Jean de Bernardi, Pawel Wisnik
June 7th, 2017

BEST PRACTICES FOR SUCCESSFUL RETROFITS WITH SOLSTICE® N40 (R-448A)

Honeywell
THE POWER OF CONNECTED

Introduction

Solstice® N40 (R-448A) Refrigerant Adopted by Tesco for its Carbon Reduction Roadmap.

"We continue to streamline the retrofit process along with our contractors in order to minimise impact on the store and cost to change. Also, to add to the 68 % reduction of direct emissions provided by R-448A versus R-404A, we have incorporated a leak reduction process to further minimise our carbon footprint and environmental impact."

Matthew Reeves-Smith,
Tesco, Group Head of Refrigeration & HVAC

Honeywell
THE POWER OF CONNECTED

Solstice® N40 (R-448A)

- Lowest GWP, non-flammable highest performance direct replacement product to R-404A and R-507
- Reduces energy consumption
- Save 68% direct emissions
- Serviceable beyond 2030
- 2,000 systems worldwide by end of 2016
- Possible to retrofit after 2022 systems placed on the market before 2022

R-448A As An Alternative For Medium And Low Temperature

	R-448A
Baseline	R-404A (A1, 3922 / 3943)
Composition	26%/26%/21%/7%/20% R-32/R-125/R-134a/R-1234ze/R-1234yf
GWP 4th / 5th	1386 / 1273
Class.	A1
Potential app.	MT and LT stationary refrigeration
Use	New/Retrofit
Drop-in (1) Cap.	Similar
Drop-in (1) Eff.	5% to 10% higher
Compressor (2)	Recip, Scroll, Screw
Comments	No TXV change Good compressor envelope
Status	Commercial

(1) Drop-in test in non-optimized system
(2) Suitable compressor technology

R-404A/R-507

GWP
-68%

Solstice® N40
R-448A

WHY?

Lower Tdis

Lower quota,
taxes and TEWI

Lower energy consumption than R-404A

Lower operating costs than R-404A

Lower CO_2e emissions than R-404A

Honeywell
THE POWER OF CONNECTED

Prior to Retrofit

Safety Recommendations

- Don’t smoke in non-authorised areas or in areas with potential exposure to refrigerants
- Always try to work in well ventilated environments
- Use the mandatory PPE (Personal Protection Equipment)
- Pressurized gas: keep bottles away from direct sunlight and hermetically sealed in a fresh ventilated area; avoid bottles from exposure at temperatures above 50º C
- Avoid overfilling of bottles during R-404A / 507 recovery
- Always use the most accurate leak detectors

Keep the MSDS of R-448A available during the whole retrofit process

Safety Data Sheet (SDS)

Read Safety Data Sheet (SDS) before beginning work with the material

1. Identification of the substance/mixture and of the company/undertaking
2. Hazards identification
3. Composition/information on ingredients
4. First aid measures
5. Firefighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information

Download the SDS from

http://msds-resource.honeywell.com

Honeywell
THE POWER OF CONNECTED

Prior to Retrofit

- A retrofit is a perfect occasion to check issues related to life cycle of aged stores
- The technician preparing the evaluation report can identify improvement points
- It is important to communicate to the retailer the options for those possible upgrades
- The installation will be shut down for a few hours, that can be enough to take measures to extend the system life and to improve efficiency
- It is also important to identify status of critical components to ensure proper performance

Site Survey and Preparation

Site Survey

- System issues & review: performance, efficiency, cabinets cleanliness…
- Quantity of refrigerant (nº of recovery bottles needed)
- Compressor compatibility
- Type and number of expansion valves
- Control: is R-448A included?
- Leak prevention measures
- Assess line sizes
- Test oil and refrigerant
- Define how to preserve goods when downloaded for cabinets adjustments
- Inventory of retrofit parts and material
- Record baseline data
- Forward completed survey to the customer

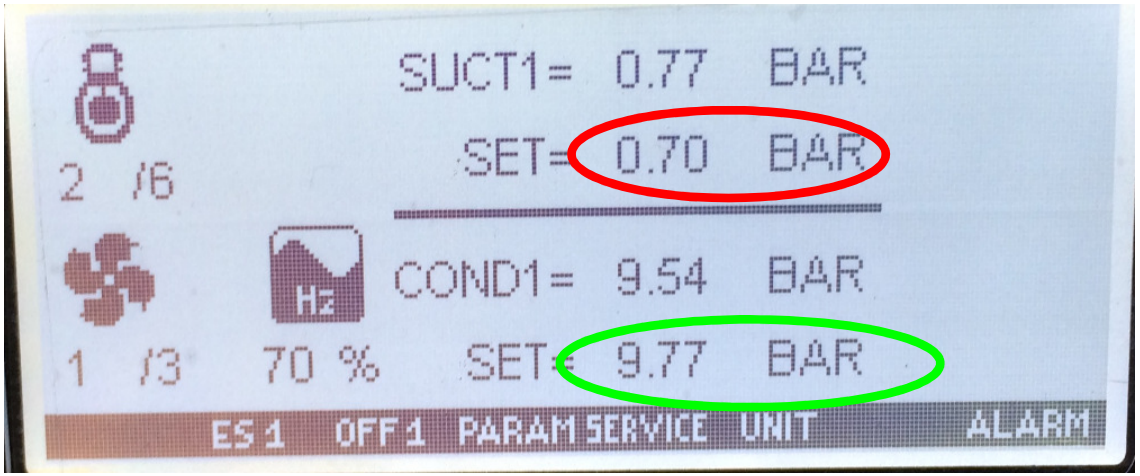
Preparation

- Coordination with store. Send reminder a couple of days prior to retrofit date.
- Store coordination
- Order parts and refrigerant
  - POE oil compatible with compressor and Solstice® N40 (R-448A)
  - O-rings, filters, desiccants..
  - Dry ice, plastic, labels.. or goods preservation (if needed)
  - R-448A labels for refrigerant identification in system
- Perform system changes / upgrades
- Training of technical personnel
- Change suction and liquid filters and driers
- Upgrade controller with Solstice® N40 (R- 448A) PT curves
- Leak check and repair

Retrofit: Check-up And Preparations Prior Retrofit

Record running parameters of a system:

a) Evaporation temperature/pressure and condensing temperature/pressure set points
b) TD in condenser set point
c) Minimum condensing temperature/pressure
d) Superheat set points (if EEVs are used) or running superheat if TEXs
e) Settings of mechanical pressure switches and EPRs
f) Settings of other pressure regulating valves (in hot recovery or hot gas defrost system)



Retrofit: Check-Up and Preparations Prior Retrofit

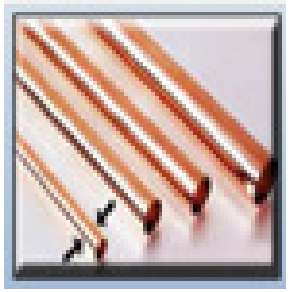
- Evaluate whether existing compressor type requires additional mitigation for higher variation of discharge temperature (head fan cooling, oil cooler with increased capacity etc.)-**this is difference between minus and plus**
- Prepare pressure-temperature tables / slider with R-448A and R-404A / R-507A

		404A			N40 (R-448A)		
p abs	p gaug	tbubb	tdew	t mid	tbubb	tdew	t mid
11.3	10.29	21.09	21.51	21.30	20.16	25.4	22.78
11.35	10.34	21.25	21.67	21.46	20.32	25.55	22.94
11.4	10.39	21.41	21.83	21.62	20.48	25.71	23.1
11.45	10.44	21.57	21.99	21.78	20.64	25.86	23.25
11.5	10.49	21.73	22.15	21.94	20.8	26.02	23.41

Note: you can get the tables from Genetron Properties Suite, free download at https://www.honeywell-refrigerants.com/europe/genetron-properties-suite/

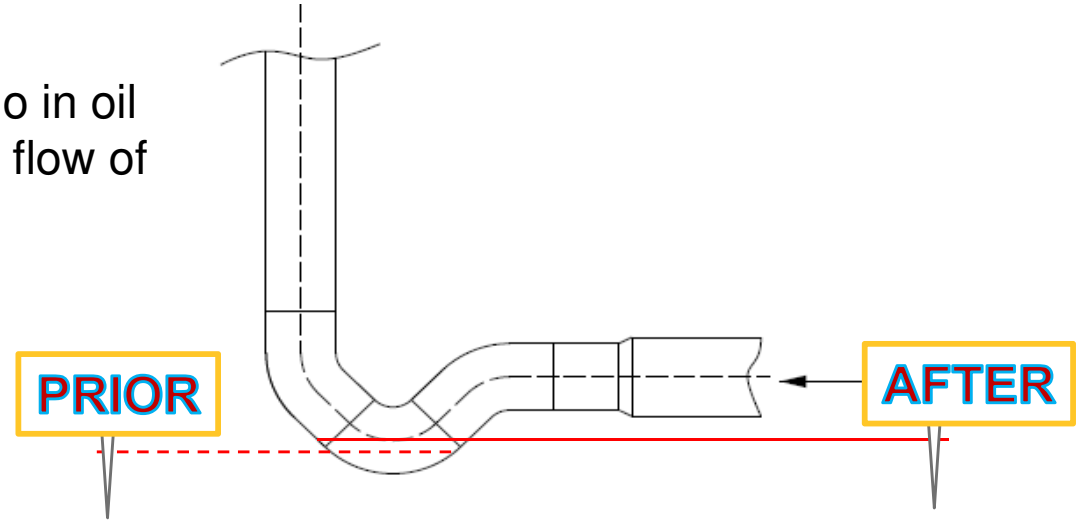
Retrofit: Check-up And Preparations Prior to Retrofit

- Check piping system and especially single/double risers in suction part in respect of sufficient velocities for new refrigerant, Honeywell **software GenePro** is useful here



- Usually, piping system properly selected for R-404A /R-507A and properly sloped on suction/condensate side works fine with R-448A

- One might expect higher oil filling ratio in oil traps due to compensate lower mass flow of R-448A



Honeywell
THE POWER OF CONNECTED

Retrofit: Check-up And Preparations Prior to Retrofit

- Evaluate: refrigerant amount in the system
- Prepare recovery machine and hoses set with capacity/diameter sufficient to recover refrigerant from the system in required timing
- Capacity of your recovery machine mainly determines timing of retrofit
- Provide tank with sufficient volume for recovered refrigerant, equip it with scale
- For bigger systems prepare recovery/charging point enabling sufficient flow rate of recovery / charging, e.g. modified cap of main liquid line filter with bigger port
- Prepare throttling device if charging N40 / R-448A is projected via suction line

Honeywell
THE POWER OF CONNECTED

Retrofit: Check-up and Preparations Prior to Retrofit

- Evaluate oil type in a system
- Check whether existing oil type is compatible with Solstice N40 / R-448A
- Evaluate acidity of existing oil and replace it when necessary on the occasion of retrofit
- **Procedure of replacement MO into POE oil is n / R-448A works with POE as well**

Retrofit: Check-up and Preparations Prior to Retrofit

- Evaluate if it is necessary to replace any gaskets due to their worn out/possible displacement during vacuuming
- Evaluate type and quantity of cartridges for main liquid line and oil filter
- Evaluate type of TEVs, and recommended by their OEM adjustment for Solstice N40 / R-448A
- Prepare set of stickers and labels for retrofitted system

Honeywell
THE POWER OF CONNECTED

Retrofit

Retrofit: Steps

- Report arrival to store security, confirm operation timing
- Agree with store unloading cabinets where TEVs are installed in order to have access to them
- Conduct preparation for retrofit: unload equipment, parts, cylinders, tools, make connections etc.
- Collect existing charge in HP side of the system, switch off the system
- Discharge system refrigerant to tank
- Recover rest of the refrigerant to tank using recovery machine

Retrofit: Steps

Conduct following steps:

a) Replace oil if necessary

b) Replace filters

c) Replace gaskets if necessary

d) If it is a case, assemble mitigations for higher variations of discharge temperature (if not done prior retrofit)-this phase might be prolonged beyond retrofit timing

e) Adjust TEVs or upgrade EEVs drivers

f) Adjust pressure switches, EPR and other valves

g) Set-up compressor and condenser control system for new refrigerant

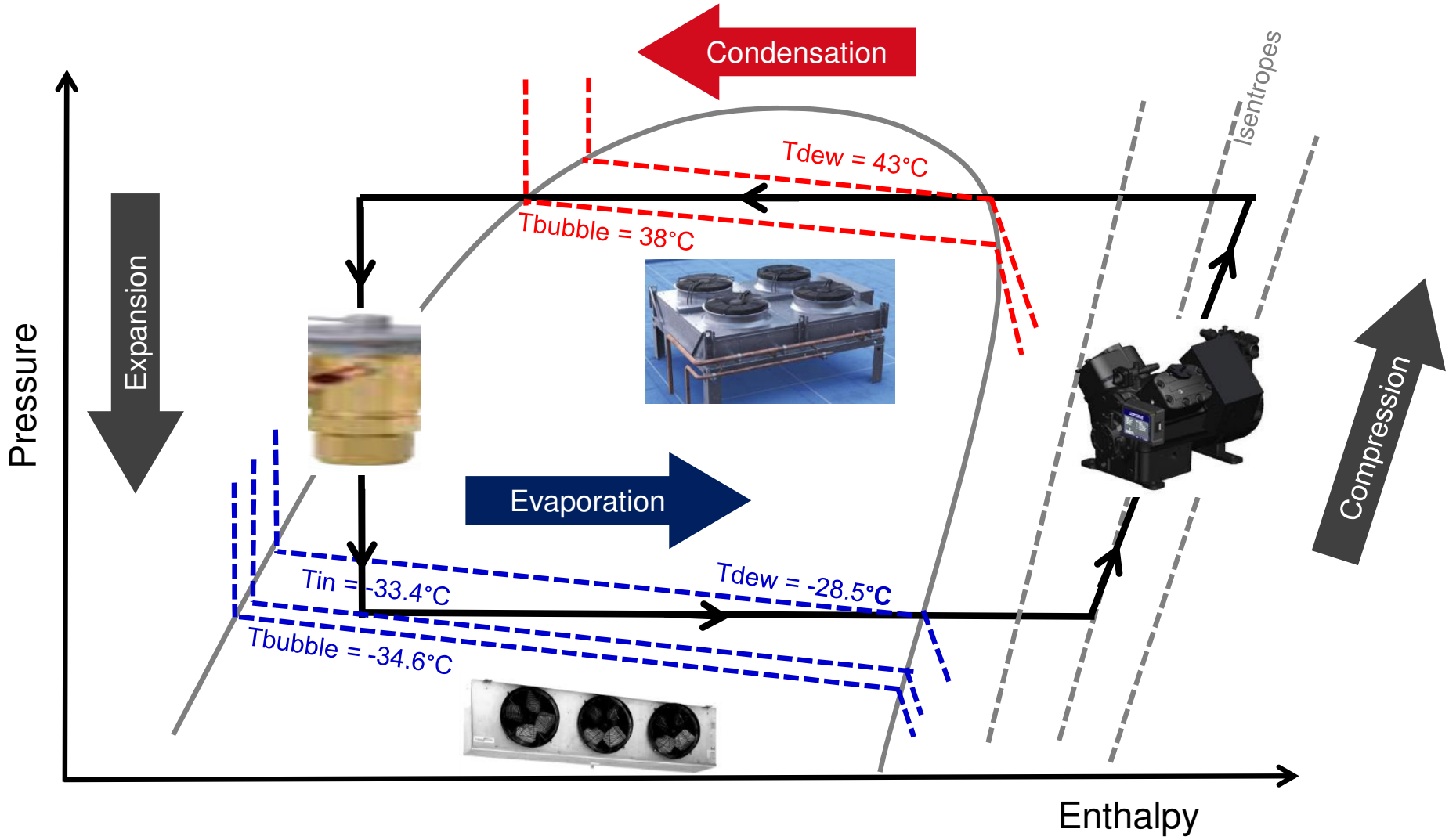
Retrofit: Steps

- Vacuum the system down to 500 microns, lower vacuum might, among others, harm composition of POE oil
- Charge the system with Solstice N40 /R-448A in liquid form only,
- Put the system ON
- Initial charge of Solstice N40 / R-448A should be 85% of that of R-404A / R-507A, observe system behaviour, use throttling device to charge suction side if necessary
- Final charge of Solstice N40 / R-448A should not exceed 104% of the charge of R-404A / R-507A
- Label retrofitted system
- Decommission equipment, report retrofit completion

Retrofit: Insight into TEVs Adjustment

- Solstice N40 / R-448A has ~20% lower mass flow vs R-404A / R-507A,
- TEVs rated for R-404A / R-507A needs to be closed in order to keep proper feeding of evaporator
- How much should it be closed? Check recommendations of TEVs producer, and follow its guidelines
- Or, close all TEVs in a system with 1/4 …..1/2 turn and observe running superheat at rack collector, repeat this step until 10…15 K running superheat is achieved there

Behavior of R-4xx Refrigerants in a System



Retrofit: Insight in EEVs Adjustment

- Upgrade EEVs driver with Solstice N40 (R-448A) curve

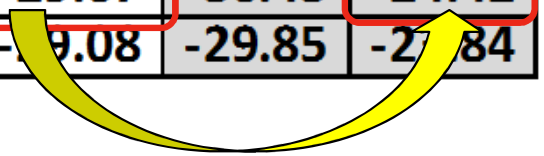
- If Solstice N40 (R-448A) curve is not available, or driver cannot be upgraded, do following:

Set R-22 curve, and left superheat set point as prior retrofit

		N40 (R-448A)		R22
p abs	p gaug	tbubb	tdew	Temp
2	0.99	-31.03	-25	-25.18
2.05	1.04	-30.43	-24.42	-24.56
2.1	1.09	-29.85	-23.84	-23.96

Set R-404A curve, and increase superheat set point prior retrofit by 5 K

		404A		N40 (R-448A)	
p abs	p gaug	tbubb	tdew	tbubb	tdew
2	0.99	-30.93	-30.27	-31.03	-25
2.05	1.04	-30.33	-29.67	-30.43	-24.42
2.1	1.09	-29.74	-29.08	-29.85	-23.84



+5 K

Retrofit: Insight Into PS Adjustment

- Convert PS adjustments for Solstice N40 (R-448A) using p-t table and find new pressure set point based on the same mean temperatures

		404A			N40 (R-448A)		
p abs	p gaug	tbubb	tdew	t mid	tbubb	tdew	t mid
2	0.99	-30.93	-30.27	-30.60	-31.03	-25	-28.02
2.05	1.04	-30.33	-29.67	-30.00	-30.43	-24.42	-27.43
2.1	1.09	-29.74	-29.08	-29.41	-29.85	-23.84	-26.85
2.15	1.14	-29.16	-28.51	-28.84	-29.28	-23.28	-26.28
2.2	1.19						-25.72
2.25	1.24	-28.03	-27.39	-27.71	-28.17	-22	-25.18
2.3	1.29	-27.49	-26.84	-27.17	-27.63		-24.64
2.35	1.34	-26.95	-26.31	-26.63	-27	-21.12	-24.11
2.4	1.39	-26.42	-25.78	-26.10		-20.6	-23.59
2.45	1.44			-25.58	-26.06	-20.09	-23.08
2.5	1.49	-25.38	-25.75	-25.07	-25.56	-19.59	-22.58

Retrofit: Insight Into EPR Adjustment

- Convert PS adjustments for Solstice N40 (R-448A) using p-t table and find new pressure set point based on the same mean pressure

	R-404A			N-40 (R-448A)		
t	pbubb	pdew	p mid	pbubb	pdew	p mid
-15	3.69	3.61	3.65	3.73	3	3.37
-14	3.82	3.74	3.78	3.87	3.11	3.49
-13	3.96	3.88	3.92	4.01	3.23	3.62
-12	4.1	4.02	4.06	4.16	3.36	3.76
-11	4.24	4.16	4.2	4.3	3.49	3.90
-10	4.39	4.31	4.35	4.46	3.6	4.04

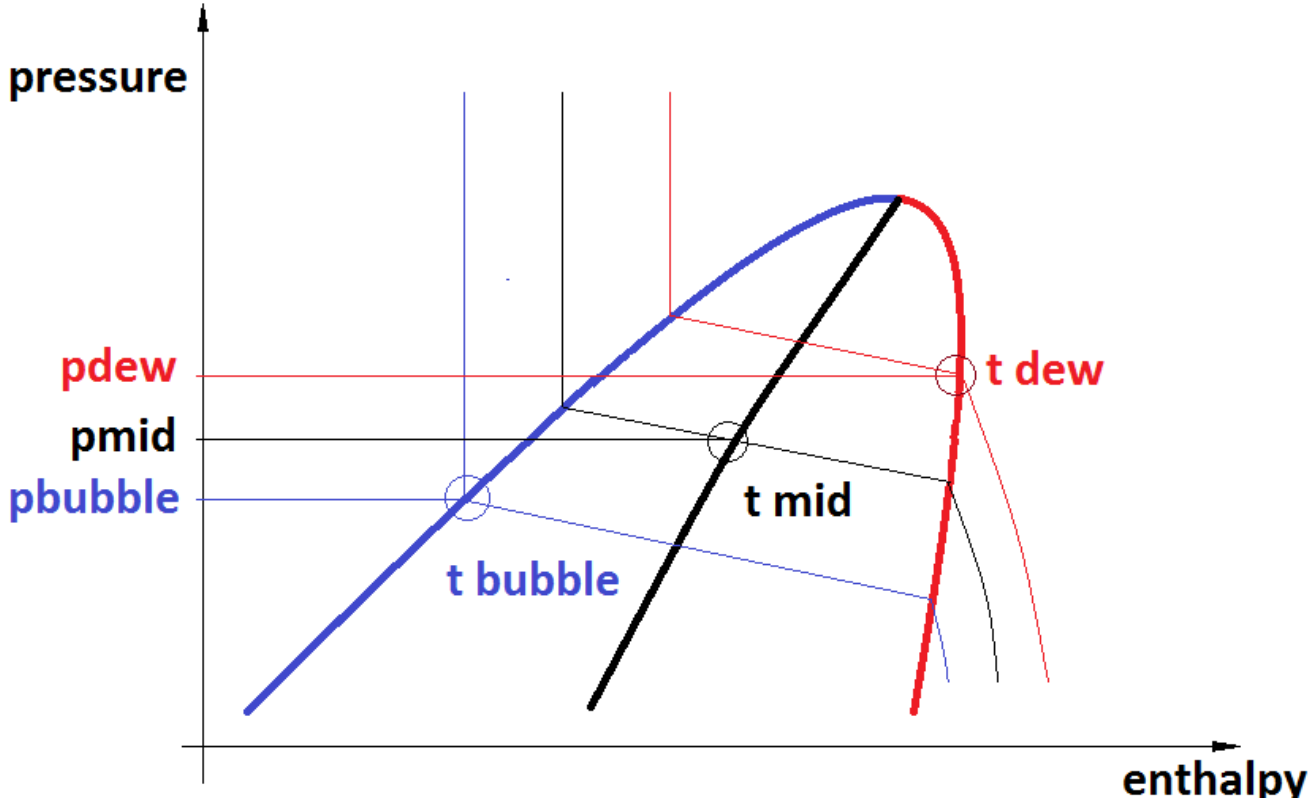
SET POINT 3.9 BAR

SET POINT 3.6 BAR

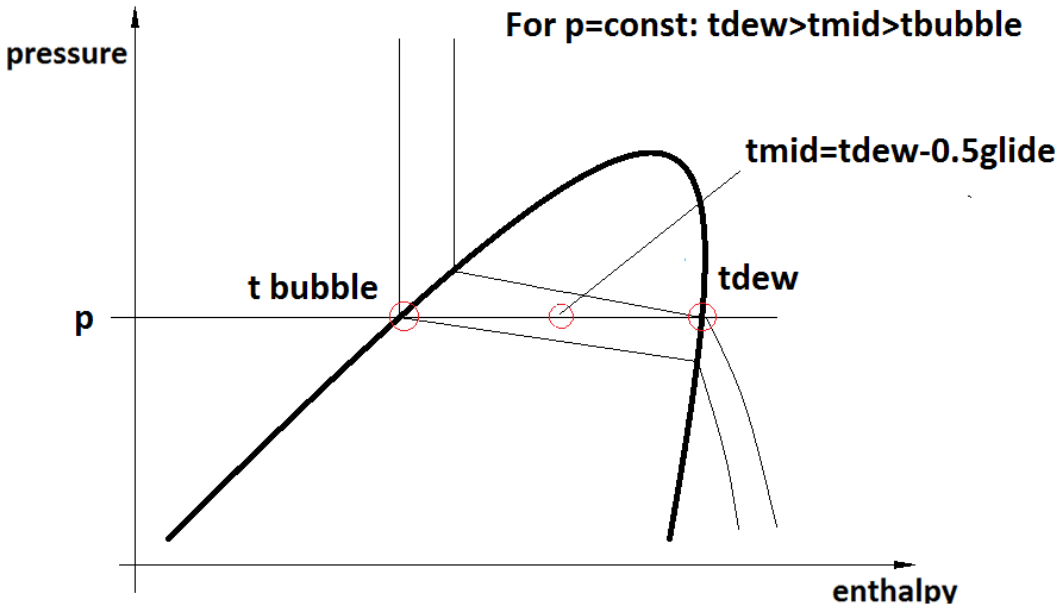
Retrofit: Insight Into Compressor/Condenser Set Points

- Upgrade condenser and compressor controllers with Solstice N40 (R-448A) curve

- If your controller receives set point as temperature, detect whether it operates based on dew / mid / bubble curve



Retrofit: Insight Into Compressor/Condenser Set Points



- If your controller receives set point as temperature, and works e.g. based on dew curve, remember to increase all set point by half of a glide for give pressure / pressure range:

$t_{(\text{dew point=set point in controller})} = t_{(\text{mean in a system})} + ½ \times \text{glide}$

Example: Solstice N40 (R-448A) glide is 5K, effective mean Tevapas to be -10°C, set point is -7.5°C

Retrofit: Insight Into Compressor/Condenser Set Points

If curve of system refrigerant does not exist in controller, use any of existing refrigerants (R-404A…) and apply proper offsets based on p-t table

	404A			N40 (R-448A)		
p gaug	tbubb	tdew	t mid	bubb	tdew	t mid
10.29	21.09	21.51	21.30		25.4	22.78
[illegible]	21.25	[illegible]	21.46	20.32	[illegible]	[illegible]
10.39	21.41	21.83	21.62	20.48		23.1
10.44	21.57	21.99	21.78	20.64		23.25
10.49	21.73	22.15	21.94	20.8	6.02	23.41
10.54	21.9	22.31	22.11	20	26.18	23.57
10.59	22.06	22.47	22.27		26.33	23.73
[illegible]	[illegible]	[illegible]	[illegible]	28	26.48	23.88
10.69			22.59	21.43	26.64	24.04

Example of converting t_{con} set point if we have R-404A curve in rack/condenser controller after Solstice N40 retrofit, rack controller use dew point curve, and set points as a temperature:

- Previous set point for R-404A was ~22.7 °C or 10.74 barg (1)
- Using p-t chart we find mid temperature 22.7°C for Solstice N40 (R-448A)(2)
- For mid t_{con} 27.7°C new pressure set point is 10.3 barg (3) or dew point 21.5°C

Retrofit: Compressor Capacity Using Mean Temperatures

Refrigerant	R404A
Reference temperature	Mean temperature
Evaporating SST	-10.00 °C
Condensing SDT	45.0 °C
Liq. subc. (in condenser)	5.00 K
Suct. gas superheat	15.00 K
Operating mode	Auto
Power supply	400V-3-50Hz
Capacity Control	100%
Useful superheat	7.00 K

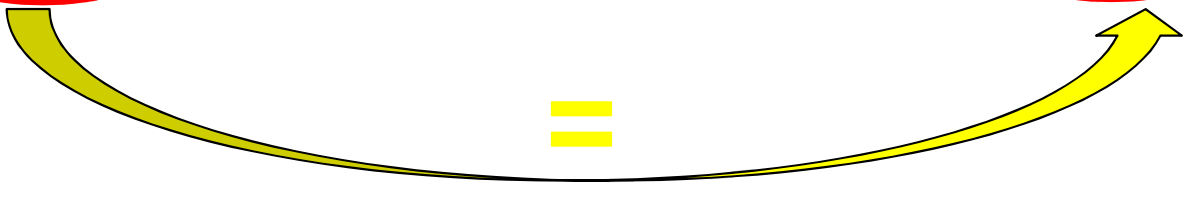
Result

Compressor	4TES-9Y-40P
Capacity steps	100%
Cooling capacity	21.3 kW

Refrigerant	R448A
Reference temperature	Mean temperature
Evaporating SST	-10.00 °C
Condensing SDT	45.0 °C
Liq. subc. (in condenser)	5.00 K
Suct. gas superheat	15.00 K
Operating mode	Auto
Power supply	400V-3-50Hz
Capacity Control	100%
Useful superheat	7.00 K

Result

Compressor	4TES-9Y-40P
Capacity steps	100%
Cooling capacity	21.5 kW



Use mid point parameters while selecting compressor

Retrofit: Condenser Capacity Using Mean Temperatures

R-404A		
Mean condensing temp 45°C for R-404A gives following buble/dew:		
t bub	t dew	t mean
44.91	45.22	45

R-448A		
Mean condensing temp 45°C for R-448A gives following buble/dew:		
t bub	t dew	t mean
42.90	47.13	45

GÜNTNER

Date: 2017-05-28
Enquiry dated:
Project:
Quotation-no.:
Item:
Reference:

Condenser GCHC RD 050.1 51-0006449M

Capacity:	68.0 kW	**Refrigerant:**	**R404A**(1)
			45.2 °C
Air flow:	31076 m³/h	Cond	43.8 °C
Air inlet:	35.0 °C	Hot gas flow:	
Altitude:	100 m	Mass flow:	
Air velocity:	3.0 m/s	Pressure drop:	0.053 bar /
Heat transf. coeff.:	40.34 W/(m²·K)		

GÜNTNER

Date: 2017-05-28
Enquiry dated:
Project:
Quotation-no.:
Item:
Reference:

GCHC RD 050.1/14-51-0006449M

Capacity:	69.7 kW	**Refrigerant:**	**R448A**(1)
		Hot gas temp.:	77.1 °C
Air flow:	31076 m³/h	Condensation temp. (dew pt.):	47.1 °C
Air inlet:	35.0 °C	Condensate outlet:	
Altitude:	100 m	Hot gas flow:	15.36 m³/h
Air velocity:	3.0 m/s	Mass flow:	1327 kg/h
Heat transf. coeff.:	40.68 W/(m²·K)	Pressure drop:	0.046 bar / 0.09 K

Define reference temperatures corresponding to mid point temperatures

Retrofit: DX Air Cooler Capacity Using Mean Temperatures

R-404A		
Mean evaporating temp -10°C for R-404A gives following bubble/dew:		
t bub	t dew	t mean
-10.3	-9.72	-10

R-448A		
Mean evaporating temp -10°C for R-404A gives following bubble/dew:		
t bub	t dew	t mean
-12.9	-7.01	-10

GÜNTNER

Date: 2017-05-28
Enquiry dated:
Project:
Quotation-no.:
Item:
Reference:

Evaporator (dx) GASC RX 031.1/4-70.A-1821072P

Capacity:	9.7 kW(1)	**Refrigerant:**	R404A(2)
Surface reserve:	0.1 %	Evaporation temp. (mean):	-10.0 °C
Air flow:	6400 m³/h	Superheating:	5.0 K
Air velocity:	2.2 m/s		
Air inlet:	0.0 °C	Condensation temp. (mean):	45.0 °C
Air outlet:	-3.5 °C	Subcooled temp.:	37.7 °C
Air pressure:	1013 mbar		

GÜNTNER

Date: 2017-05-28
Enquiry dated:
Project:
Quotation-no.:
Item:
Reference:

GASC RX 031.1/4-70.A-1821072P

Capacity:	9.8 kW(1)	**Refrigerant:**	R448A(2)
Surface reserve:	0.1 %	Evaporation temp. (mean):	-10.0 °C
Air flow:	6400 m³/h	Superheating:	5.0 K
Air velocity:	2.2 m/s		
Air inlet:	0.0 °C	Condensation temp. (mean):	45.0 °C
Air outlet:	-3.5 °C	Subcooled temp.:	37.7 °C
Air pressure:	1013 mbar		

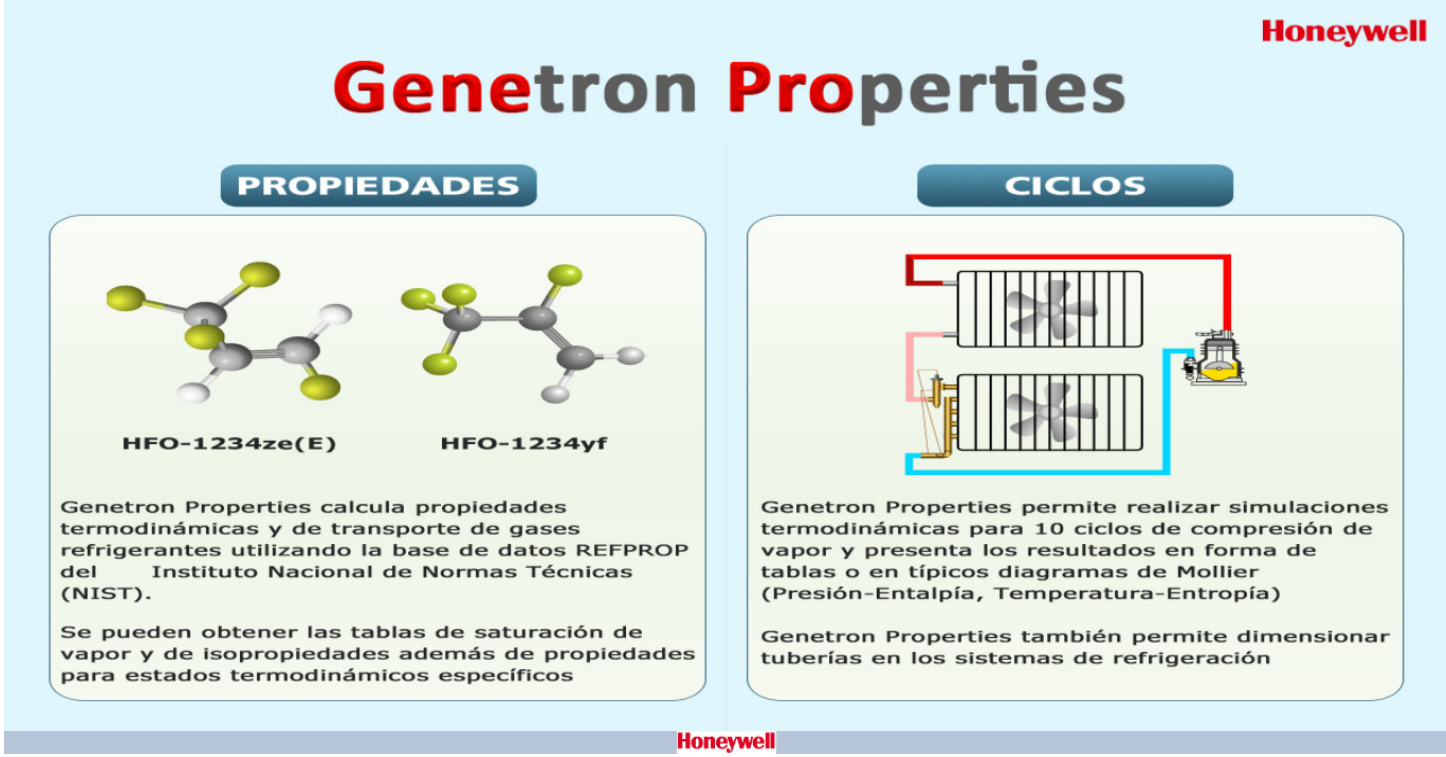
Use mid point selection whenever possible

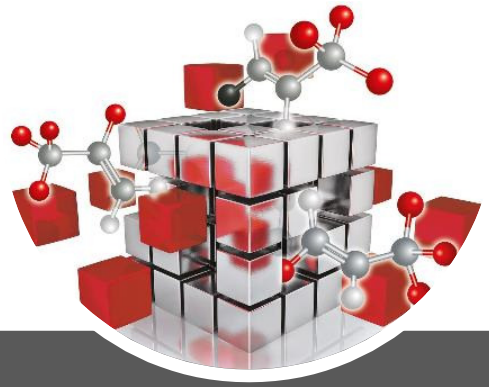
F-gas Compliance

Make sure to comply with requirements of F-Gas Regulation 517/2014

Honeywell Apps, Online and Software Tools and Other

- Genepro simulation software
- PT chart app
- Refrigerants selection app
- Components chart for Solstice
- Savings calculator Solstice® N40
- Website
- LinkedIn
- Slideshare
- **Technical training on glide management**





Thank you!

http://www.honeywell-refrigerants.com/europe/

For further information please visit our website or ask your local contact

Honeywell
THE POWER OF CONNECTED