



EUROPE solutions for europe  
natural refrigerants

19 & 20 April, 2016 – Barcelona



# **TRANSCRITICAL CO<sub>2</sub> COMPRESSORS FOR ECONOMIZED CYCLES**



OFFICINE MARIO DORIN SINCE 1918  
**DORIN**<sup>®</sup>  
INNOVATION

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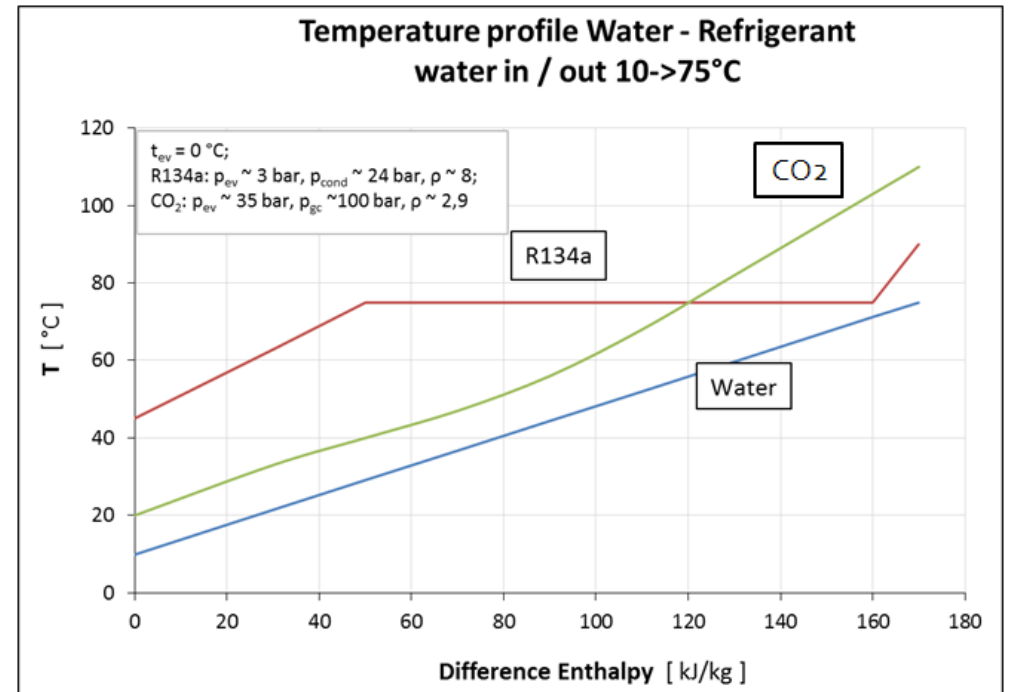
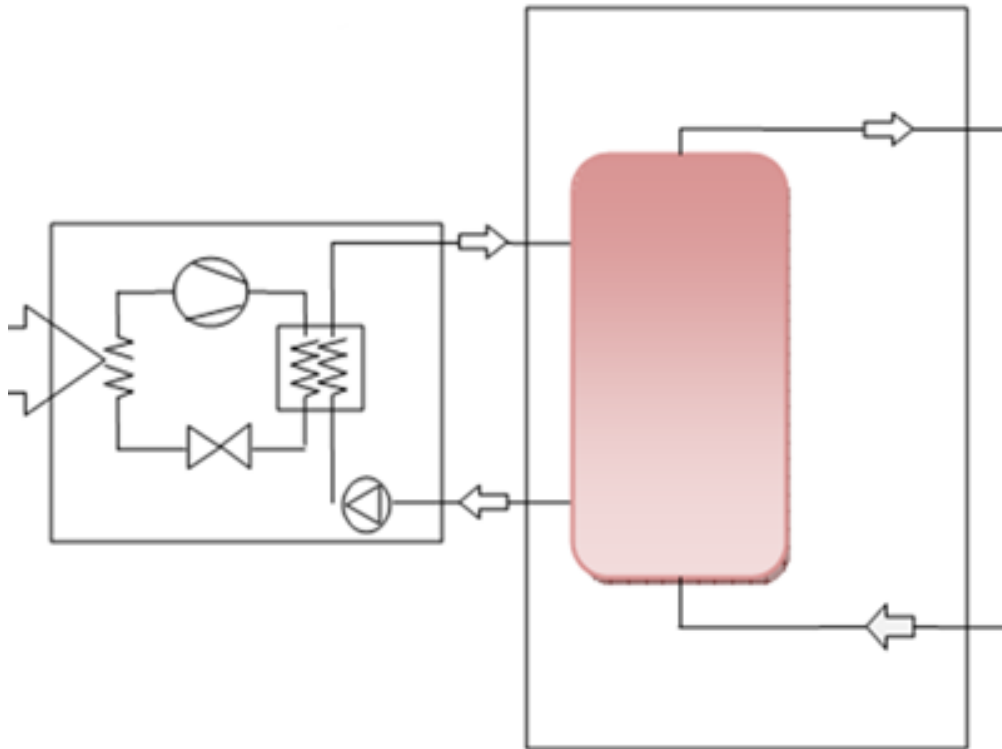
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## 1.INTRODUCTION: DORIN

- **COMPANY FOUNDED IN 1918**
- **FIRST CFC COMPRESSOR: 1932**
- **FIRST SEMIHERMETIC COMPRESSOR: 1952**
- **CO<sub>2</sub> TK APPLICATIONS SINCE 1995**
- **4 PRODUCTION SITES IN ITALY – HQ FIRENZE**
- **1 PRODUCTION SITE IN CHINA – SHANGHAI**
- **SALES OFFICES IN CHINA, RUSSIA AND INDIA**



# 1. INTRODUCTION: CO<sub>2</sub> HEAT PUMPS - STATE OF THE ART



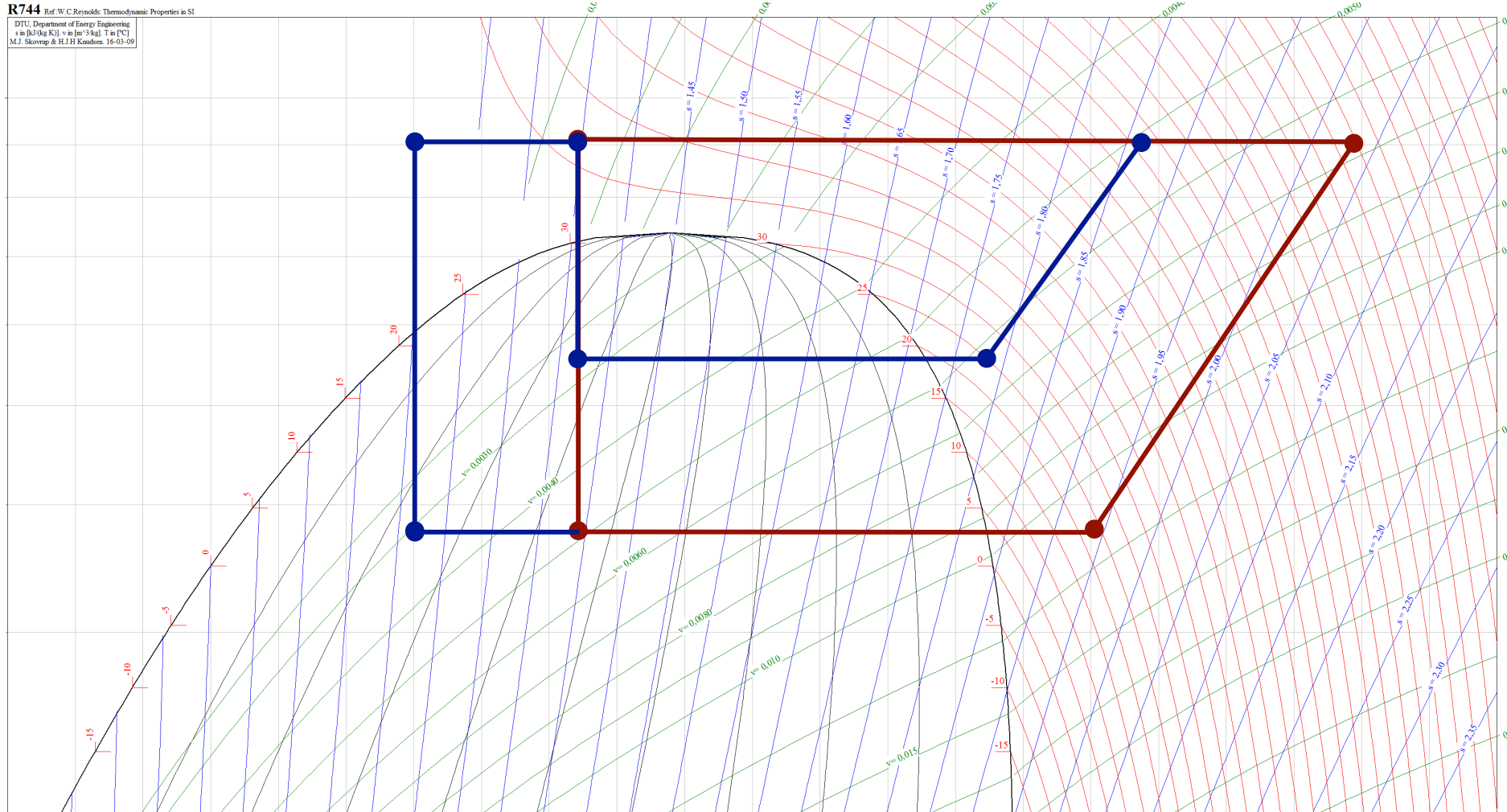
✓ **NO CONDENSATION: WATER TEMP PROFILE IS PERFECTLY MATCHED**

✓ **EXCELLENT COPs FOR LARGE WATER TEMPERATURE LIFT**

✓ **PERFECT FOR SANITARY PURPOSES**

✓ **PERFORMANCE DROP FOR WATER LOOP SYSTEMS**

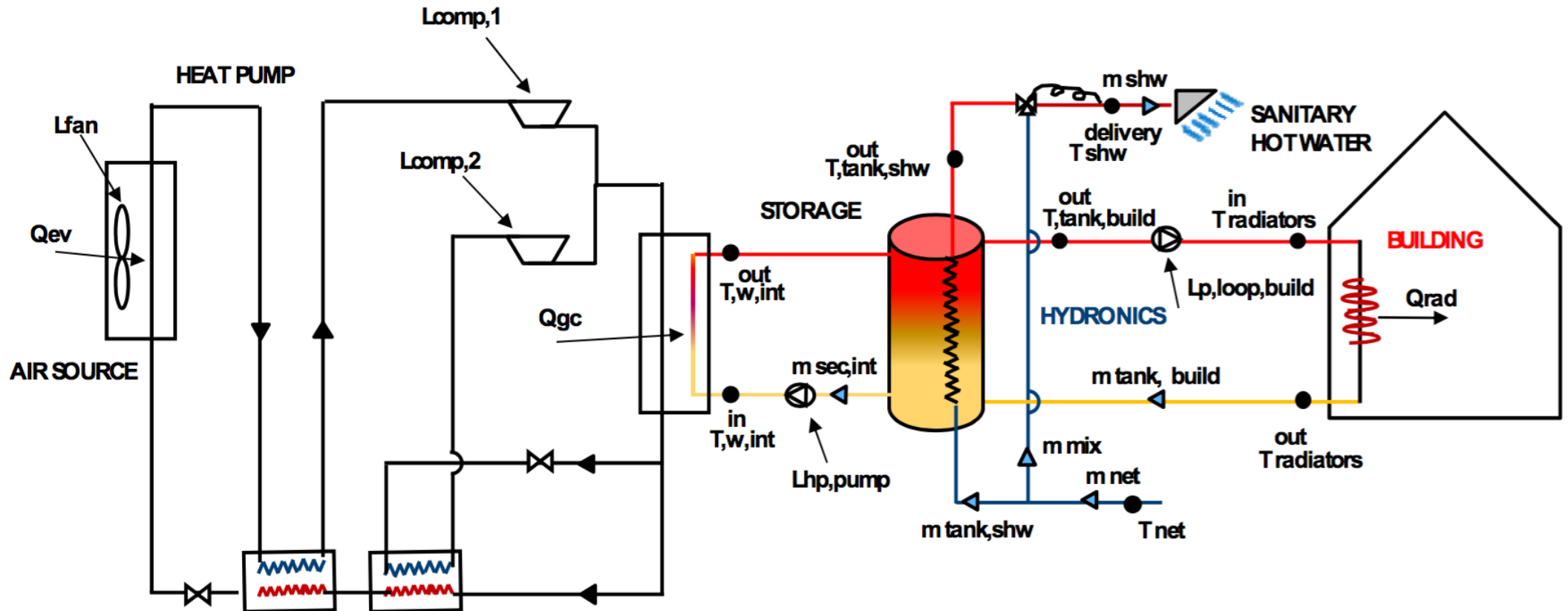
## 2. ECONOMIZED CYCLES: ADVANTAGES FOR HEAT PUMPS



✓ **SIGNIFICANT COP INCREASE**

✓ **POSSIBLE APPLICATION TO WATER LOOP CYCLES**

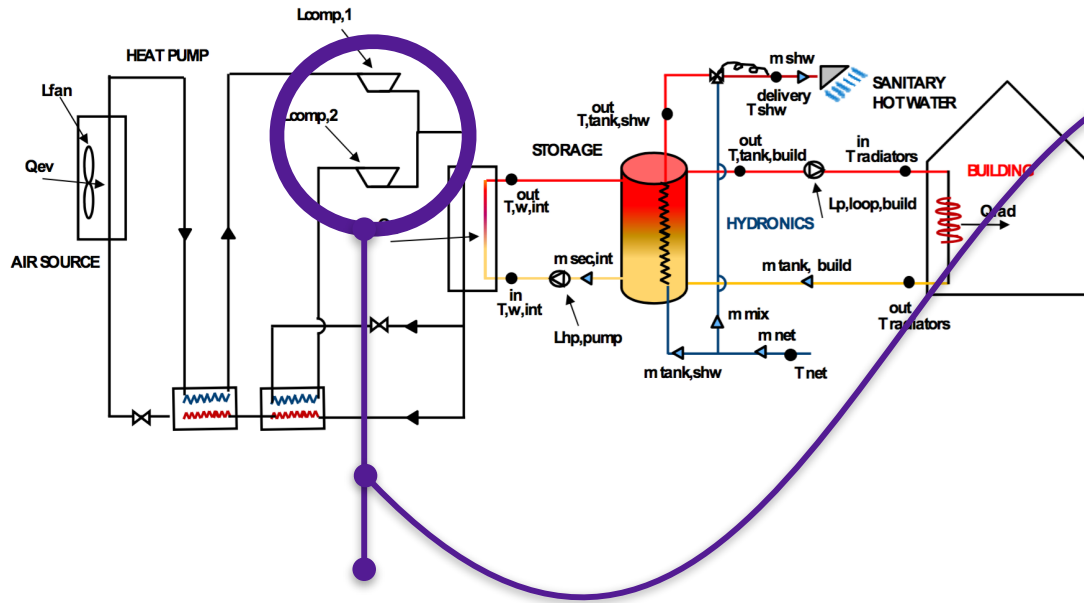
## 2. ECONOMIZED CYCLES: ADVANTAGES FOR HEAT PUMPS



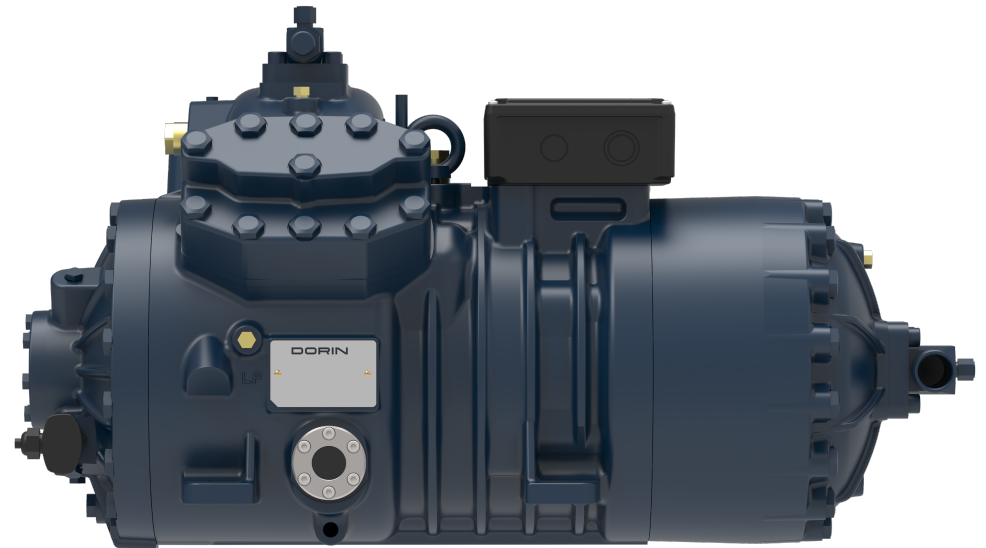
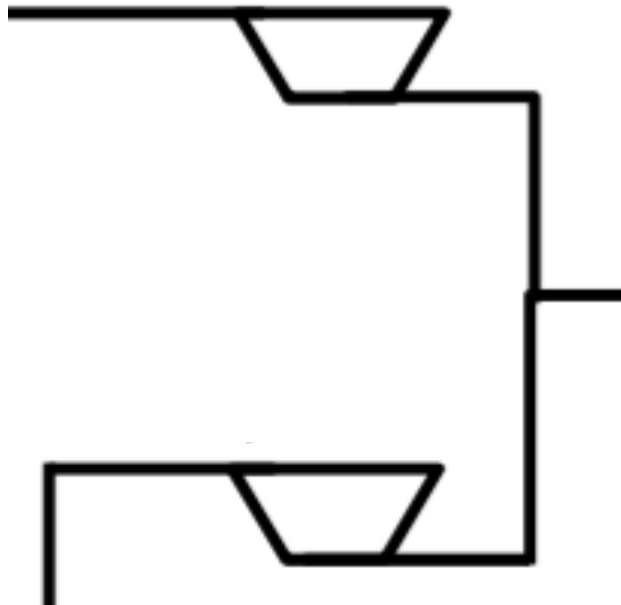
✓ POTENTIALLY APPLICABLE FOR SPACE HEATING

✓ INTERESTING PERFORMANCES WHEN COMPARED TO BUILDINGS HEATED UP WITH OLD GAS BOILERS (WATER LIFT FROM 40°C TO 80°C)

### 3. CO<sub>2</sub> COMPRESSORS FOR ECONOMIZED CYCLES



- ✓ SATELLITE COMPRESSOR NEEDED
- ✓ VERY COSTLY SOLUTION
- ✓ 4 CYLINDERS COMPRESSORS CAN BE ADAPTED TO WORK IN ECONOMIZED CYCLES

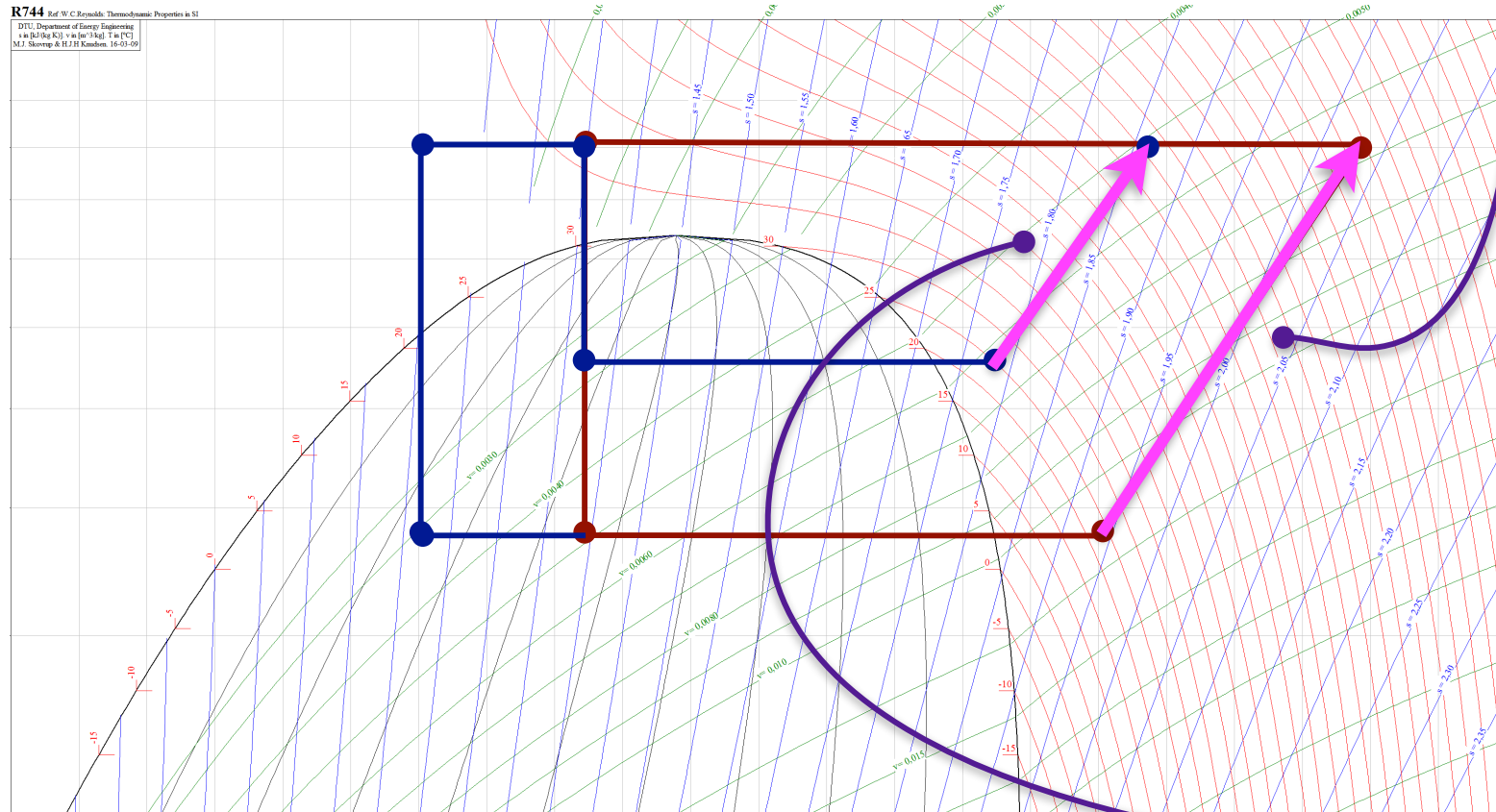




### 3. CO<sub>2</sub> COMPRESSORS FOR ECONOMIZED CYCLES

✓ MODIFICATIONS TO STANDARD 4 CYLINDERS DESIGN

✓ 3 PISTONS WORK BETWEEN LOW PRESSURE AND HIGH PRESSURE



✓ 1 PISTON WORKS BETWEEN INTERMEDIATE PRESSURE AND HIGH PRESSURE

### 3. CO<sub>2</sub> COMPRESSORS FOR ECONOMIZED CYCLES

#### CD HP COMPRESSOR RANGE

✓ INNOVATIVE MANIFOLD

✓ COMMON DISCHARGE MANIFOLD FOR ALL THE CYLINDER BANKS

✓ DEDICATED SUCTION PLENUM FOR ECONOMIZED PORT

✓ 8 COMPRESSORS MODELS

✓ DISPLACEMENT FROM 7.0 TO 20 m<sup>3</sup>/h (LOW PRESSURE STAGE)

✓ MOTOR POWERS FROM 15 HP TO 50 HP

✓ DESIGN PRESSURES:

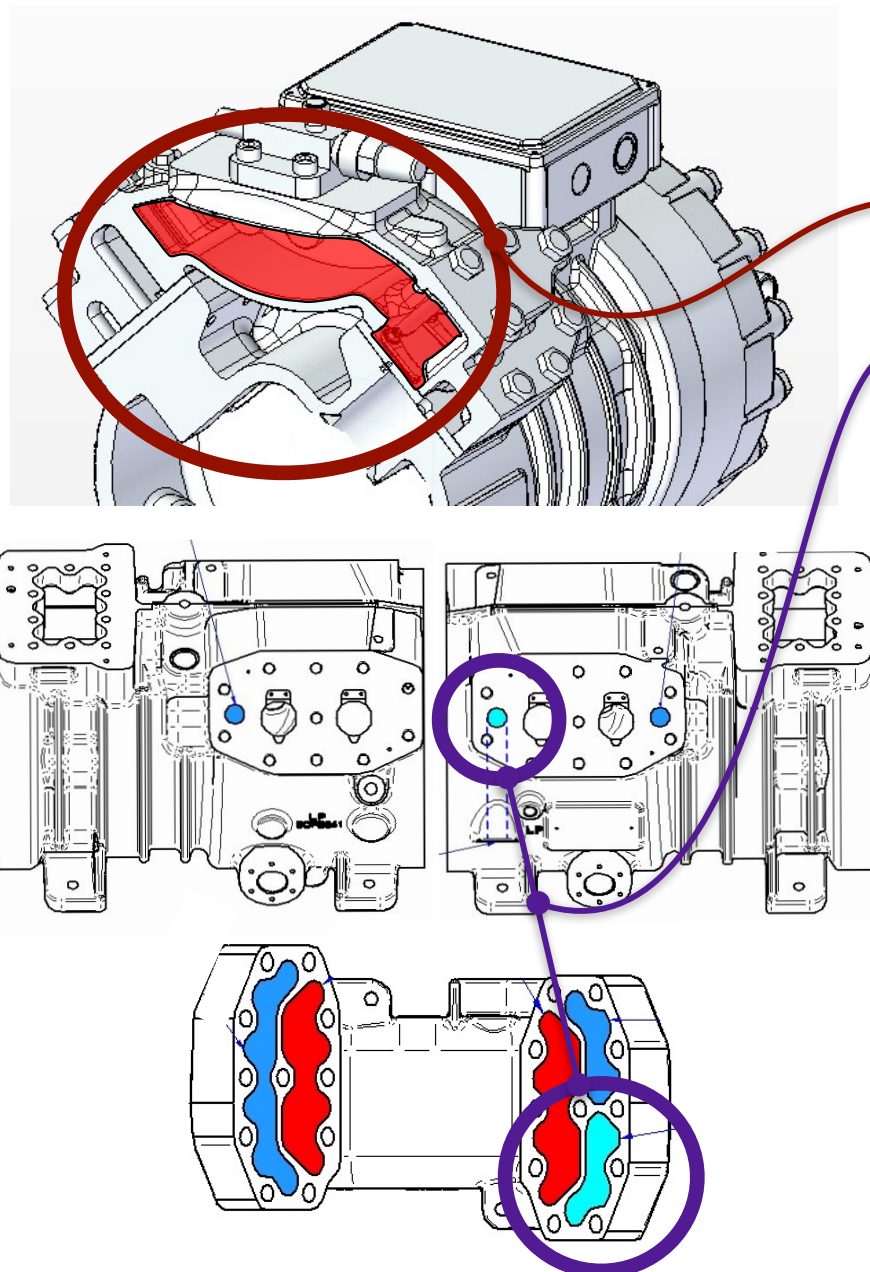
**P<sub>ss</sub> = 100 bar - P<sub>s</sub> = 150 bar**

✓ HEATING CAPACITIES:

**FROM 40 kW to 110 kW**

T<sub>amb</sub> = 7°C - Water in = 40°C - Water out = 40°C

✓ EXTRA-LOW PRESSURE PULSES AND VIBRATION



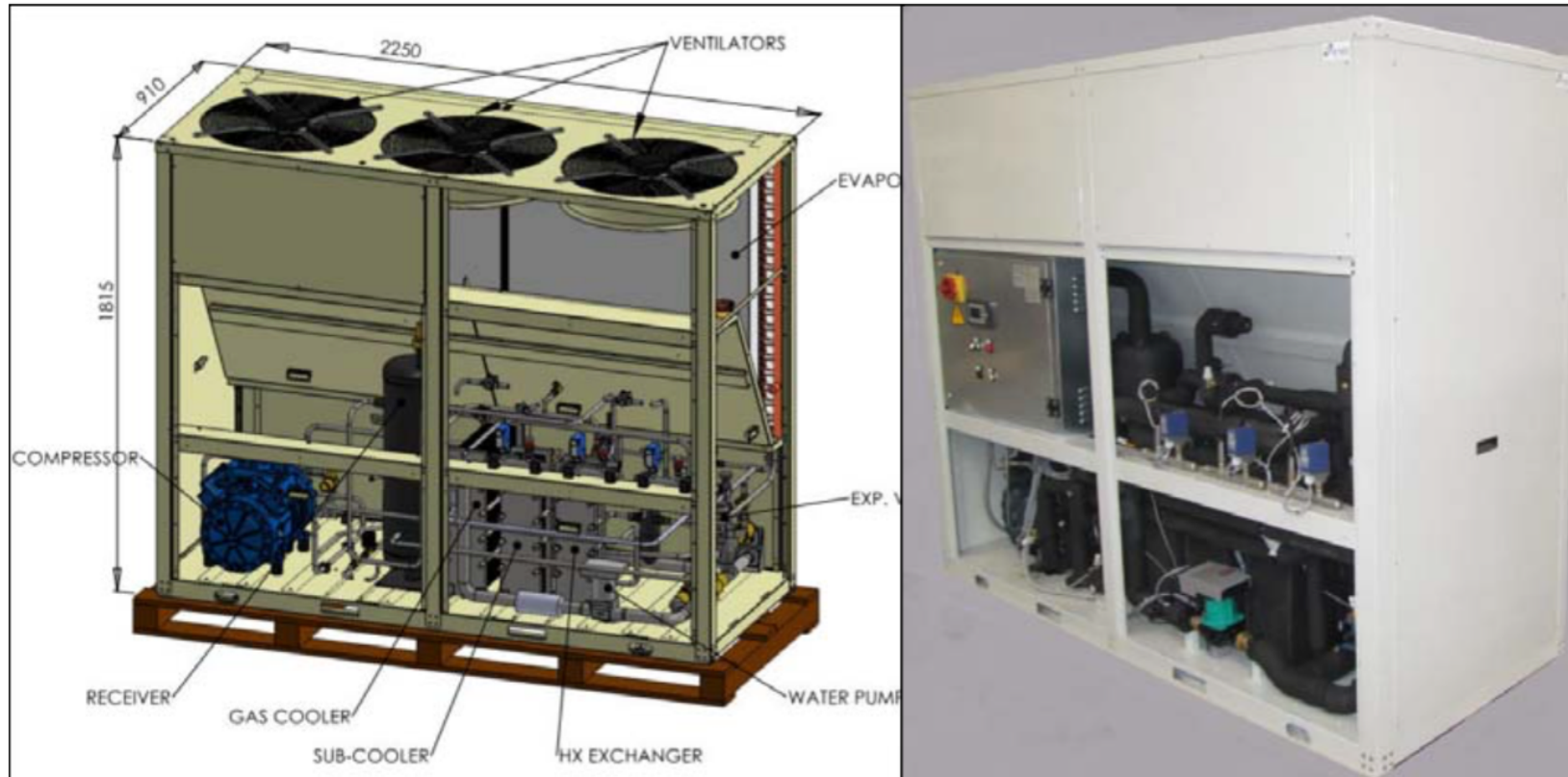
## 4. CASE STUDY: HEAT PUMP FOR RESIDENTIAL HEATING



Case	Fluid	Source	Tamb(°C)	Sink	T(°C)	Application	(kW)
1	HC (Propane)	Air	-10 to 35 (outdoor air)	Water	40 to 50	Heating water production	40
					60	Low demand of Domestic hot water	
2	HC (Propane)	Water (brine)	-5 to 15	Water	40 to 50	Heating water Production	60
					60	Low demand of Domestic hot water	
3	HC (Propane)	Water (Neutral loop)	10 to 15 (Sewage water) or 25 to 30 (Condensation loop)	Water	60	Domestic hot water production	50
4	CO <sub>2</sub>	Air	-10 to 10 (winter) 20 to 35 (summer) (outdoor air)	Water	60 to 80	Domestic hot water production	30
5	CO <sub>2</sub>	Air	-10 to 35 (outdoor air)	Water	80 (return water 40)	Heating & domestic hot water production	50

- **RENOVATION OF OLD GAS BOILER HEATING SYSTEMS (5/6 FAMILIES) WITH HIGH TEMPERATURES RADIATORS**
- **BOTH AMBIENT AND DOMESTIC HOT WATER HEATING**

## 4. CASE STUDY: HEAT PUMP FOR RESIDENTIAL HEATING

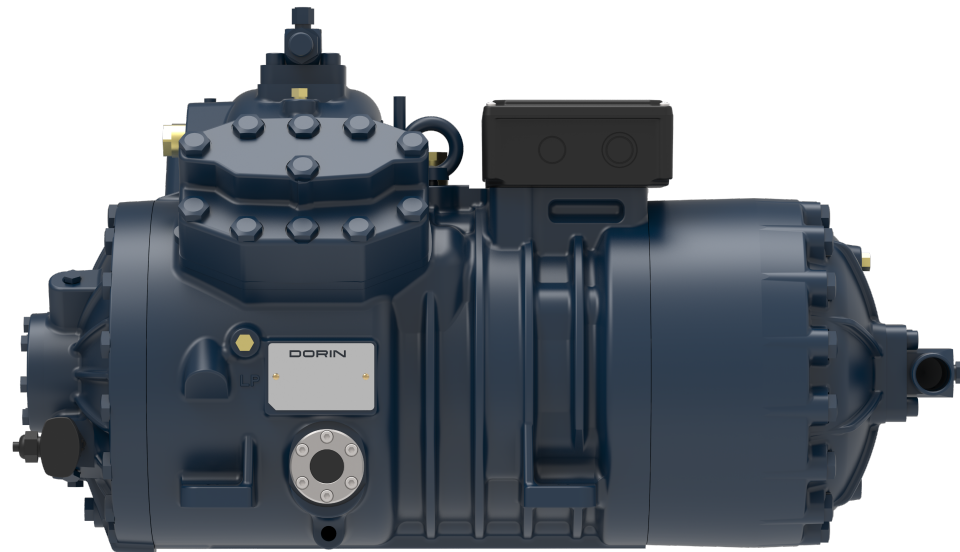


- ✓ ONE HEAT PUMP UNIT WAS ASSEMBLED AND TESTED
- ✓ RELIABLE AND EFFICIENT OPERATION DOWN TO -15°C AMBIENT TEMPERATURE
- ✓ 20% CO<sub>2</sub> EMISSION SAVINGS COMPARING TO SAME SIZE GAS BOILER

## 5. CONCLUSIONS

- ✓ **CO<sub>2</sub> OFFERS EXCELLENT PERFORMANCES FOR HEAT PUMPS OPERATION IN OPEN WATER LOOPS (LARGE WATER TEMPERATURE LIFTS)**
- ✓ **PERFORMANCE ARE NOT ATTRACTIVE FOR SMALLER WATER TEMPERATURE LIFTS**
- ✓ **ECONOMIZED CO<sub>2</sub> CYCLES CAN IMPROVE HEAT PUMP PERFORMANCES WHEN APPLIED TO CLOSED WATER LOOPS AND SMALLER WATER TEMPERATURE LIFTS**
- ✓ **A DEDICATED 4 CYLINDERS COMPRESSORS RANGE HAS BEEN DEVELOPED TO COPE WITH ECONOMIZED CYCLES REQUIREMENTS IN A COST EFFECTIVE WAY**
- ✓ **A HEAT PUMP PROTOTYPE HAS BEEN BUILT AND TESTED TO REPLACE OLD GAS FIRED BOILERS FOR HIGH TEMPERATURE RADIATORS**
- ✓ **THE HEAT PUMP PROVED TO WORK RELIABLY AND EFFICIENTLY IN A WIDE RANGE OF AMBIENT TEMPERATURES**
- ✓ **20% EMISSION SAVINGS ARE PROSPECTED WHEN COMPARING THE HEAT PUMP WITH A SAME SIZE GAS FIRED BOILER**

**! THANK YOU FOR YOUR ATTENTION !**  
**? QUESTIONS ?**





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Thank you very much!