Indus Engineering

Heat Exchanger Design Case Study
Monobloc Heat Pump Evaporator

Customer Requirement

- **Development of mobobloc heat pump evaporator (Condenser during defrosting)**
- **Use of next generation low GWP refrigerant gas to reduce environmental impact of HFC**
- **Reduction of material cost and refrigerant charge**

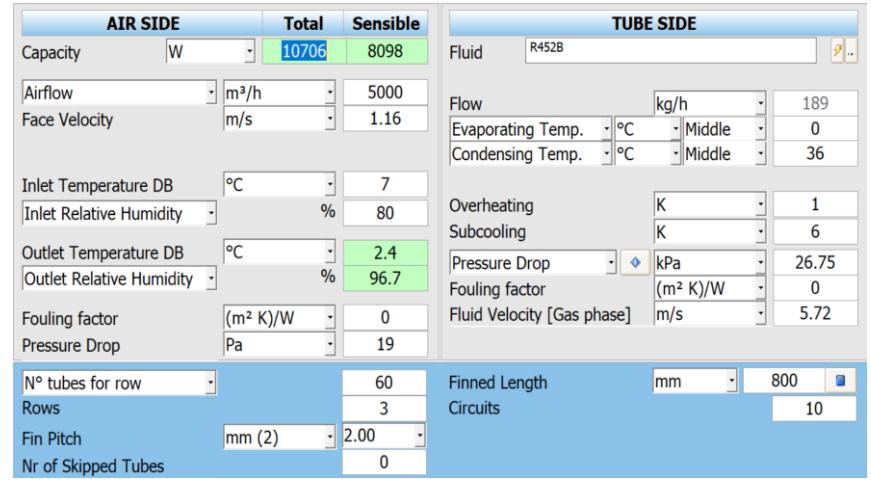
Task

- Design of heat pump evaporator coil with low GWP refrigerant R452B

- Task is to achieve:
  - Maximum performance keeping wide fin spacing
  - Minimum pressure drop both air side and refrigerant side
  - Lower superheating and subcooling values
  - Mounting of Evaporator within existing coil envelope

Actions

- Indus Engineering team took up the challenge and with our software simulation program and HVAC/ refrigeration system knowledge, evaporator design were carried out



AIR SIDE		Total	Sensible
Capacity	W	10706	8098
Airflow	m³/h		5000
Face Velocity	m/s		1.16
Inlet Temperature DB	°C		7
Inlet Relative Humidity	%		80
Outlet Temperature DB	°C		2.4
Outlet Relative Humidity	%		96.7
Fouling factor	(m² K)/W		0
Pressure Drop	Pa		19
N° tubes for row			60
Rows			3
Fin Pitch	mm (2)		2.00
Nr of Skipped Tubes			0

TUBE SIDE			
Fluid	R452B		
Flow	kg/h		189
Evaporating Temp.	°C	Middle	0
Condensing Temp.	°C	Middle	36
Overheating	K		1
Subcooling	K		6
Pressure Drop	kPa		26.75
Fouling factor	(m² K)/W		0
Fluid Velocity [Gas phase]	m/s		5.72
Finned Length	mm		800
Circuits			10

- Tube diameter selection:
  - Simulation with different tube diameter to minimize internal volume of coil
  - Minimisation of refrigerant charge of R452B refrigerant
  - Keeping desired performance of coil

Actions

- **Fin Selection:**
  - **Performance simulation carried out with different fin geometry**
  - **Keeping wide fin spacing**
  - **Meet less air side pressure drop and fast defrosting**
  - **Use of pre-coated fins to minimise air flow blockage**

Solution

- Based on various iterations, we choose two geometries:
  1. Mini-channel tube of 5mm OD and compact fin geometry pattern 20 x 17.32mm and sine wave type fin
  2. Tube of 7mm OD and fin geometry pattern 25 x 21.65mm and sine wave type fin

5MM DIA TUBES

indus

Solution

- **Compressor flow rate design:**
  - Refrigerant flow rate is designed for a certain level of superheating and subcooling

- **A complete matrix of simulation results was prepared with various options**

- **After deliberation, optimum performance and cost viable option is selected with 7mm OD tube**

Solution

- Coil circuit designed to keep refrigerant side pressure drop optimum
- Sampling and testing were carried out at customer end and coils performed as per desired target

Benefits

- Achieved targeted performance both as Evaporator coil and during defrosting

- Cost Effective Solution:
  - Reduction in material weight by 15% and cost reduction by 18%
  - Low refrigerant charge (A2L Categary Refrigerant)

- Meeting EU f-gas regulations of low GWP refrigerant using R452B compared to R410a