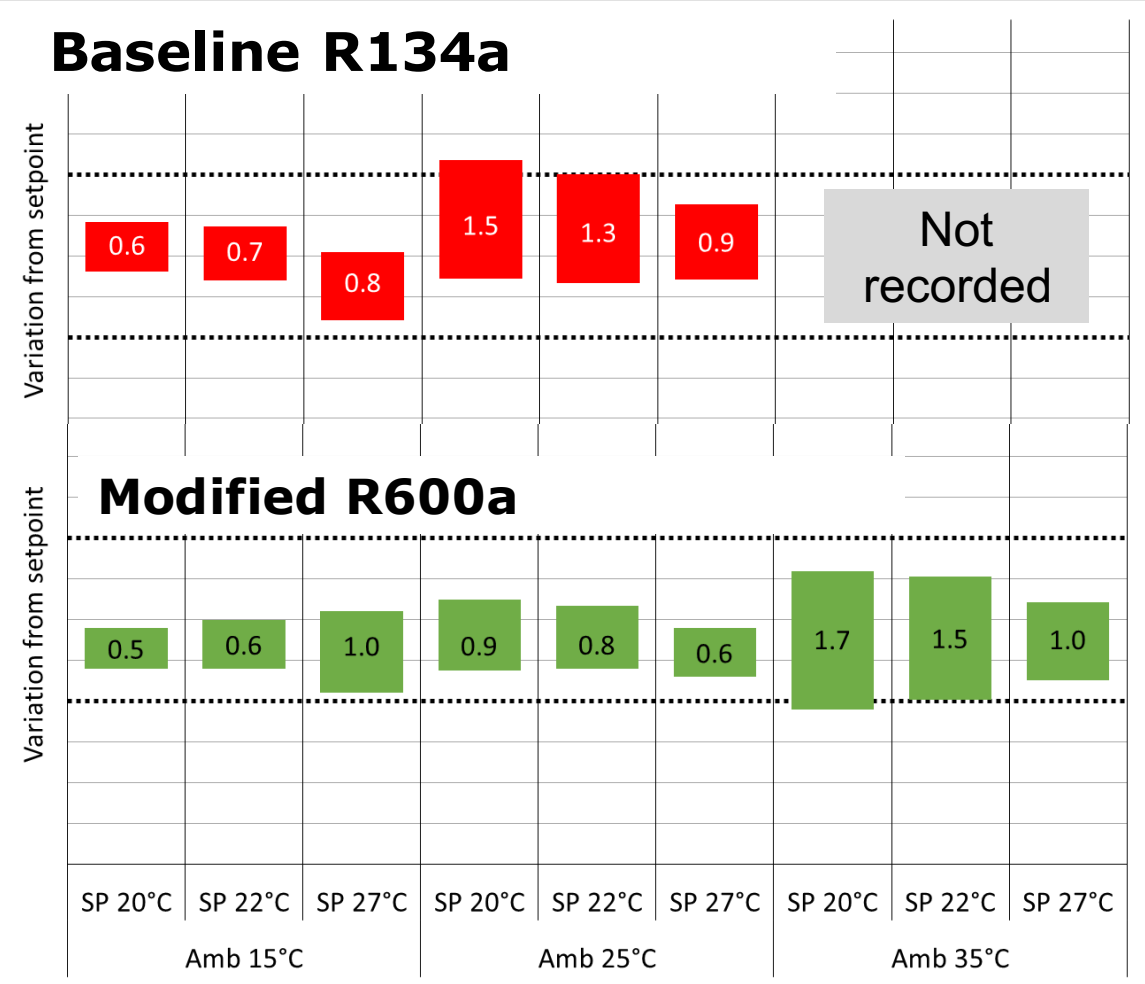


20% lower energy consumption with R600a



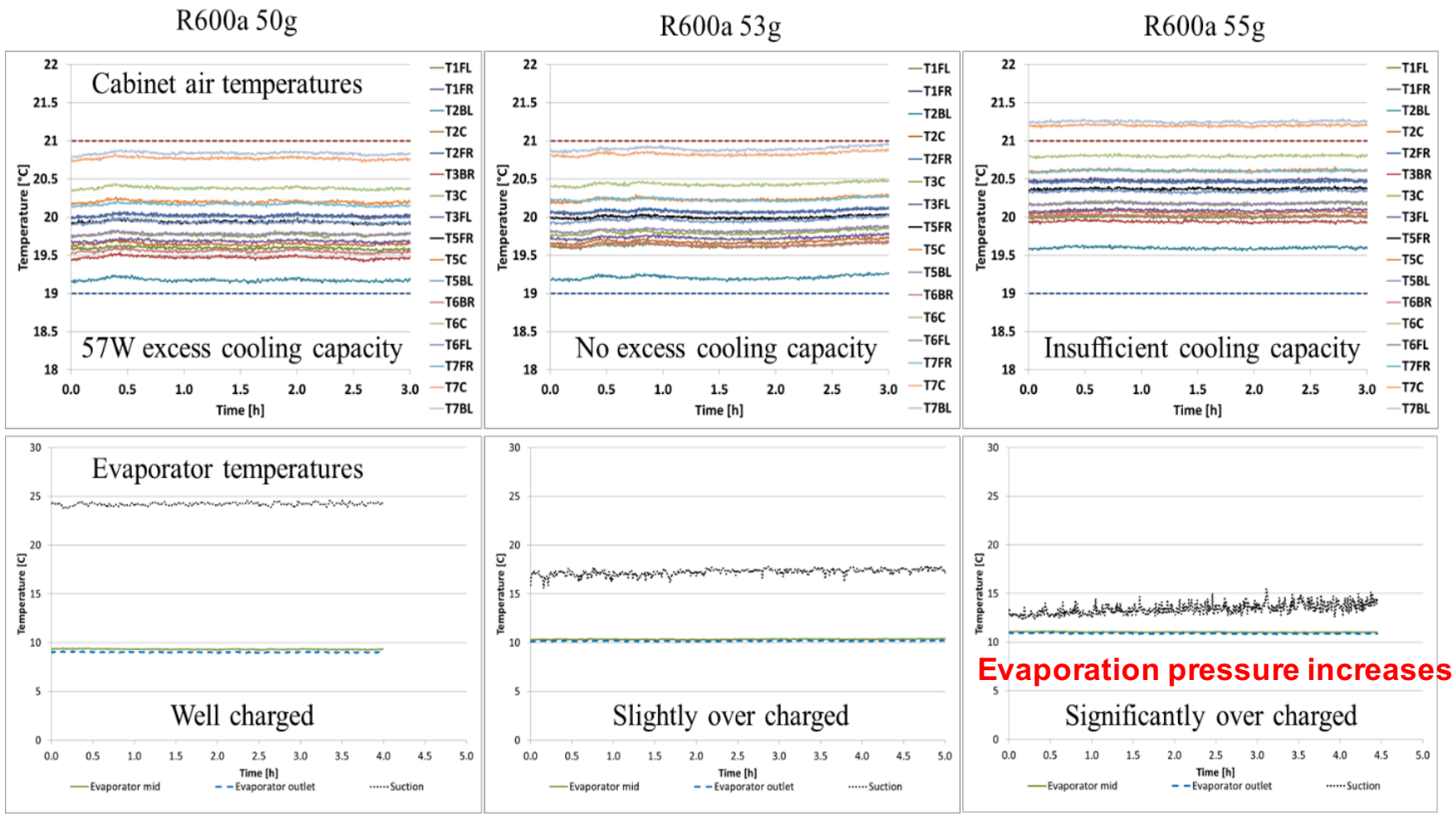
- Reduction of energy consumption on the order of 20%
- For identical equipment cost: shorter payback periods

Cabinet air uniformity R134a vs. R600a



- Required temperature uniformity reached and even improved for converted hydrocarbon incubator
- Temperature uniformity at ambient conditions similar to air-conditioned laboratory is +/- 0.5°C

Impact of refrigerant charge on performance



- Low charge systems are more sensitive to accurate charge amount
- In critically charged systems small variation of charge has large effect on the performance
- Incubator's 50g of charge is far below the limit of 150g

Compressor flooded with liquid

Conclusions

- Refrigeration system of specialty medical equipment such as platelet incubator can be converted to low GWP hydrocarbon refrigerant with minimum system changes without compromising its thermal performance and reliability
- Compressor, capillary tube adjustment and refrigerant charge amount are necessary changes of the system
- Energy consumption of R600a system is 20% lower than with R134a baseline
- Hard to find small capacity high back pressure compressors for 120V-60Hz
- R600a compressors are more efficient than R134a models for this application
- Accuracy of charging equipment needs to be assured during production process to achieve performance repeatability and incubator reliability with isobutane – refine sensitivity
- Technology may be applied to other pharmaceutical / medical appliances

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Thank you very much!