Hints on Energy Efficiency

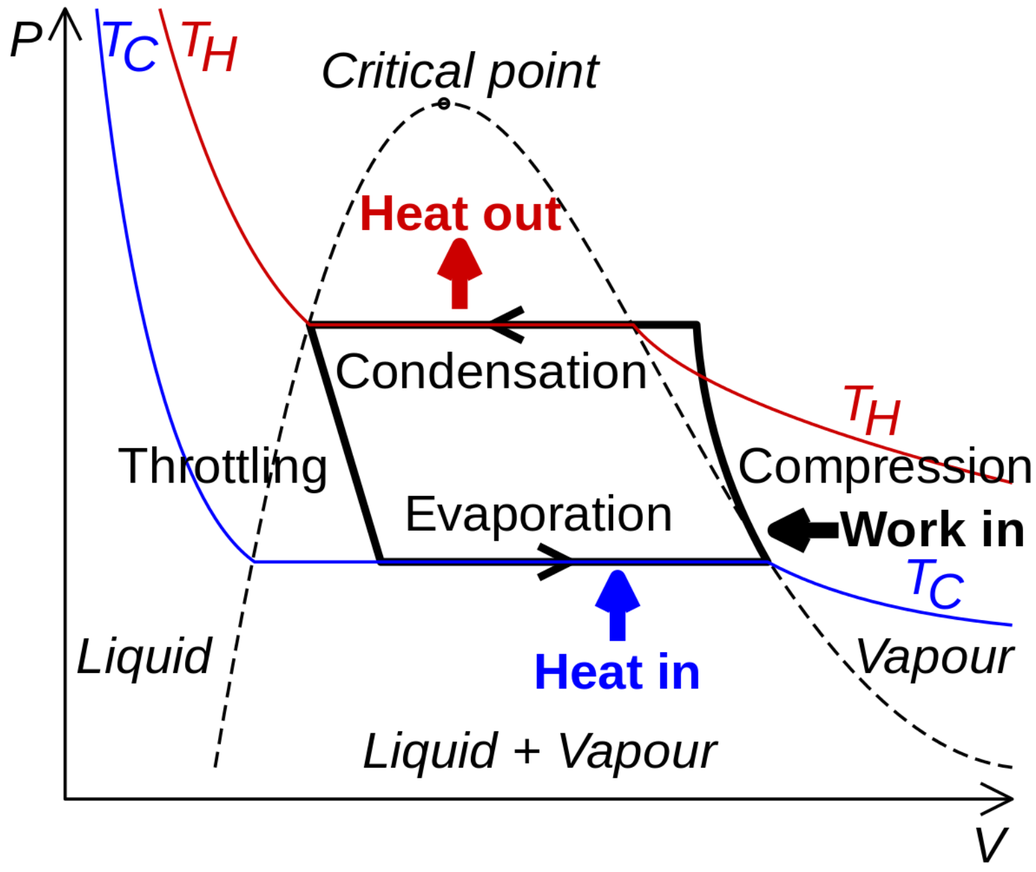
ASEH
TEJARAT ASIA

How to increase HVAC/R systems efficiency

The new concern at this time.

How to increase HVAC/R systems efficiency

- **High efficiency compressor**
- **Condenser temperature control**
- **Evaporator temperature control**



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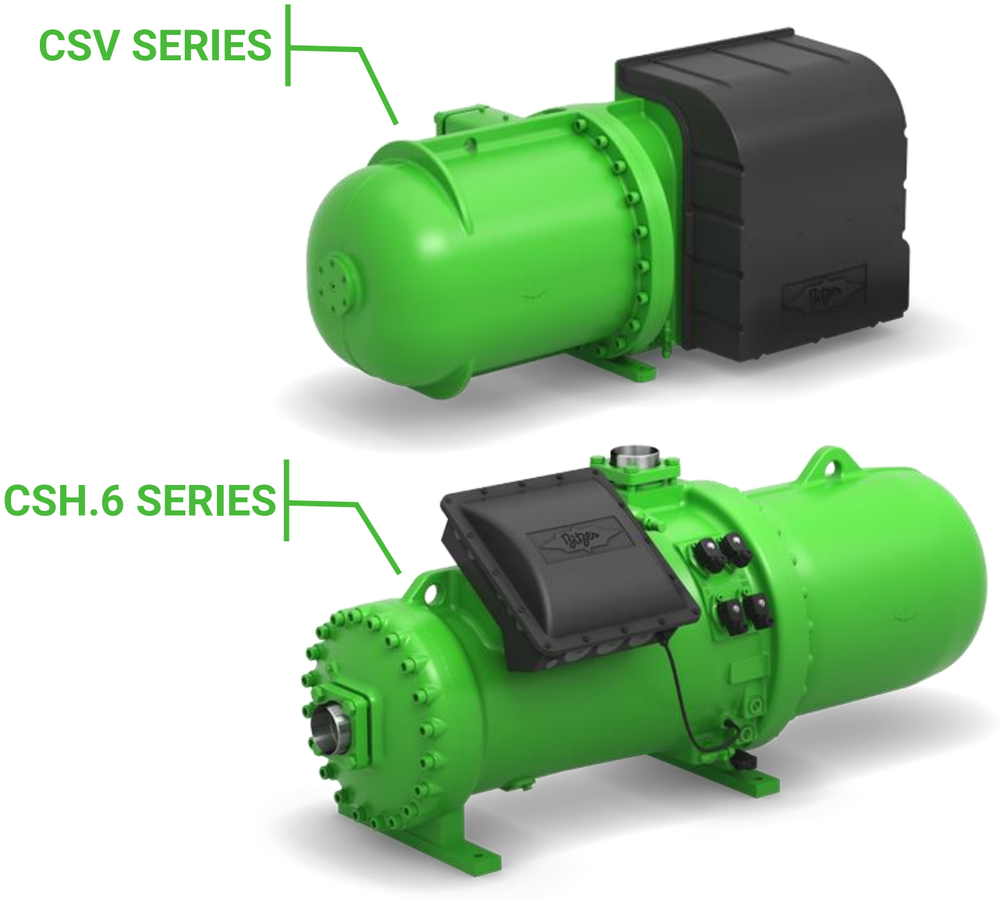
High efficiency compressor

Powerful but little food!

High efficiency compressor

- **Variable speed compressor**

- **New generation compressor**



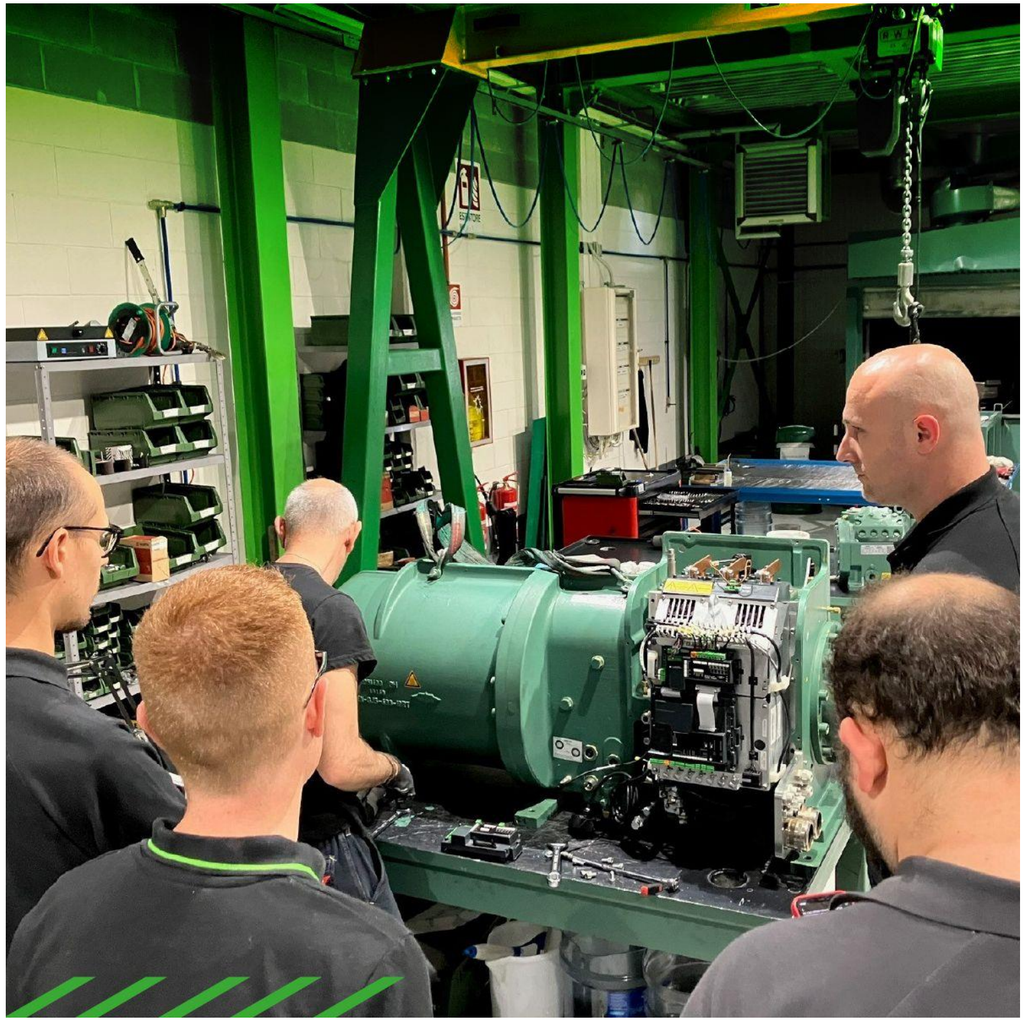
Variable speed compressor

CSVH

designed for air cooled A/C and process chillers and heat pumps

CSVW

designed for water cooled A/C and process chillers and air cooled systems with lower condensing temperatures



CSVH

- Best-in-class seasonal efficiency in wide application range
- Automatic V_i control
- Control range: down to 15% of full load with automatic V_i adaptation
- Infinite capacity modulation by FI
- Wide speed range – up to 8000 rpm
- FI cooling plate with evaporating refrigerant
- On-board IQ functionality with protection, monitoring, data log, and communication
- Frequency inverter, motor, sensors, and controller prewired ex-factory

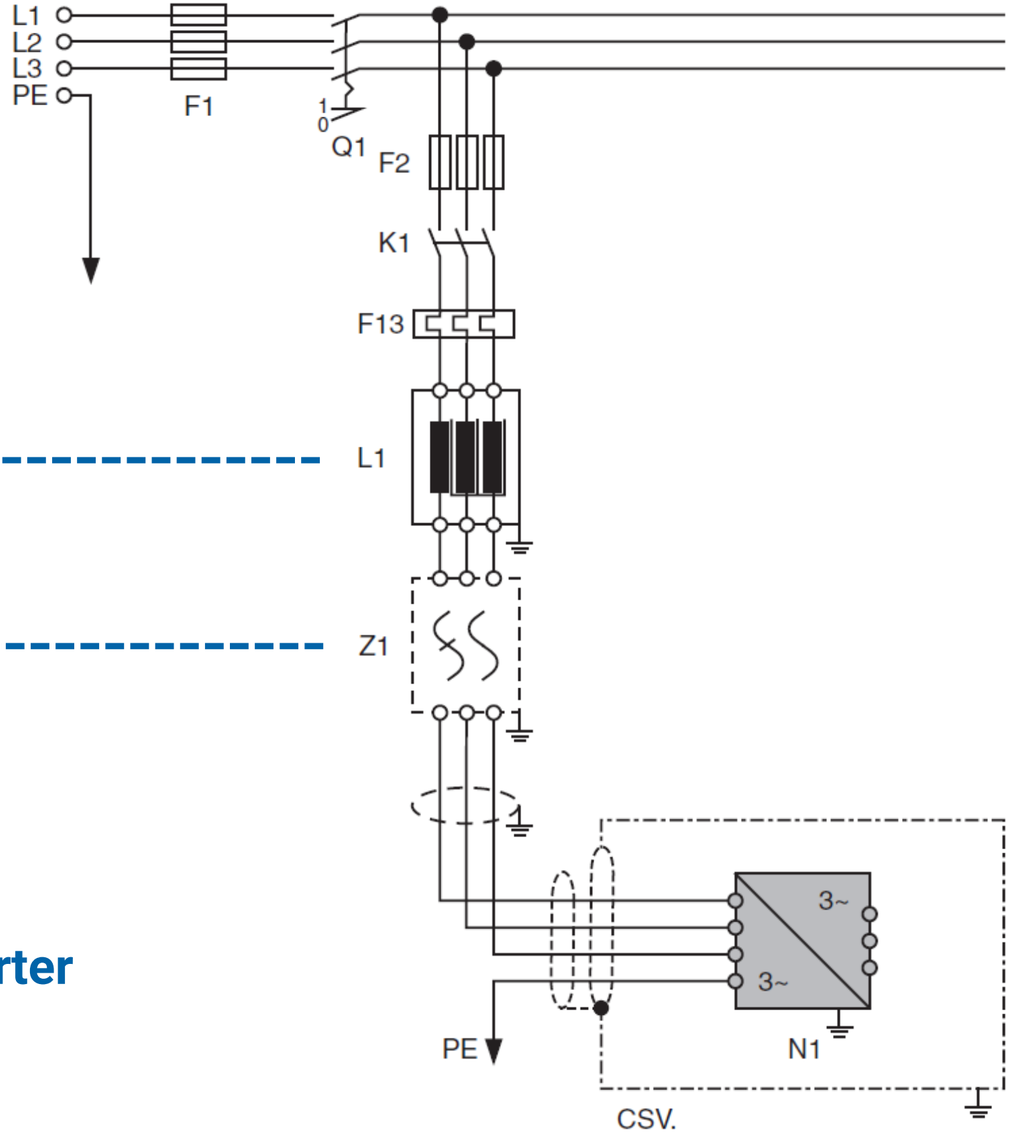
  only 3 wire power connection cables and single phase auxiliary voltage
- All compressors are 100% factory-tested and preparameterized

Optional electrical accessories

Line reactor

RFI filter

BEST Interface Converter



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New generation compressor

CSH.6

The CSH.6 is especially designed for use in chillers with improved seasonal efficiency.

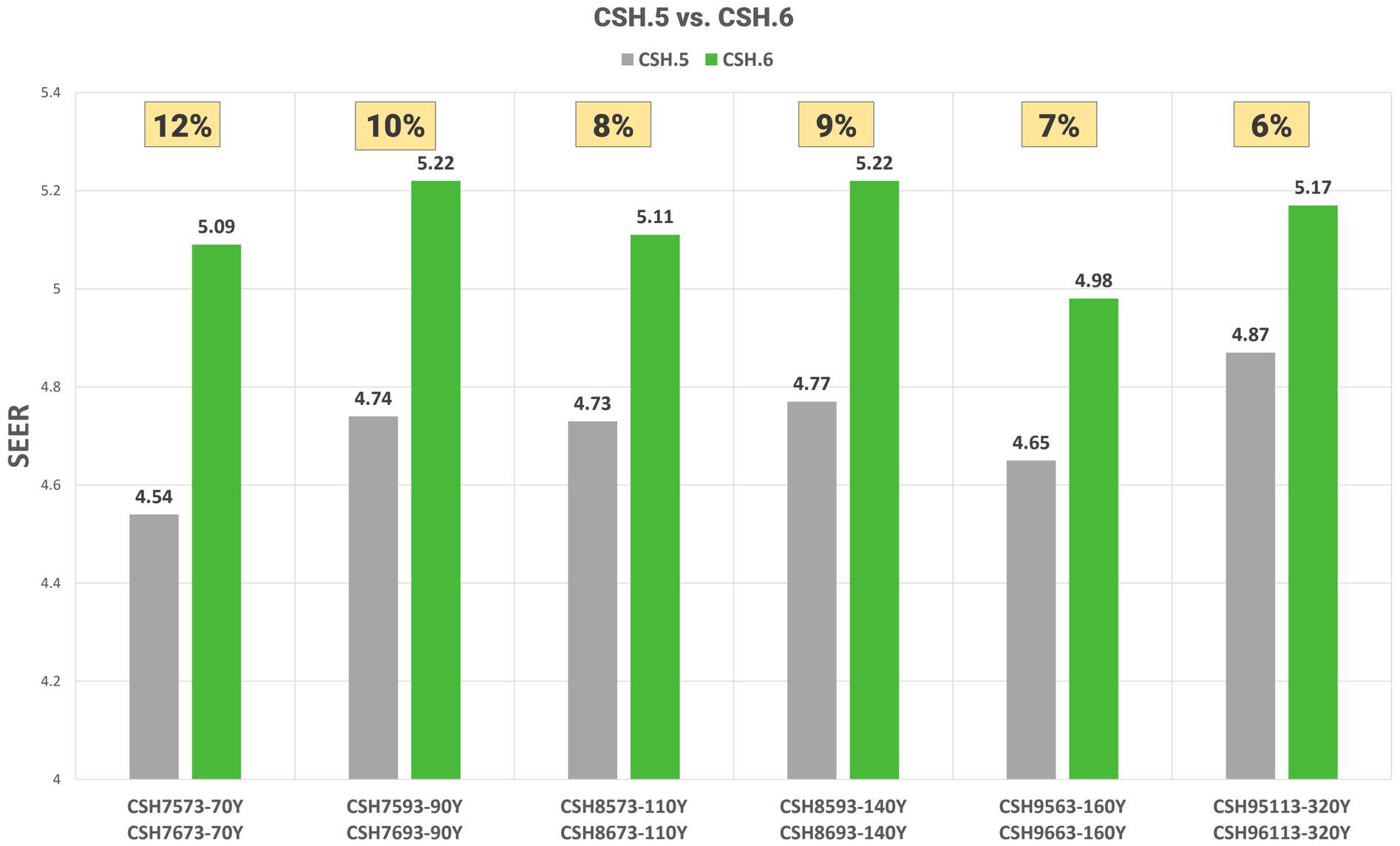
- ✓ **Air cooled chiller**
- ✓ **Data center cooling**
- ✓ **Heat pump operation of liquid chiller**
- ✓ **Chillers with high efficiency requirements**

CSH.6

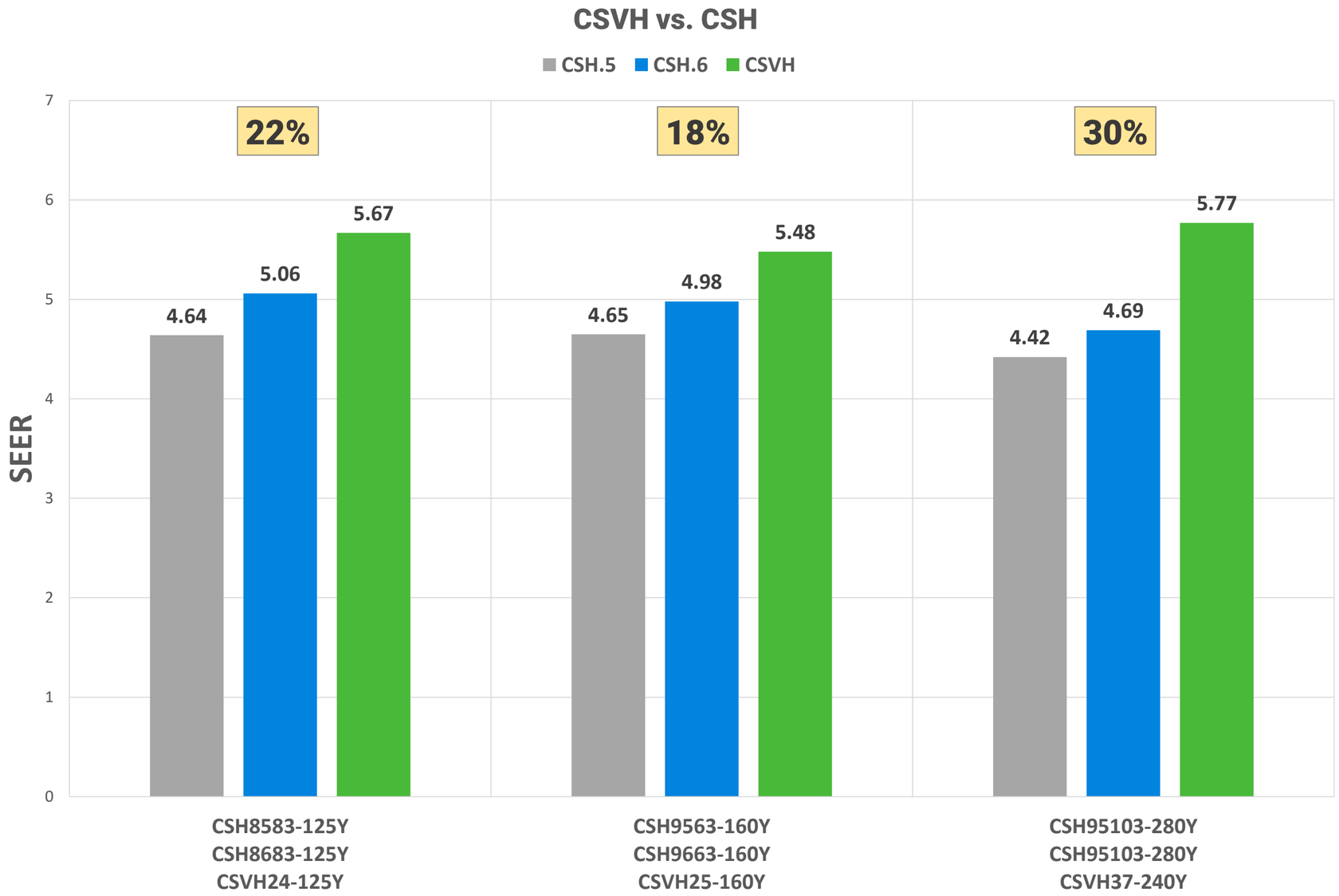
- **Measures for improved seasonal energy efficiency for A/C and process chiller**
- **12 models from 258 to 1120 m³/h @ 50 Hz CSH7673-70Y --- CSH96113-320Y**
- **Optimized for chiller with DX and flooded evaporator**
- **Connection for oil and gas return (for systems with flooded evaporator)**
- **Standard oil for CSH.6 : BSE170L / t_c>60°C : BSE170**

Operation point

- **Refrigerant = R134a**
- **Evaporating SST = 3.5 °C**
- **Condensing SDT = 50 °C**
- **Subcooling = 3 K**
- **Superheat = 6 K**


CSH.5 vs. CSH.6
CSH.5
CSH.6
SEER
5.4
5.2
5
4.8
4.6
4.4
4.2
4
12%
10%
8%
9%
7%
6%
4.54
5.09
4.74
5.22
4.73
5.11
4.77
5.22
4.65
4.98
4.87
5.17
CSH7573-70Y
CSH7673-70Y
CSH7593-90Y
CSH7693-90Y
CSH8573-110Y
CSH8673-110Y
CSH8593-140Y
CSH8693-140Y
CSH9563-160Y
CSH9663-160Y
CSH95113-320Y
CSH96113-320Y

ASEH


CSVH vs. CSH
CSH.5
CSH.6
CSVH
SEER
0
1
2
3
4
5
6
7
22%
18%
30%
4.64
5.06
5.67
4.65
4.98
5.48
4.42
4.69
5.77
CSH8583-125Y
CSH8683-125Y
CSVH24-125Y
CSH9563-160Y
CSH9663-160Y
CSVH25-160Y
CSH95103-280Y
CSH95103-280Y
CSVH37-240Y

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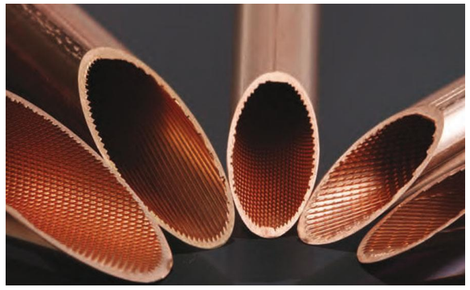
Condenser temperature control

Please be cool...

/ Condenser temperature control

Construction

- High efficiency tubes
- High efficiency fin
- High efficiency fan
- Adiabatic Condenser



Logic control

- Condenser approach control

Condenser temperature control

Operation point

- CSH8583-125Y
- Ambient Temp. = 35 °C
- Refrigerant = R134a
- Evaporating SST = 3.5 °C
- Condensing SDT = 50 °C
- Subcooling = 3 K
- Superheat = 6 K

SEER

Ambient Temp.	Constant ΔT in Condenser	Variable ΔT in Condenser
35 °C	50 °C	50 °C
30 °C	45 °C	40.6 °C
25 °C	40 °C	35.8 °C
20 °C	35 °C	27.4 °C

Condenser temperature control

Constant Condensing Temperature

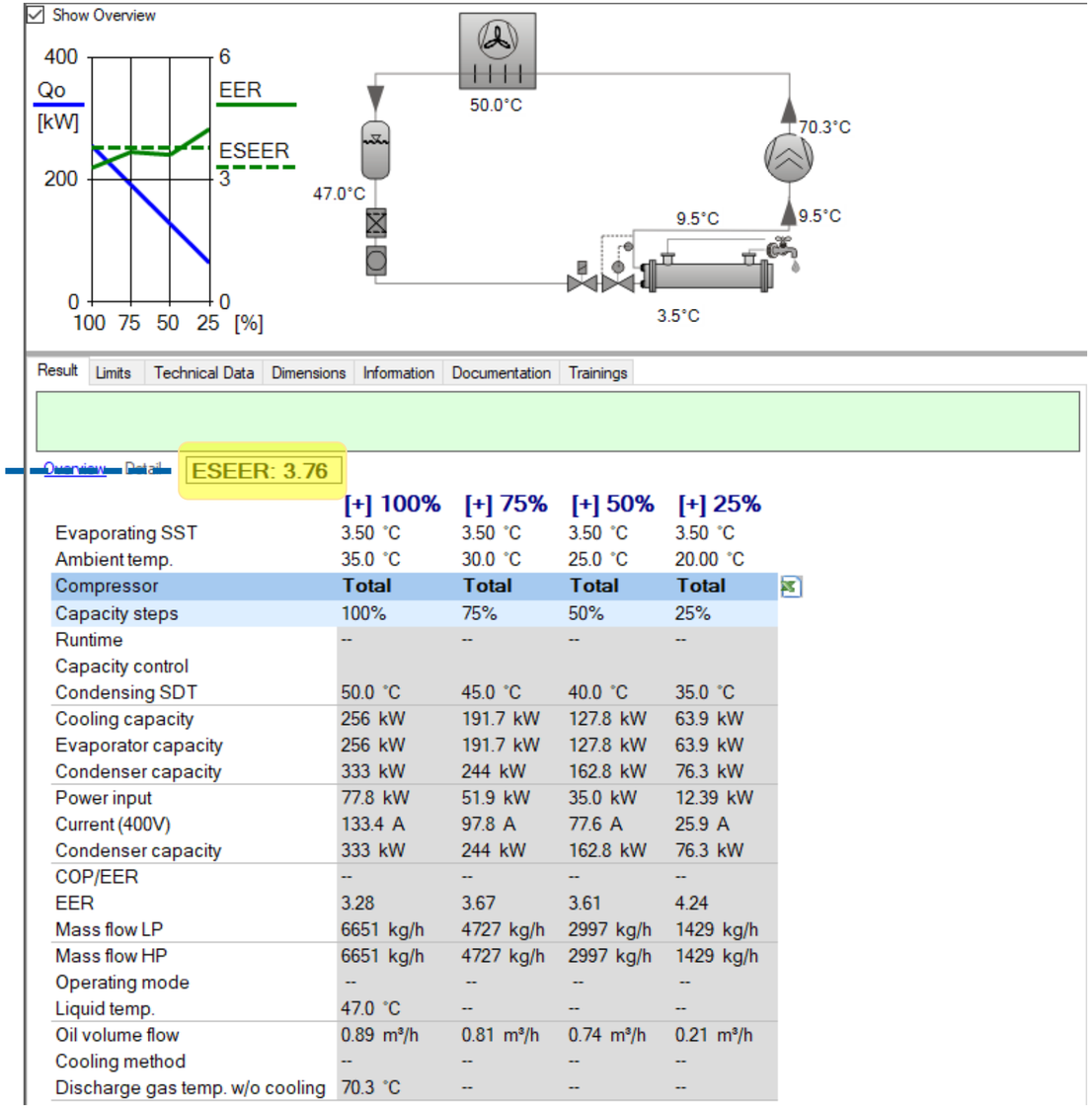
- **Set to design pressure**
- **Constant condenser pressure**
- **Control with pressure switch or pressure transmitter**
- **Pressure control regardless of ambient temperature**

Condenser Pressure ----------→ **10 ~ 12 bar**

SEER ----------→ **3.05**

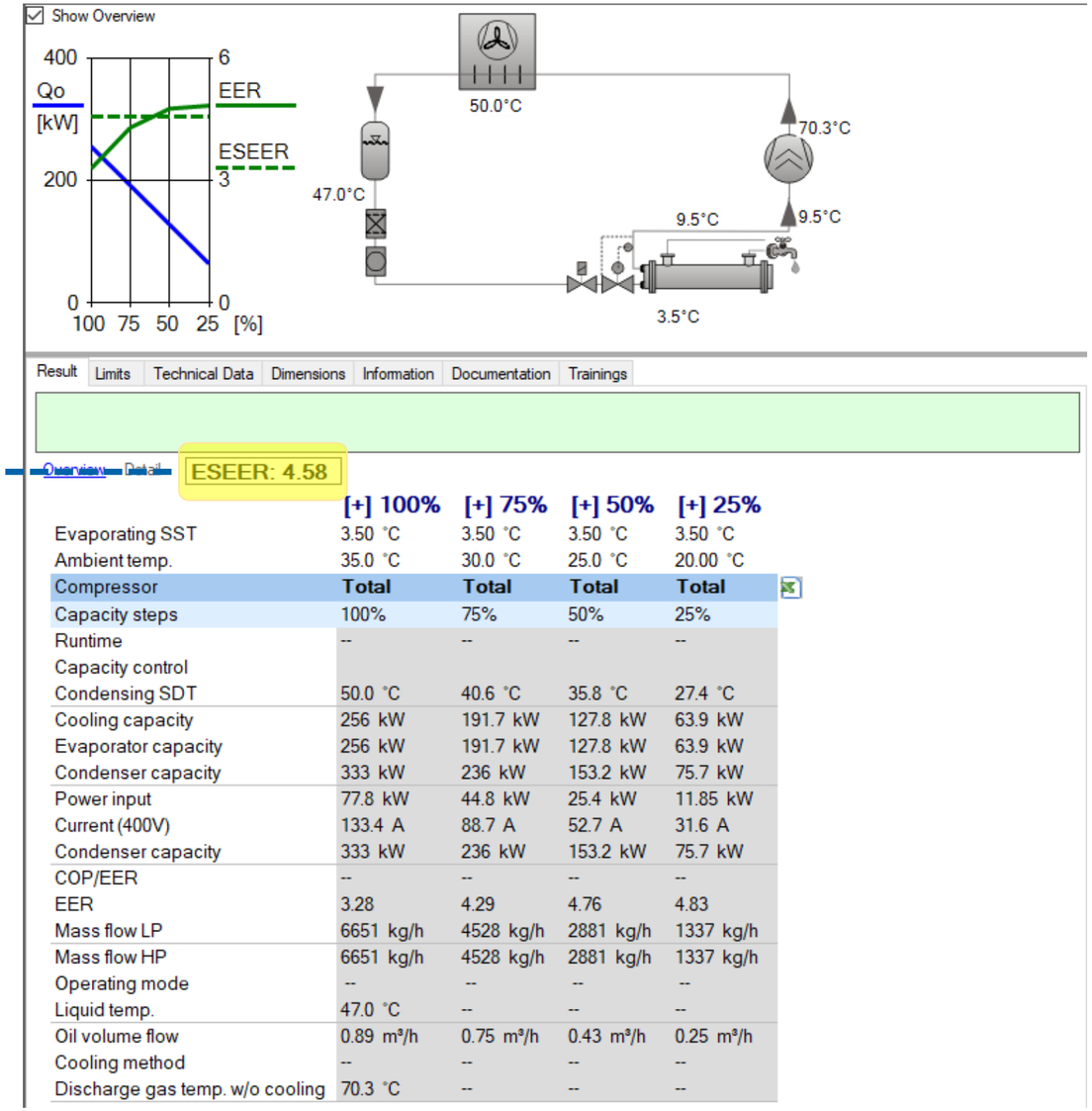
Condenser temperature control

3.76



	[+] 100%	[+] 75%	[+] 50%	[+] 25%
Evaporating SST	3.50 °C	3.50 °C	3.50 °C	3.50 °C
Ambient temp.	35.0 °C	30.0 °C	25.0 °C	20.00 °C
Compressor	Total	Total	Total	Total
Capacity steps	100%	75%	50%	25%
Runtime	--	--	--	--
Capacity control				
Condensing SDT	50.0 °C	45.0 °C	40.0 °C	35.0 °C
Cooling capacity	256 kW	191.7 kW	127.8 kW	63.9 kW
Evaporator capacity	256 kW	191.7 kW	127.8 kW	63.9 kW
Condenser capacity	333 kW	244 kW	162.8 kW	76.3 kW
Power input	77.8 kW	51.9 kW	35.0 kW	12.39 kW
Current (400V)	133.4 A	97.8 A	77.6 A	25.9 A
Condenser capacity	333 kW	244 kW	162.8 kW	76.3 kW
COP/EER	--	--	--	--
EER	3.28	3.67	3.61	4.24
Mass flow LP	6651 kg/h	4727 kg/h	2997 kg/h	1429 kg/h
Mass flow HP	6651 kg/h	4727 kg/h	2997 kg/h	1429 kg/h
Operating mode	--	--	--	--
Liquid temp.	47.0 °C	--	--	--
Oil volume flow	0.89 m³/h	0.81 m³/h	0.74 m³/h	0.21 m³/h
Cooling method	--	--	--	--
Discharge gas temp. w/o cooling	70.3 °C	--	--	--

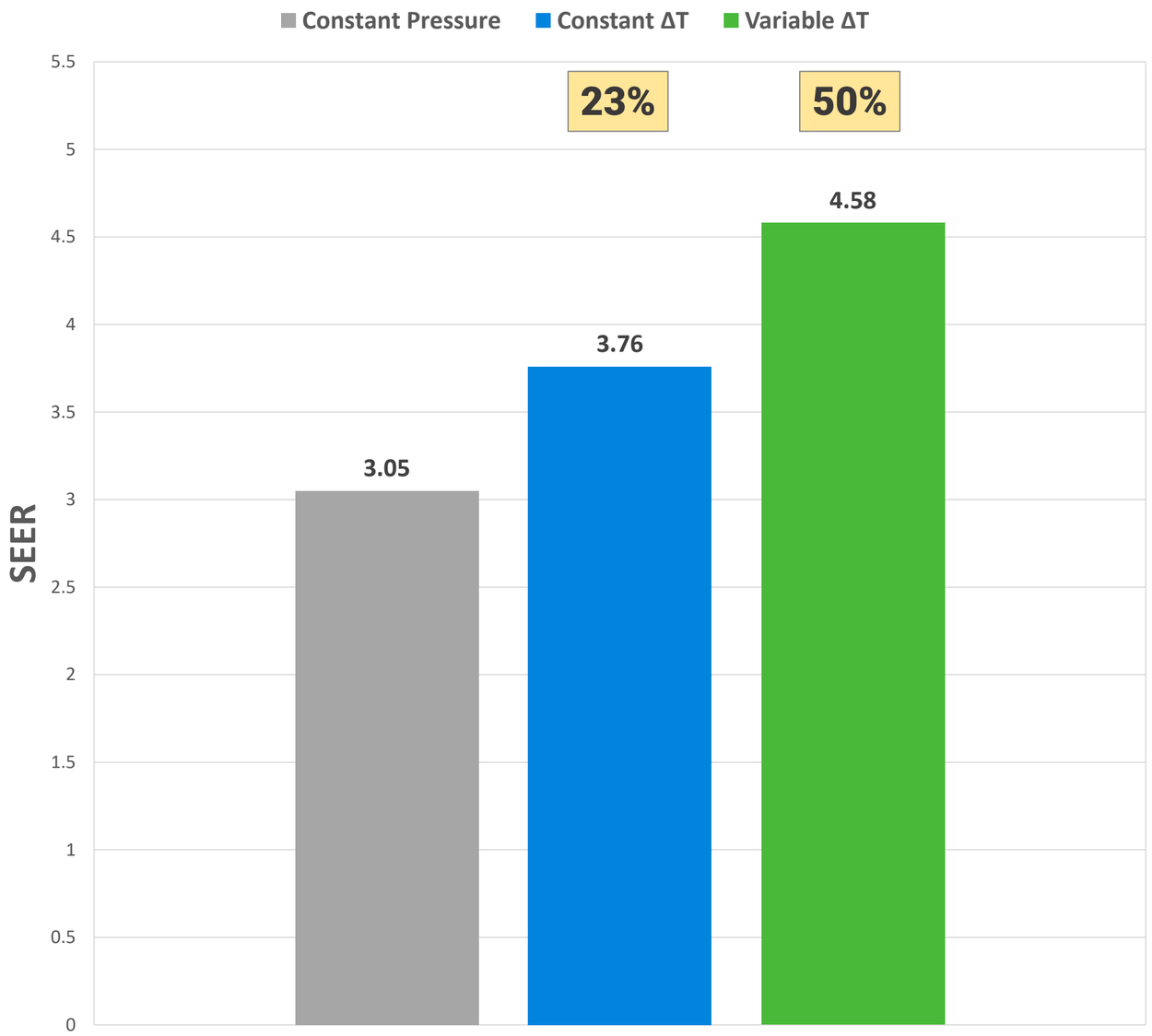
Condenser temperature control



4.58

	[+] 100%	[+] 75%	[+] 50%	[+] 25%
Evaporating SST	3.50 °C	3.50 °C	3.50 °C	3.50 °C
Ambient temp.	35.0 °C	30.0 °C	25.0 °C	20.00 °C
Compressor	Total	Total	Total	Total
Capacity steps	100%	75%	50%	25%
Runtime	--	--	--	--
Capacity control				
Condensing SDT	50.0 °C	40.6 °C	35.8 °C	27.4 °C
Cooling capacity	256 kW	191.7 kW	127.8 kW	63.9 kW
Evaporator capacity	256 kW	191.7 kW	127.8 kW	63.9 kW
Condenser capacity	333 kW	236 kW	153.2 kW	75.7 kW
Power input	77.8 kW	44.8 kW	25.4 kW	11.85 kW
Current (400V)	133.4 A	88.7 A	52.7 A	31.6 A
Condenser capacity	333 kW	236 kW	153.2 kW	75.7 kW
COP/EER	--	--	--	--
EER	3.28	4.29	4.76	4.83
Mass flow LP	6651 kg/h	4528 kg/h	2881 kg/h	1337 kg/h
Mass flow HP	6651 kg/h	4528 kg/h	2881 kg/h	1337 kg/h
Operating mode	--	--	--	--
Liquid temp.	47.0 °C	--	--	--
Oil volume flow	0.89 m³/h	0.75 m³/h	0.43 m³/h	0.25 m³/h
Cooling method	--	--	--	--
Discharge gas temp. w/o cooling	70.3 °C	--	--	--

Condenser temperature control



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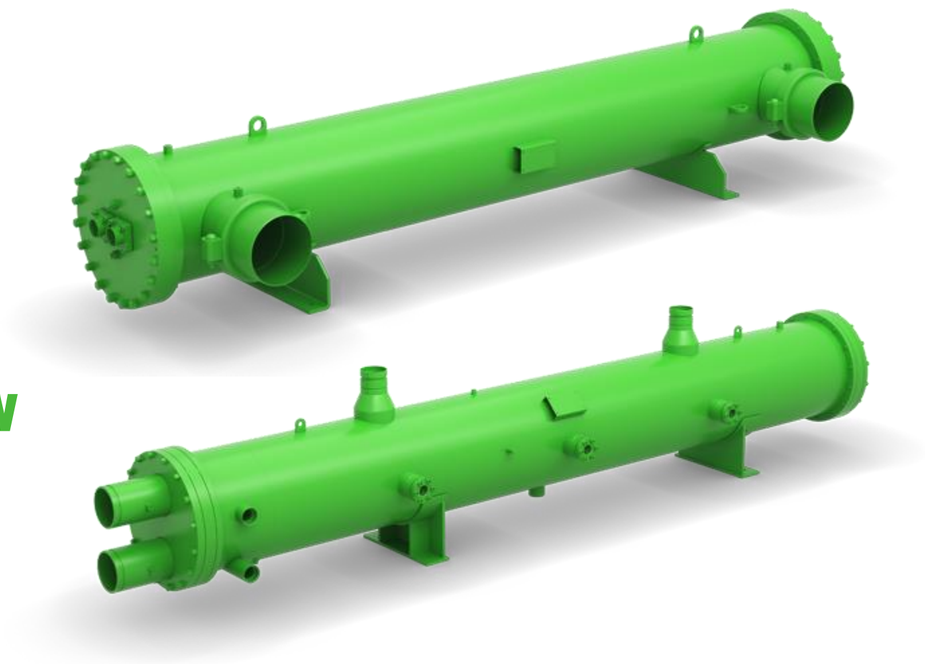
Evaporator temperature control

Liquid or gas, that is the question.

/ Evaporator temperature control

Construction

- High efficiency DX evaporator
- Flooded evaporator → CSH.6, CSW, CSVW



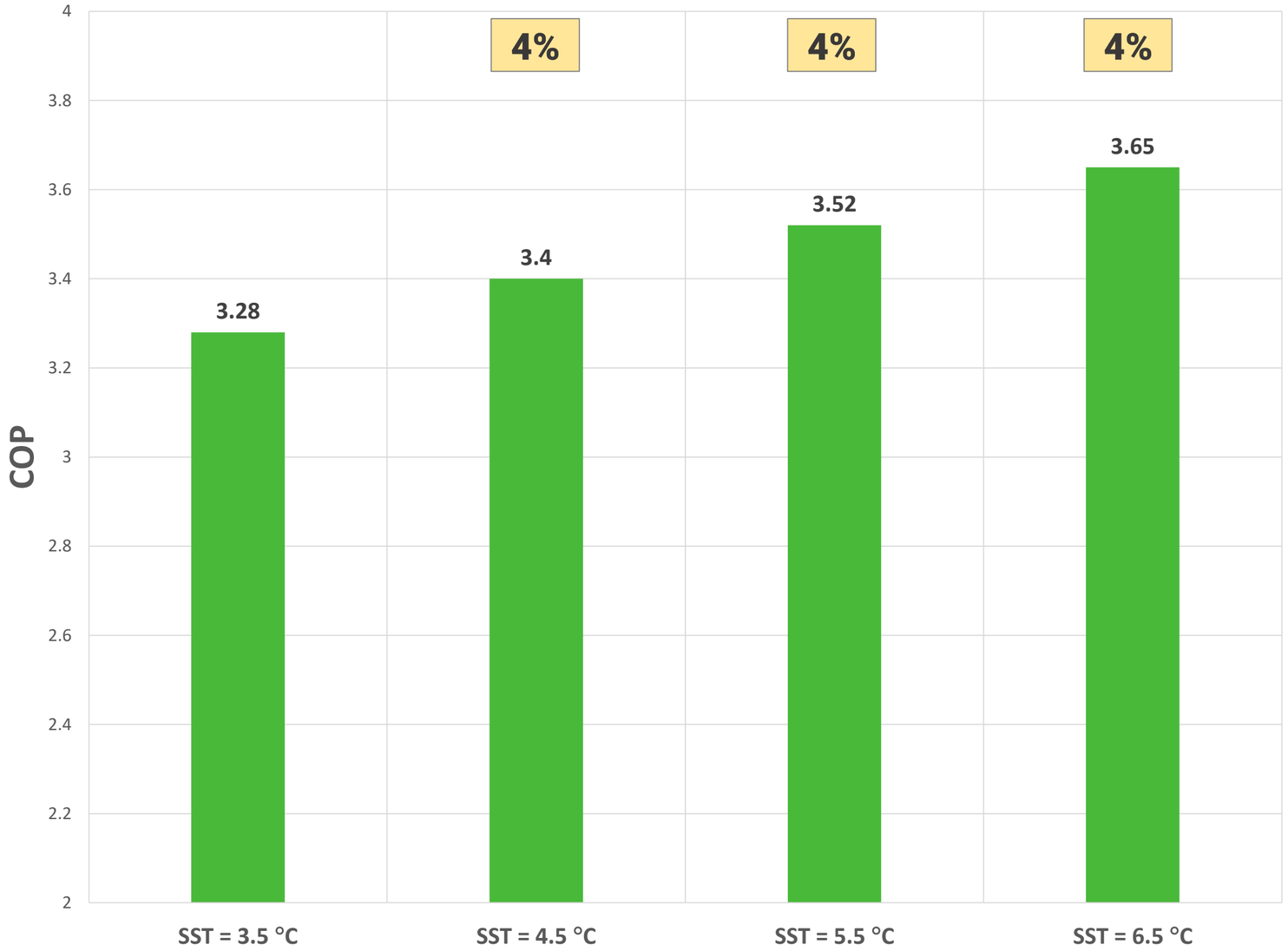
Logic control

- Raising suction pressure

Evaporator temperature control

Operation point

- CSH8583-125Y
- Refrigerant = R134a
- Evaporating SST = 3.5 °C
- Condensing SDT = 50 °C
- Subcooling = 3 K
- Superheat = 6 K



Evaporator temperature control

Raising suction pressure

Operation point

- CSH8583-125Y
- Refrigerant = R134a
- Evaporating SST = 3.5 °C
- Condensing SDT = 50 °C
- Subcooling = 3 K
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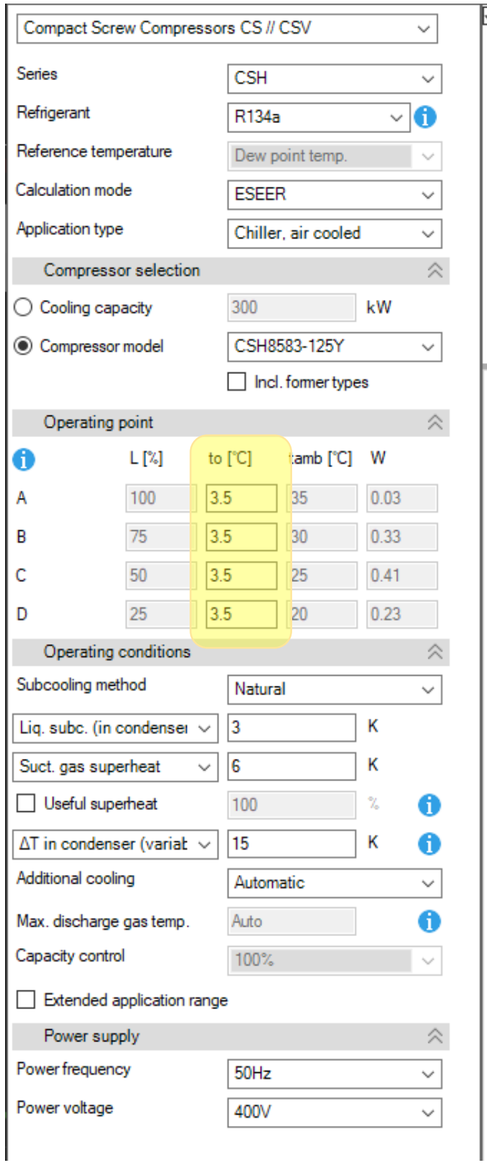

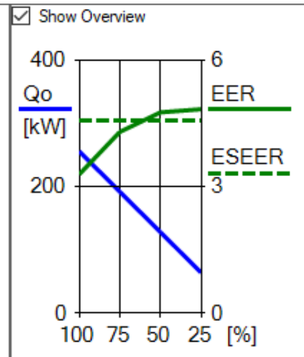

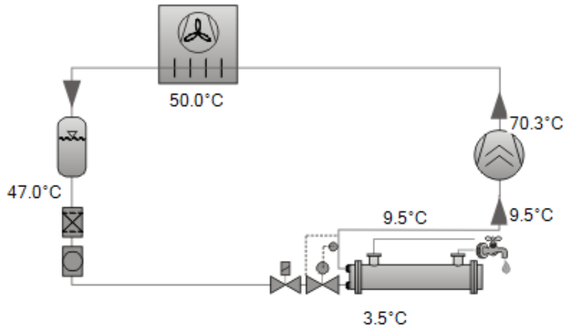

Result | Limits | Technical Data | Dimensions | Information | Documentation | Trainings

Overview | Detail

ESEER: 4.58

	[+] 100%	[+] 75%	[+] 50%	[+] 25%
Evaporating SST	3.50 °C	3.50 °C	3.50 °C	3.50 °C
Ambient temp.	35.0 °C	30.0 °C	25.0 °C	20.00 °C
Compressor	**Total**	**Total**	**Total**	**Total**
Capacity steps	100%	75%	50%	25%
Runtime	--	--	--	--
Capacity control				
Condensing SDT	50.0 °C	40.6 °C	35.8 °C	27.4 °C
Cooling capacity	256 kW	191.7 kW	127.8 kW	63.9 kW
Evaporator capacity	256 kW	191.7 kW	127.8 kW	63.9 kW
Condenser capacity	333 kW	236 kW	153.2 kW	75.7 kW
Power input	77.8 kW	44.8 kW	25.4 kW	11.85 kW
Current (400V)	133.4 A	88.7 A	52.7 A	31.6 A
Condenser capacity	333 kW	236 kW	153.2 kW	75.7 kW
COP/EER	--	--	--	--
EER	3.28	4.29	4.76	4.83
Mass flow LP	6651 kg/h	4528 kg/h	2881 kg/h	1337 kg/h
Mass flow HP	6651 kg/h	4528 kg/h	2881 kg/h	1337 kg/h
Operating mode	--	--	--	--
Liquid temp.	47.0 °C	--	--	--
Oil volume flow	0.89 m³/h	0.75 m³/h	0.43 m³/h	0.25 m³/h
Cooling method	--	--	--	--
Discharge gas temp. w/o cooling	70.3 °C	--	--	--

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Evaporator temperature control

Compact Screw Compressors CS // CSV

Series: CSH
Refrigerant: R134a
Reference temperature: Dew point temp.
Calculation mode: ESEER
Application type: Chiller, air cooled

Compressor selection

Cooling capacity: 300 kW
Compressor model: CSH8583-125Y
Incl. former types

Operating point

	L [%]	to [°C]	tamb [°C]	W
A	100	3.5	35	0.03
B	75	5	30	0.33
C	50	5.5	25	0.41
D	25	6	20	0.23

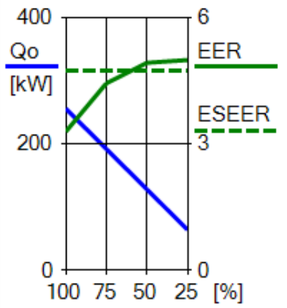
Operating conditions

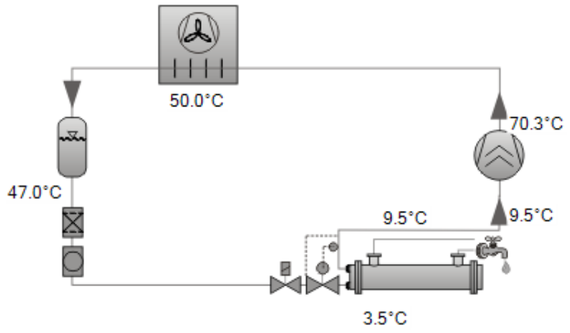
Subcooling method: Natural
Liq. subc. (in condenser): 3 K
Suct. gas superheat: 6 K
Useful superheat: 100 %
ΔT in condenser (variat: 15 K
Additional cooling: Automatic
Max. discharge gas temp.: Auto
Capacity control: 100%
Extended application range

Power supply

Power frequency: 50Hz
Power voltage: 400V

Show Overview





Result | Limits | Technical Data | Dimensions | Information | Documentation | Trainings

Overview | Detail | ESEER: 4.72

	[+] 100%	[+] 75%	[+] 50%	[+] 25%
Evaporating SST	3.50 °C	5.00 °C	5.50 °C	6.00 °C
Ambient temp.	35.0 °C	30.0 °C	25.0 °C	20.00 °C
Compressor	Total	Total	Total	Total
Capacity steps	100%	75%	50%	25%
Runtime	--	--	--	--
Capacity control				
Condensing SDT	50.0 °C	40.6 °C	36.6 °C	28.1 °C
Cooling capacity	256 kW	191.7 kW	127.8 kW	63.9 kW
Evaporator capacity	256 kW	191.7 kW	127.8 kW	63.9 kW
Condenser capacity	333 kW	235 kW	152.1 kW	75.1 kW
Power input	77.8 kW	43.1 kW	24.3 kW	11.25 kW
Current (400V)	133.4 A	86.7 A	49.7 A	29.1 A
Condenser capacity	333 kW	235 kW	152.1 kW	75.1 kW
COP/EER	--	--	--	--
EER	3.28	4.43	4.92	4.99
Mass flow LP	6651 kg/h	4500 kg/h	2879 kg/h	1333 kg/h
Mass flow HP	6651 kg/h	4500 kg/h	2879 kg/h	1333 kg/h
Operating mode	--	--	--	--
Liquid temp.	47.0 °C	--	--	--
Oil volume flow	0.89 m³/h	0.74 m³/h	0.40 m³/h	0.23 m³/h
Cooling method	--	--	--	--
Discharge gas temp. w/o cooling	70.3 °C	--	--	--

ASEH

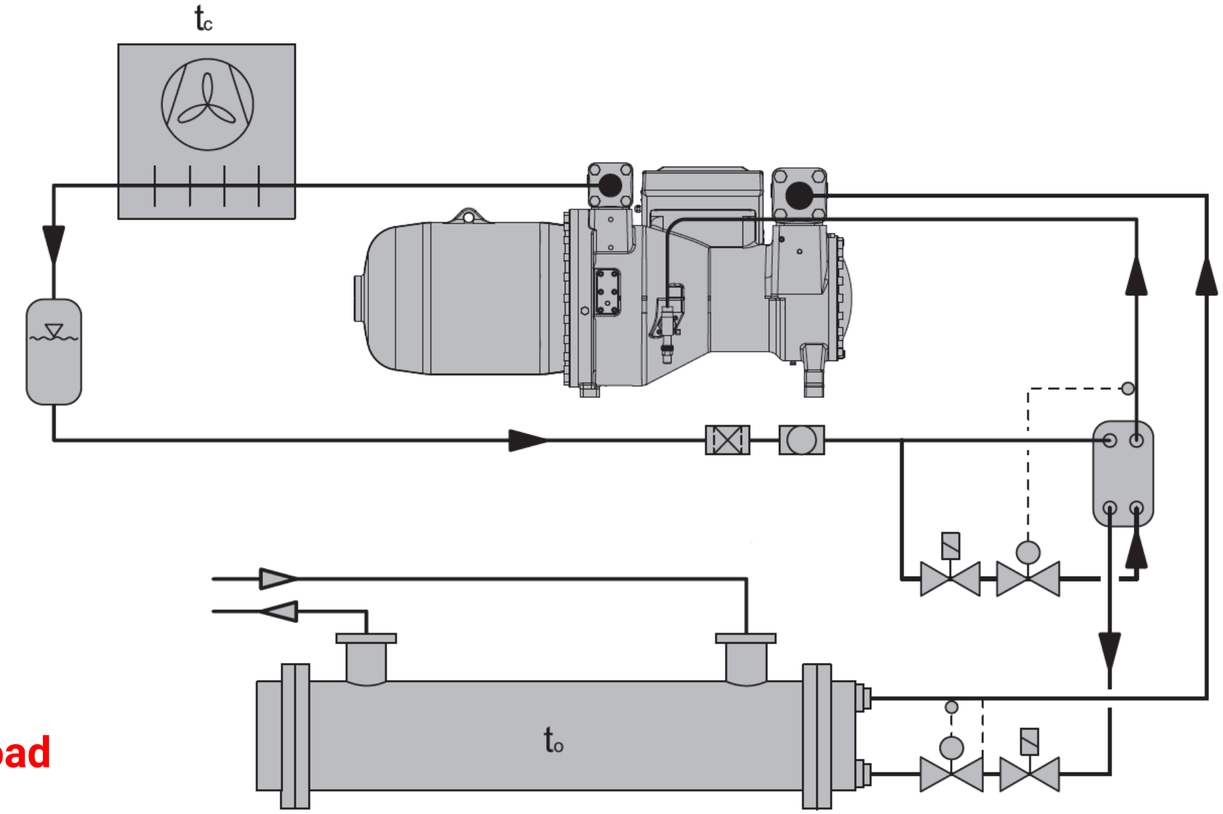
Economizer

The Last Samurai

Economizer

- **Increase system efficiency**
- **Downsizing the compressor**

  in the same capacity



*** Economizer operation (ECO) in full and partial load**

Economizer

Example A

- Air cooled chiller
- Cooling capacity = 200 kW
- Ambient Temp. = 35 °C
- Refrigerant = R134a

1st option

- CSH8563-90Y
- Evaporating SST = 3.5 °C
- Condensing SDT = 50 °C
- Subcooling = 3 K
- Superheat = 6 K
- Cooling capacity = 197.3 kW

2nd option

- CSH7593-90Y + Economizer
- Evaporating SST = 3.5 °C
- Condensing SDT = 50 °C
- Subcooling = 3 K
- Superheat = 6 K
- Cooling capacity = 209 kW

Example B

- Air cooled chiller
- Cooling capacity = 350 kW
- Ambient Temp. = 35 °C
- Refrigerant = R134a

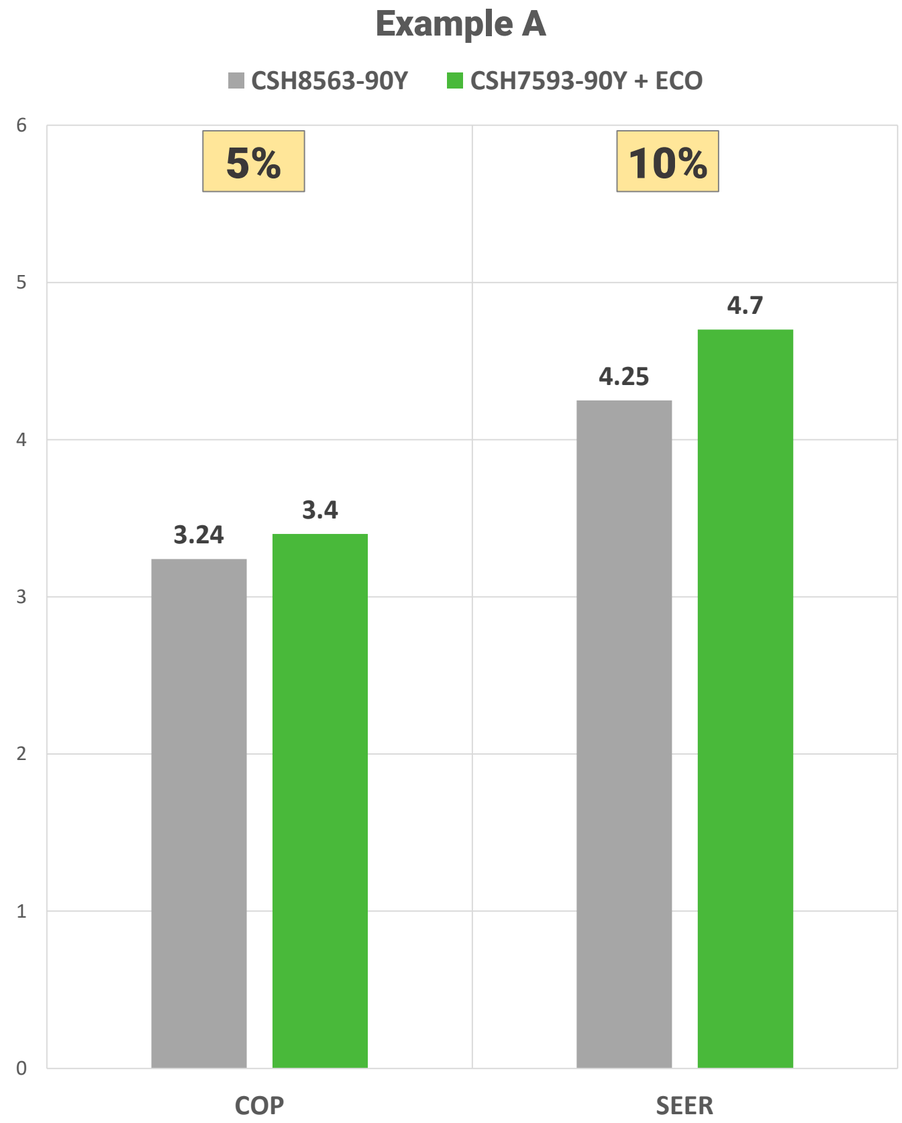
1st option

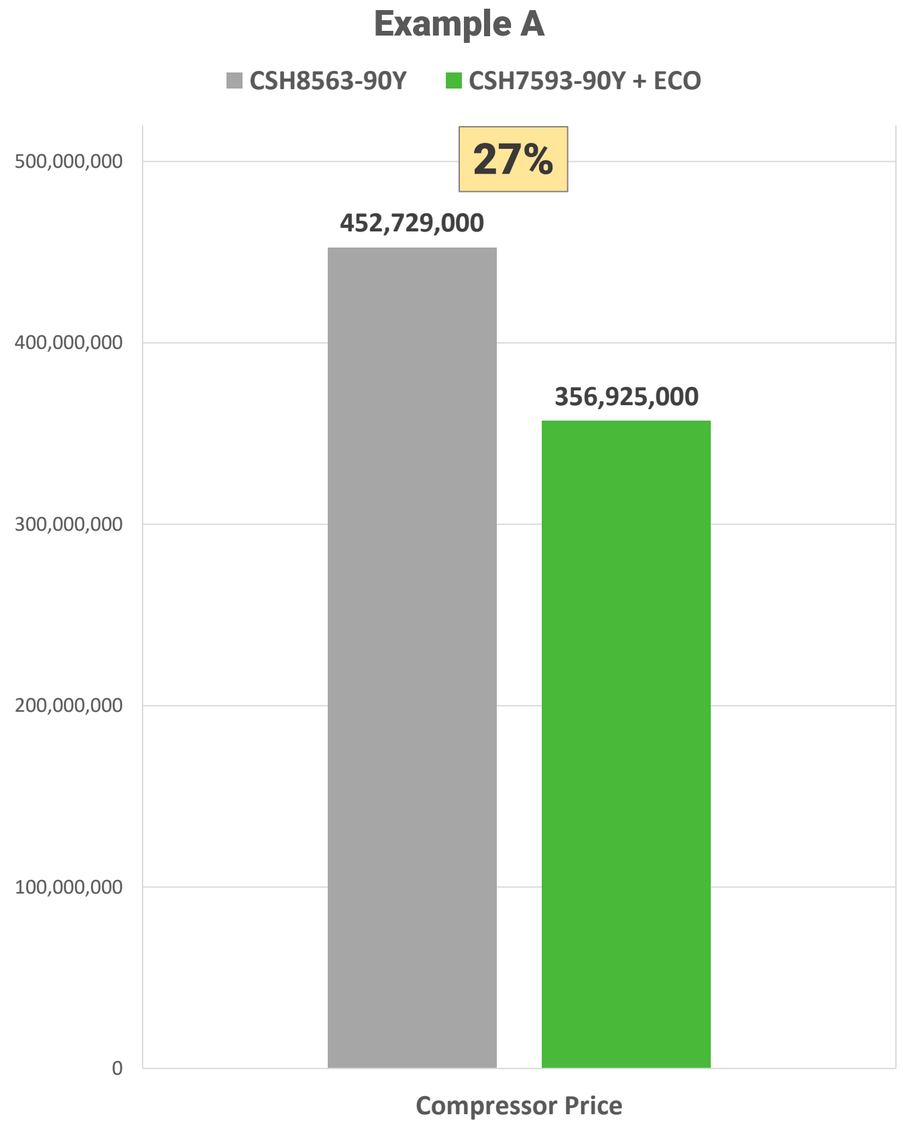
- CSH9563-160Y
- Evaporating SST = 3.5 °C
- Condensing SDT = 50 °C
- Subcooling = 3 K
- Superheat = 6 K
- Cooling capacity = 345 kW

2nd option

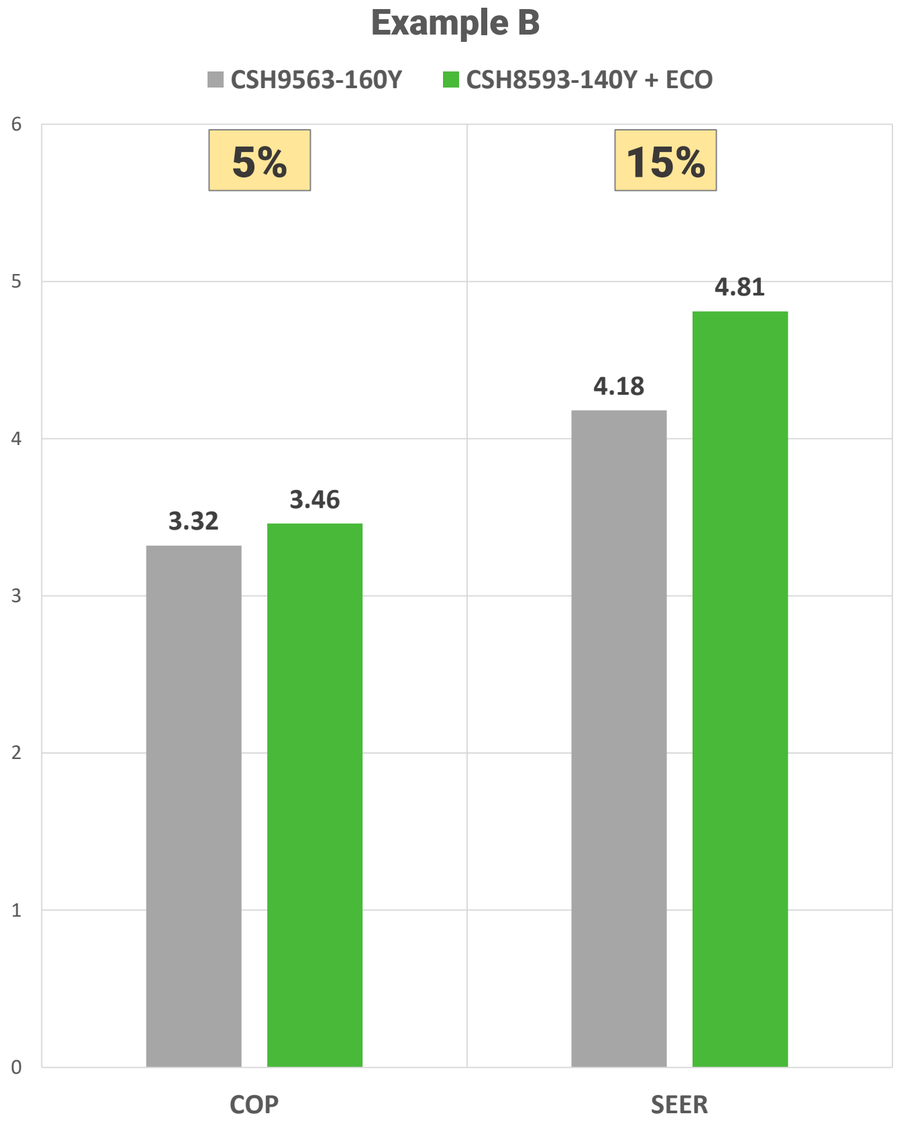
- CSH8593-140Y + Economizer
- Evaporating SST = 3.5 °C
- Condensing SDT = 50 °C
- Subcooling = 3 K
- Superheat = 6 K
- Cooling capacity = 345 kW

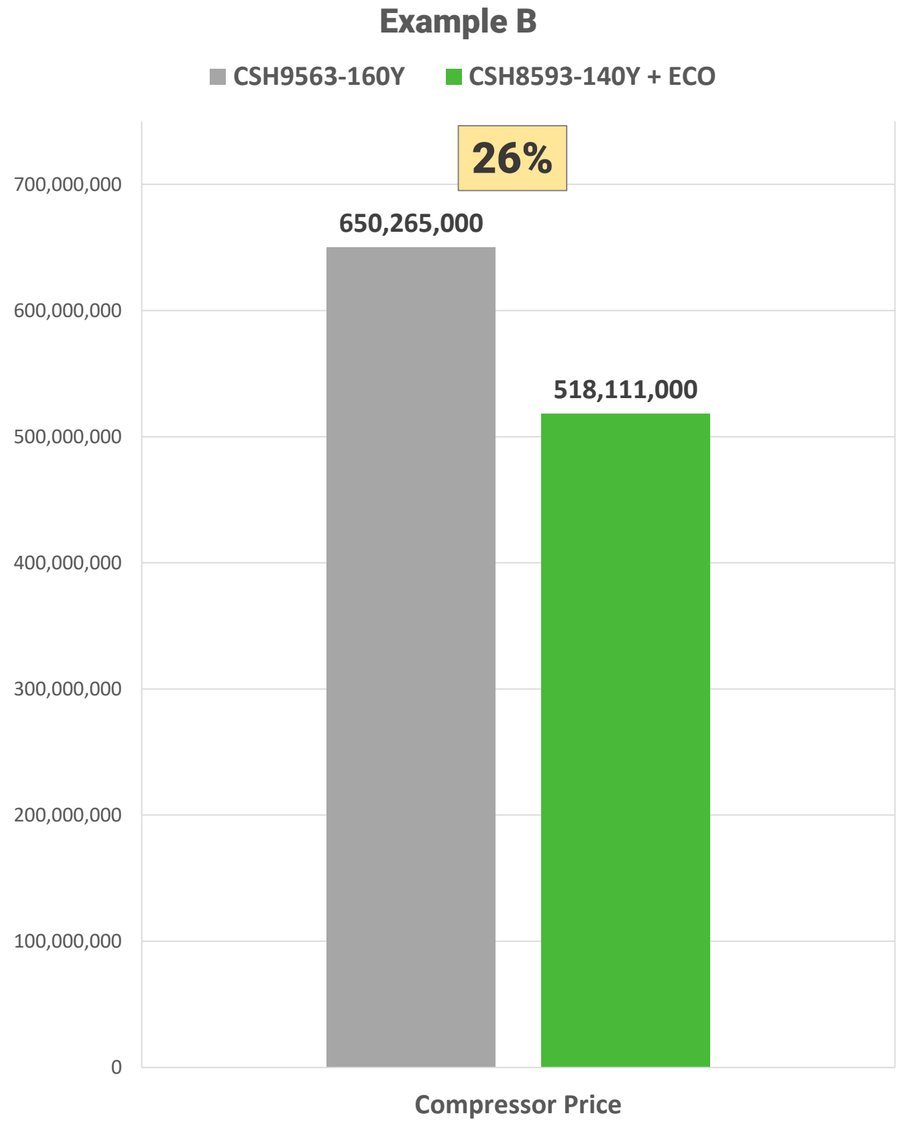
Economizer


Example A
CSH8563-90Y
CSH7593-90Y + ECO
5%
10%
6
5
4
3
2
1
0
3.24
3.4
4.25
4.7
COP
SEER


Example A
CSH8563-90Y
CSH7593-90Y + ECO
27%
500,000,000
400,000,000
300,000,000
200,000,000
100,000,000
0
452,729,000
356,925,000
Compressor Price

Economizer





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Economizer with Thermostatic expansion valve

- **Thermostatic expansion valve with standard superheating of 10 K can be used**
- **The thermostatic expansion valve should contain an MOP charge**
- **A solenoid valve must be used**
- **Install a sight glass**
- **Positioning of the valve sensor at the ECO suction gas line, maintain a distance of at least 1m to the compressor ECO port**

/ CSH + CSVH

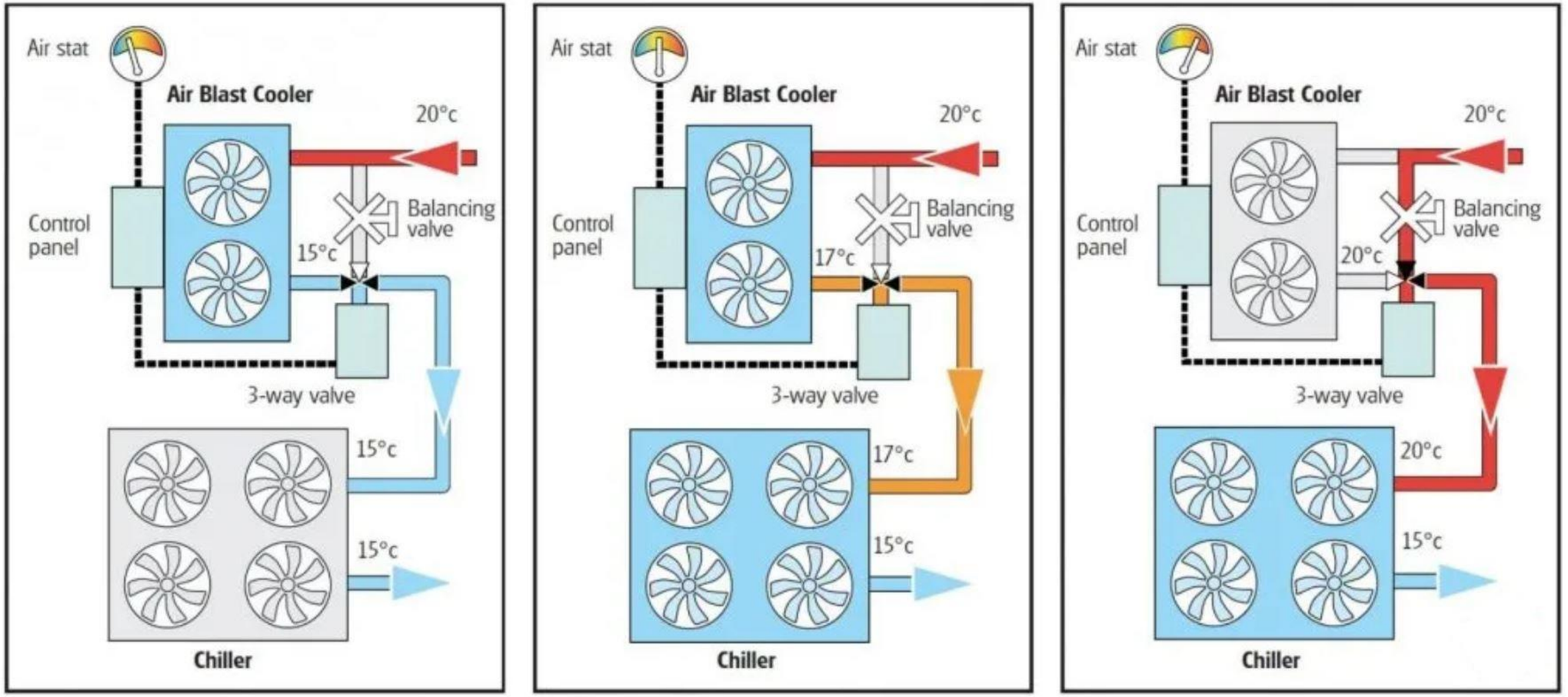
Master and Commander!

CSH + CSVH

Free Cooling

For a Few Dollars More

Free Cooling



Chiller with one Screw compressor

Screw vs. Scroll

Chiller with one Screw compressor

Chiller with one Screw compressor

Operation point

- **Refrigerant = R22**
- **Evaporating SST = 3.5 °C**
- **Condensing SDT = 50 °C**
- **Subcooling = 3 K**
- **Superheat = 6 K**

Chiller Capacity (Rton)	30		40		50		60	90
Scroll model	4× ZR125	2× ZR250	4× ZR160	2× ZR310	4× ZR190	2× ZR380	4× ZR250	4× ZR380
Screw model	1× CSH6553-50		1× CSH6563-60		1× CSH7563-80		1× CSH7573-90	1× CSH8563-125
Scroll SEER	4.58	4.31	4.42	4.38	4.35	4.38	4.31	4.38
Screw SEER	4.04		4.08		3.95		4.13	3.85
Difference	0.54	0.27	0.34	0.3	0.4	0.43	0.18	0.53
Scroll price	1,513,216,000	2,022,436,000	1,814,608,000	2,213,520,000	2,030,256,000	2,557,600,000	4,044,872,000	5,115,200,000
Screw price	1,973,600,600		2,100,503,800		2,447,749,200		2,769,976,400	3,732,640,000
Difference	-460,384,600	48,835,400	-285,895,800	113,016,200	-417,493,200	109,850,800	1,274,895,600	1,382,560,000

Chiller with one Screw compressor

Operation point

- **Refrigerant = R134a**
- **Evaporating SST = 3.5 °C**
- **Condensing SDT = 50 °C**
- **Subcooling = 3 K**
- **Superheat = 6 K**

Chiller Capacity (Rton)	30		40		50		60	90
Scroll model	4× ZR190	2× ZR380	4× ZR250	6× ZR190	4× ZR310	6× ZR250	4× ZR380	6× ZR380
Screw model	1× CSH7553-50Y		1× CSH7573-70Y		1× CSH7593-90Y		1× CSH8573-110Y	1× CSH9563-160Y
Scroll SEER	4.12	4.23	4.16	4.12	4.13	4.16	4.23	4.23
Screw SEER	4.2		4.33		4.44		4.39	4.18
Difference	-0.08	0.03	-0.17	-0.21	-0.31	-0.28	-0.16	0.05
Scroll price	2,030,256,000	2,557,600,000	4,044,872,000	3,045,384,000	4,427,040,000	6,067,308,000	5,115,200,000	7,672,800,000
Screw price	2,280,731,600		2,687,910,800		2,926,785,000		4,017,647,400	5,332,173,000
Difference	-250,475,600	276,868,400	1,356,961,200	357,473,200	1,500,255,000	3,140,523,000	1,097,552,600	2,340,627,000

Chiller with one Screw compressor

Operation point

- **Refrigerant = R134a**
- **Evaporating SST = 3.5 °C**
- **Condensing SDT = 50 °C**
- **Subcooling = 3 K**
- **Superheat = 6 K**

✓ **Economizer function**

Chiller Capacity (Rton)	30		40		50		60	90
Scroll model	4× ZR190	2× ZR380	4× ZR250	6× ZR190	4× ZR310	6× ZR250	4× ZR380	6× ZR380
Screw model	1× CSH6563-60Y + ECO		1× CSH7563-60Y + ECO		1× CSH7583-80Y + ECO		1× CSH7593-90Y + ECO	1× CSH8593-140Y + ECO
Scroll SEER	4.12	4.23	4.16	4.12	4.13	4.16	4.23	4.23
Screw SEER	4.55		4.49		4.74		4.7	4.73
Difference	-0.43	-0.32	-0.33	-0.37	-0.61	-0.58	-0.47	-0.5
Scroll price	2,030,256,000	2,557,600,000	4,044,872,000	3,045,384,000	4,427,040,000	6,067,308,000	5,115,200,000	7,672,800,000
Screw price	2,154,058,000		2,372,301,000		2,806,638,600		2,926,785,000	4,248,510,200
Difference	-123,802,000	403,542,000	1,672,571,000	673,083,000	1,620,401,400	3,260,669,400	2,188,415,000	3,424,289,800

Thank You!

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