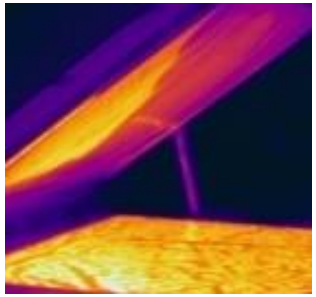
Heat Pumps for Low-Temperature Industrial Process Heat



Kurt Roth, Ph.D.
Fraunhofer USA Center for Manufacturing Innovation CMI, Energy Systems Team

"Widening the Lens on Innovation for Clean Manufacturing"

February 3, 2021

Fraunhofer USA

Question: How can we leverage the extensive and ongoing innovation in buildings-related heat-pump technology for industrial application?

Many practical challenges exist for higher temperatures:

- Refrigerant properties, pressure
- Compressor redesign
- Large air-side heat exchangers
- Limited innovation to date because of low-cost gas

Table 3-1: Refrigerants, considered to be suitable for IHPs

Refrigerant	Chemical formula	GWP	Flammability	T_c °C	p_c M Pa
R-290	CH3CH2CH3	~20	yes	96.7	4.25
R-601	CH3-CH2-CH2-CH2-CH3	~20	yes	196.6	3.37
R-717	NH3	0	yes	132.25	11.33
R-744	CO2	1	none	30.98	7.3773
R-1234yf	CF3CF=CH2	<1	weak	94.7	3.382
R-134a	CF3CH2F	1,430	none	101.06	4.0593
R-1234ze(E)	CFH=CHCF3	6	weak	109.37	3.636
R-1234ze(Z)	CFH=CHCF3	<10	weak	153.7	3.97
R-245fa	CF3CH2CHF2	1,030	none	154.01	3.651
R-1233zd		6	none	165.6	3.5709
R-1336mzz		9	none	171	n. a.
R-365mfc	CF3CH2CF2CH3	794	weak	186,85	3.266

Sources: IEA Annex 35 (2014).

Fraunhofer USA

2

Example: Mayekawa CO_2 Industrial Heat pump

- Co-generates 120°C air + 25°C chilled water
  - Chilled water inlet = 30°C
- COP_{heat}=3.1, COP_{cool}=2.1 (T_{amb}=20°C)
- Capacity = 89kW (~300 kBtu/h)
- Target applications:
  - Drying / Dehumidifying
  - Laminator, Coater, Gravure printing

Sources: Mayekawa (2021).

3

Potential Opportunities:

- New refrigerants
- Non-Vapor Compression cycles
- “Waste” heat upgrade
- Process re-engineering for lower temperatures
- “Tricks” from high-lift buildings applications
  - Cascading systems
  - Refrigerant economizer
  - Multi-stage systems
- ***Your answers here!***

BOSTON UNIVERSITY

Contact

Kurt Roth, PhD

kroth@fraunhofer.org

+ 1 617 353-1895

15 Saint Mary's Street

Brookline, MA 02446

Fraunhofer USA