



Business Case for Natural Refrigerants

June 12-14, 2018 – Long Beach

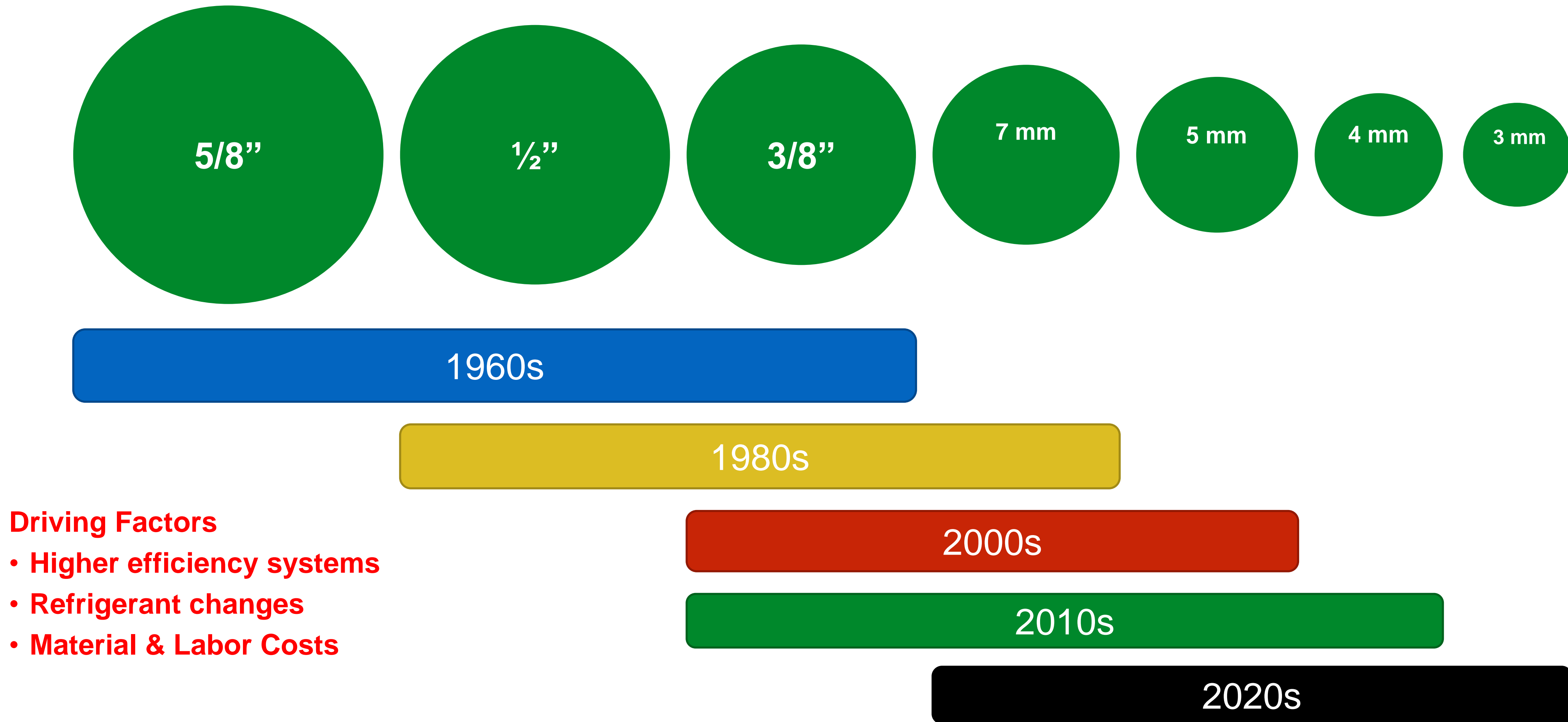


Performance Testing of MicroGroove Heat Exchangers with Natural Refrigerants

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1. **MicroGroove and reduced refrigerant charge.**
2. Early performance data on MicroGroove tubes
3. Success in AC arena with MicroGroove
4. **MTL Technologies**
 - a. History
 - b. Prototype R290 heat exchangers
 - c. Recent performance data
 - d. MTL Technologies current production
5. Global Trends

MicroGroove and reduced refrigerant charge.

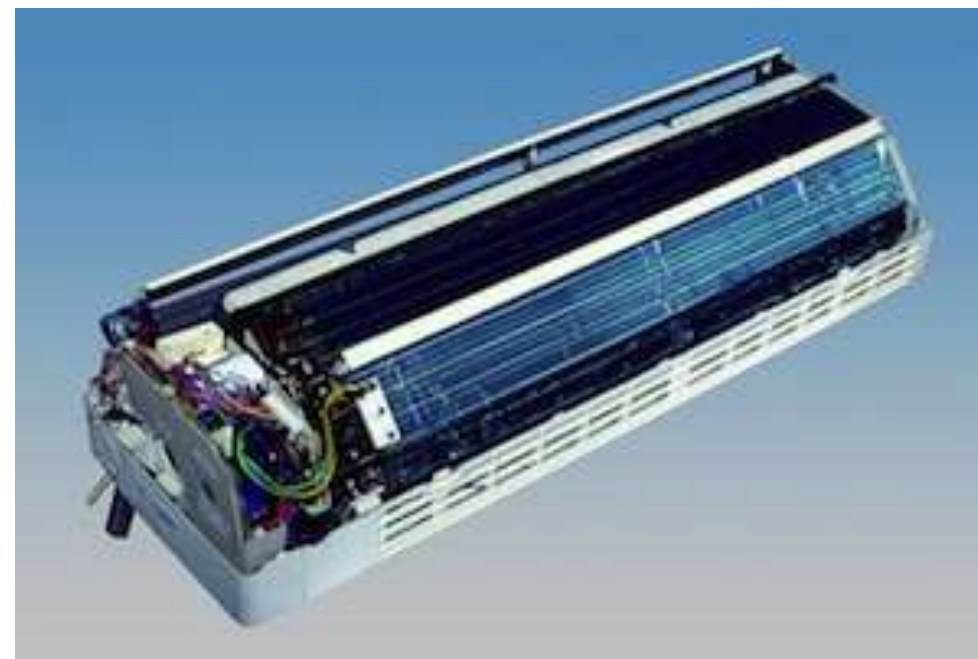


MicroGroove and reduced refrigerant charge.

Reduce the tube diameter and increase tube length:
Same performance with less refrigerant.

	Hold L Constant	Hold Performance Constant	Hold SA Constant	Hold V Constant
Tube Diameter	↓	↓	↓	↓
Total Tube Length	constant	↑	↑	↑↑
Surface Area	↓↓	↓	constant	↑
Volume	↓↓	↓↓	↓	constant
Weight	↓↓	↓	constant	↑
HTC	↑	↑	↑	↑
Performance	↓	constant	↑↑	↑↑↑

Early Performance Data on MicroGroove

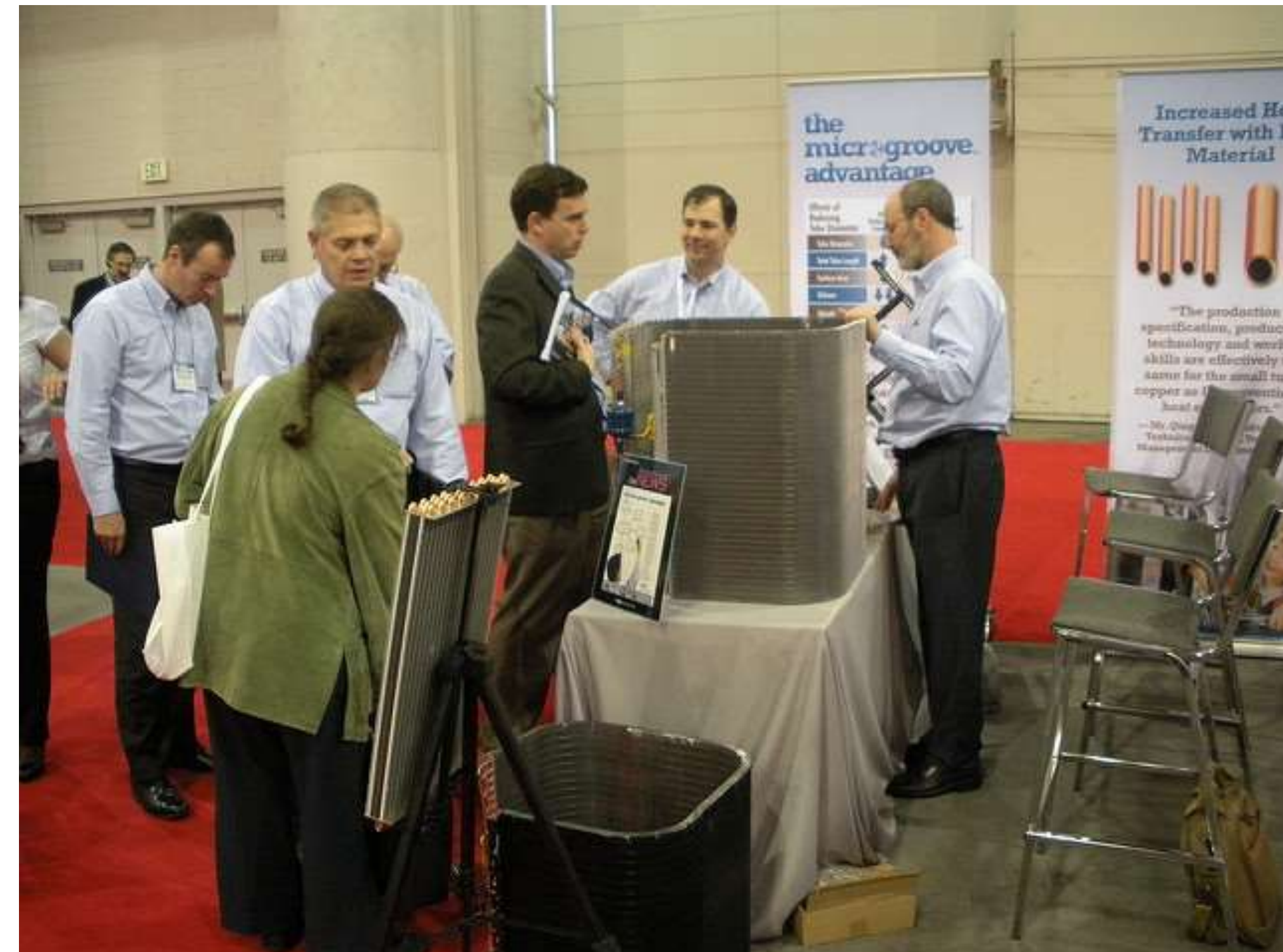


Five millimeter outer-diameter (5 mm O.D.) copper tube technology used in China since before 2010 for high volume AC applications.

Evaporator made from 5-mm copper. (Courtesy Kelon.)

Early performance data on MicroGroove tubes

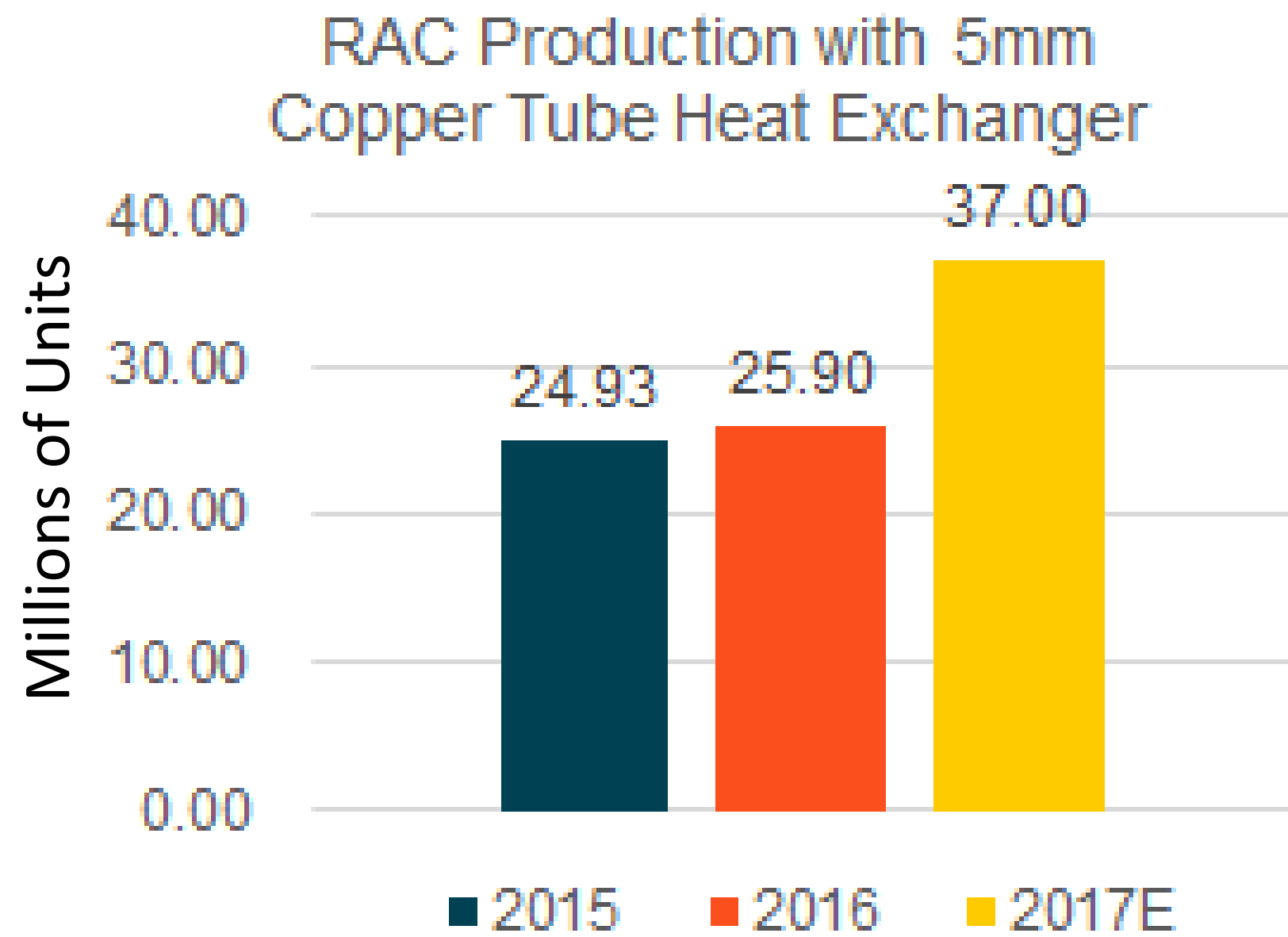
MicroGroove Debuted at the AHR Expo in 2011



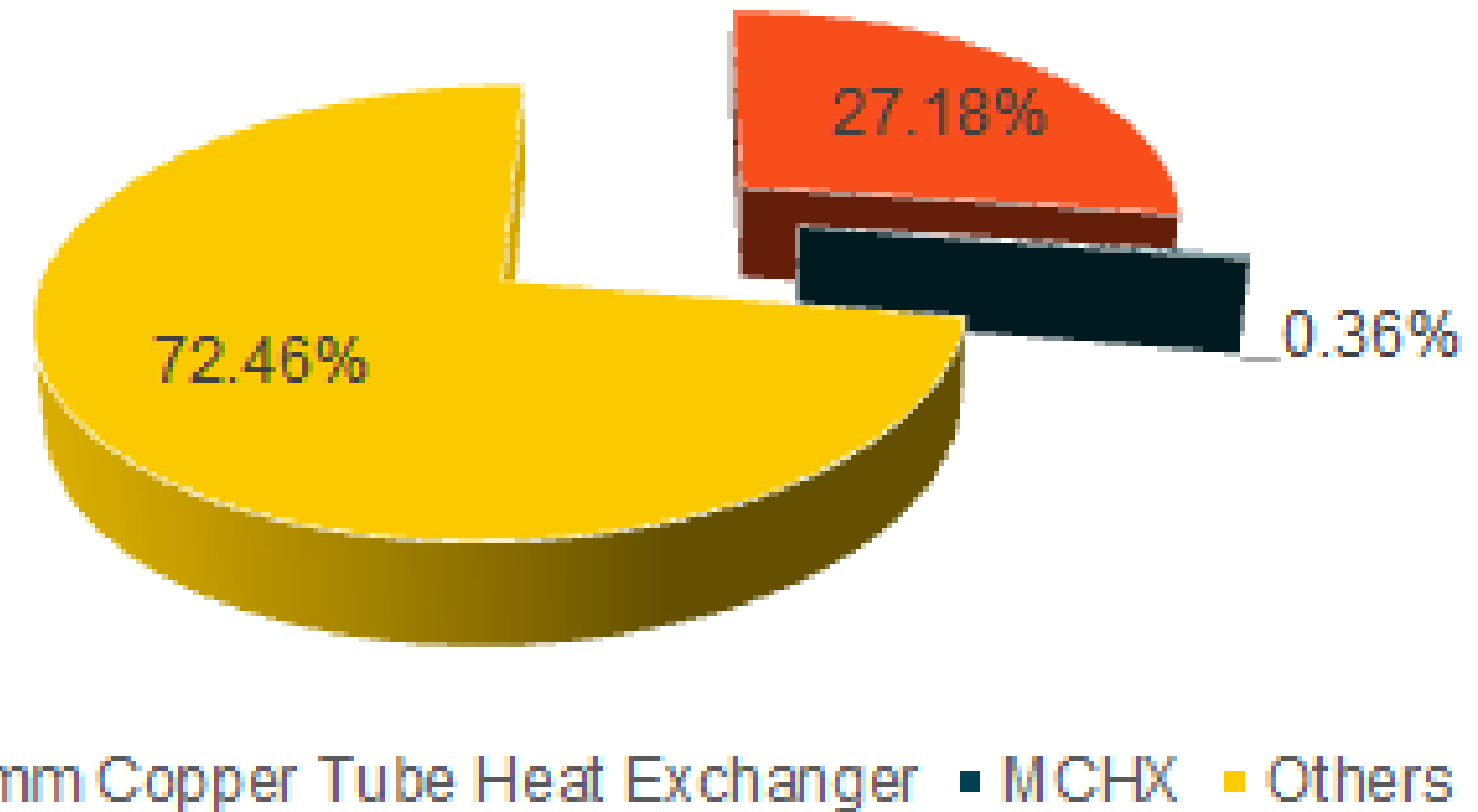
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Success in AC arena with MicroGroove



The Penetration of RAC Production with 5mm Copper Tube Heat Exchanger



Of the 136 million RAC units made in 2017, 37 million were made with 5-mm smaller diameter copper-tubes. (Source: Brilliant Consulting.)

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MTL Technologies history

Noticed two trends in the refrigeration:

1. Progression to smaller-diameter tubes
2. Use of low-GWP natural refrigerants

Applying their know-how in process cooling systems, MTL Engineers designed a whole new line of light commercial refrigeration systems using R290.

Freshpet® was among its first customers.

Super Radiator Coils provides prototype heat exchanger designs.



MTL Technologies history

Manufacturing Production Line Opened in 2017

Punch



Paint



Insulate



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Prototype MTL Heat Exchangers

Typical heat exchanger coils using smaller diameter copper

Evaporator



Condenser



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MTL Technologies Recent Performance Data



VISTA DOUBLE-DOOR DISPLAY CABINET 115V

CAPACITY: 750 L (26.5 CU FT)

- Type 1 Refrigerator. Ambient conditions 75°F/55% RH
- AMPERAGE:
 - R134a – 10.50A
 - R290a – 6.09A.....**42% reduction**
 - ✓ 5mm MicroGroove evaporator tubing
 - ✓ 5mm MicroGroove condenser tubing
 - ✓ ECM fan motors on both evaporator and condenser
 - ✓ LED lighting
- Refrigerant charge reduction.....**38%**
- Product Pulldown from 75°F to 38°F, improved by..... 9%

MTL Technologies

Recent Performance Data



LP-300 SINGLE DOOR DISPLAY CABINET 115V

CAPACITY: 300 L (10.6 CU FT)

- Type 1 Refrigerator. Ambient conditions 75°F/55% RH
- AMPERAGE:
 - R134a – 3.60A
 - R290a – 1.90A.....**47% reduction**
 - ✓ 5mm MicroGroove evaporator tubing
 - ✓ 5mm MicroGroove condenser tubing
 - ✓ ECM fan motors on both evaporator and condenser
 - ✓ LED lighting
- Refrigerant charge reduction.....**43%**
- Product Pulldown from 75°F to 38°F, improved by..... 8%



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MTL Current Production

Typical MTL Products



MTL Current Production

Double Door



Single Door



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Prior ATMO Presentations

Prototype R290 heat exchanger designs described at ATMOSphere Conferences:

Chicago, 2016 <http://www.atmo.org/media.presentation.php?id=920>

New copper-tube technologies for heat exchangers: R290 coil and R744 gas cooler

By Yoram Shabtay, Jian Yu & Nigel Cotton

San Diego, 2017 <http://www.atmo.org/media.presentation.php?id=1051>

Select case studies of copper heat exchanger coils for natural refrigerants

By Yoram Shabtay & Nigel Cotton

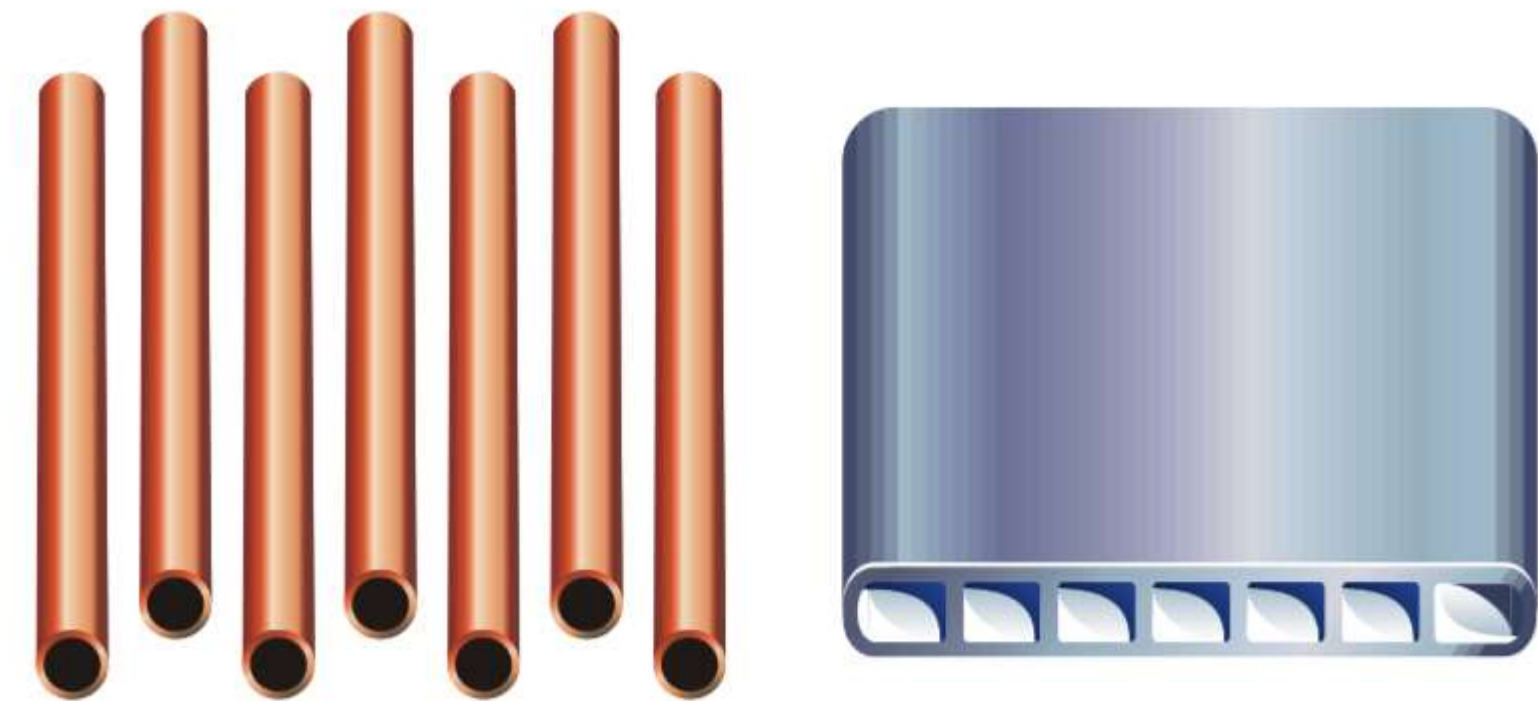
MicroGroove versus MicroChannel:

Stefano Filippini, Umberto Merlo, New Finned Heat Exchanger Development with Low Refrigerant Charge, ICR 2011, August 21 - 26 - Prague, Czech Republic, Paper 296.

Hipchen, J.C.; Weed, R.D.; Zhang, M., & Nasuta, D. (2012). Simulation-Based Comparison of Optimized AC Coils Using Small Diameter Copper and Aluminum Micro-Channel Tubes. *International Refrigeration and Air Conditioning Conference*.

Lu-Ve MINICHANNEL[®] heat exchanger

“The extraordinarily efficient performance of the heat exchanger is due to the optimum combination of special profile aluminium fins and high-efficiency \varnothing 5 mm tubes with internal grooves.”



2012: Propane AC Designs in China!

Guoliang Ding *et alia*, Developing Low Charge R290 Room Air Conditioner by Using Smaller Diameter Copper Tubes, *10th IIR Gustav Lorentzen Conference on Natural Refrigerants*, Delft, The Netherlands (2012) Paper 183.

Developing low charge R290 room air conditioners using smaller diameter copper tubes, ATMOsphere America 2013

Presented by: John Hipchen

Author: Wenson Zheng, Copper Alliance, Asia

<http://www.atmo.org/media.presentation.php?id=270>



ATMO
sphere

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Thank you very much!

