SOLAR COOLING

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Outline

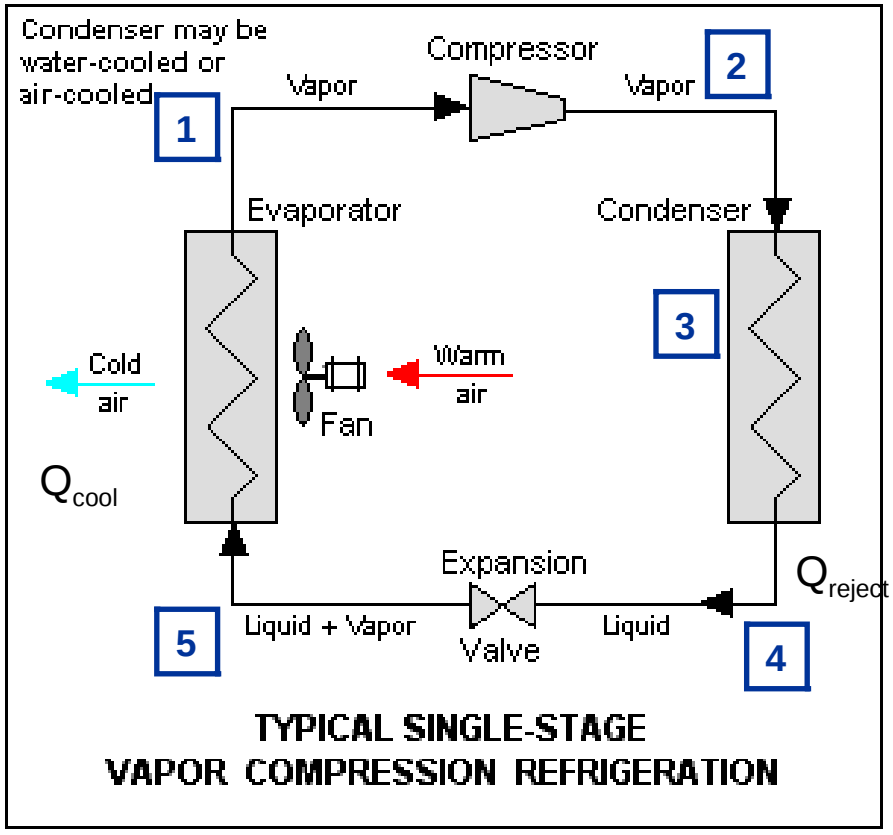
INTRODUCTION

- Cooling market
- Psychrometric processes
- Basic principle

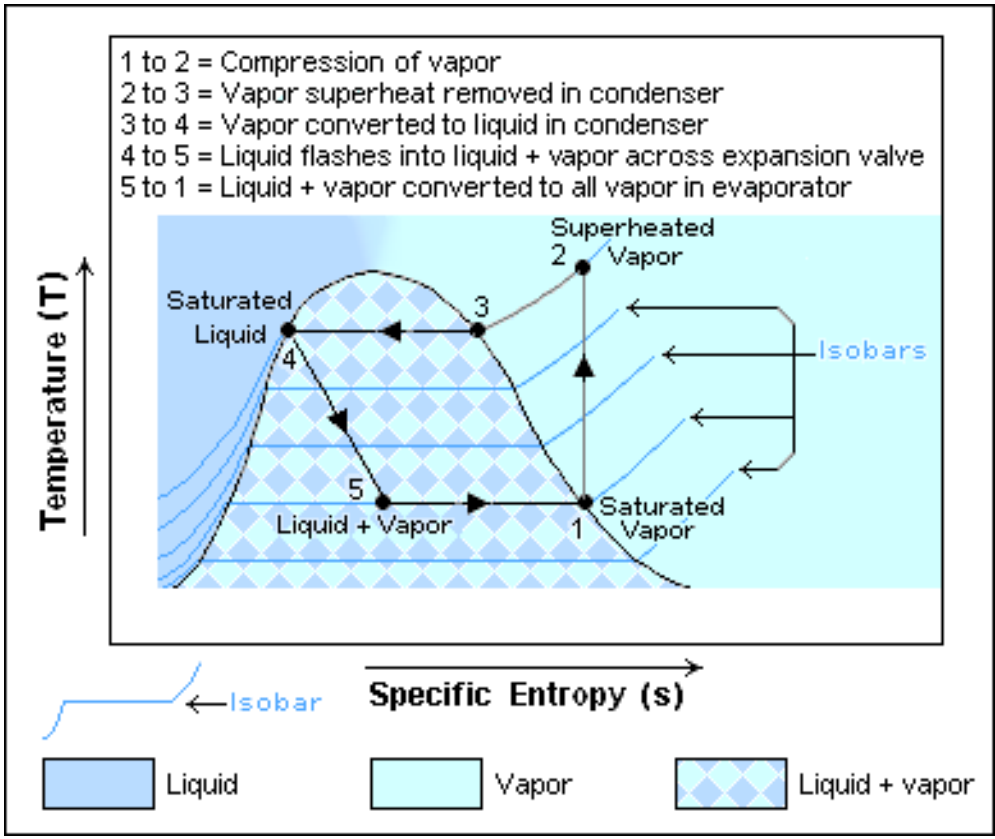
AVAILABLE TECHNOLOGIES

- Compression chillers
- TDCs:
  - Absorption chillers
  - Adsorption chillers
- Desiccant systems

Vapor compression chiller
Operation principle

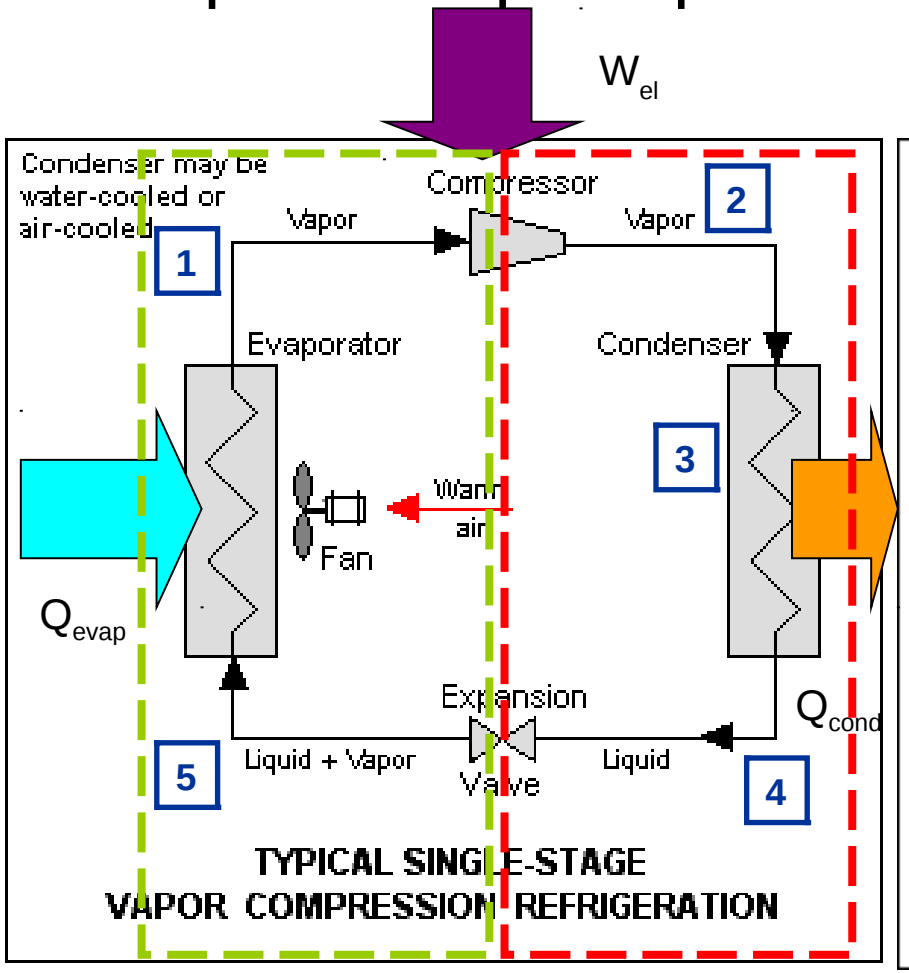


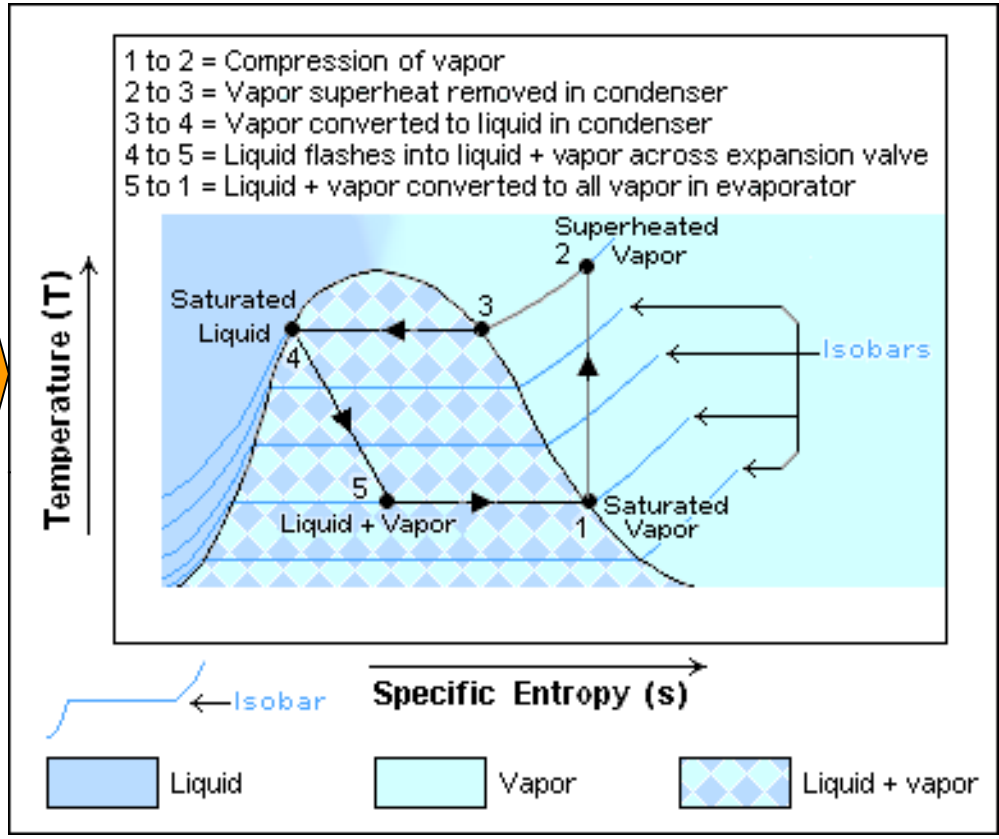
Source:commons.wikimedia.org/wiki/File:Refrigeration.png



Source:en.wikipedia.org/wiki/Vapor-compression_refrigeration#/media/File:RefrigerationTS.png

Vapor compression chiller
Operation principle





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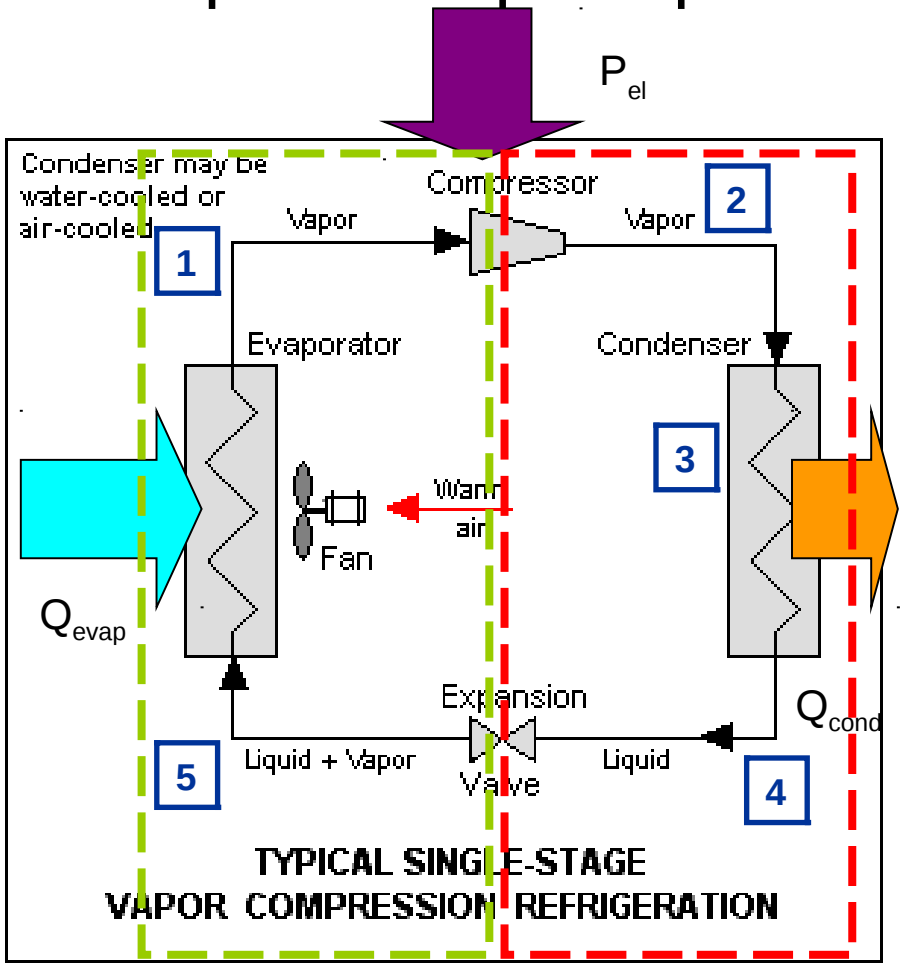
Vapor compression chiller
Operation principle



$$COP_c = \frac{Q_{evap}}{P_{el}}$$

- Instantaneous
- Seasonal
- Annual

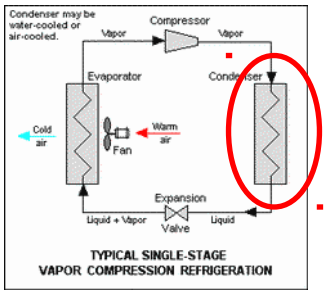
Source:commons.wikimedia.org/wiki/File:Refrigeration.png

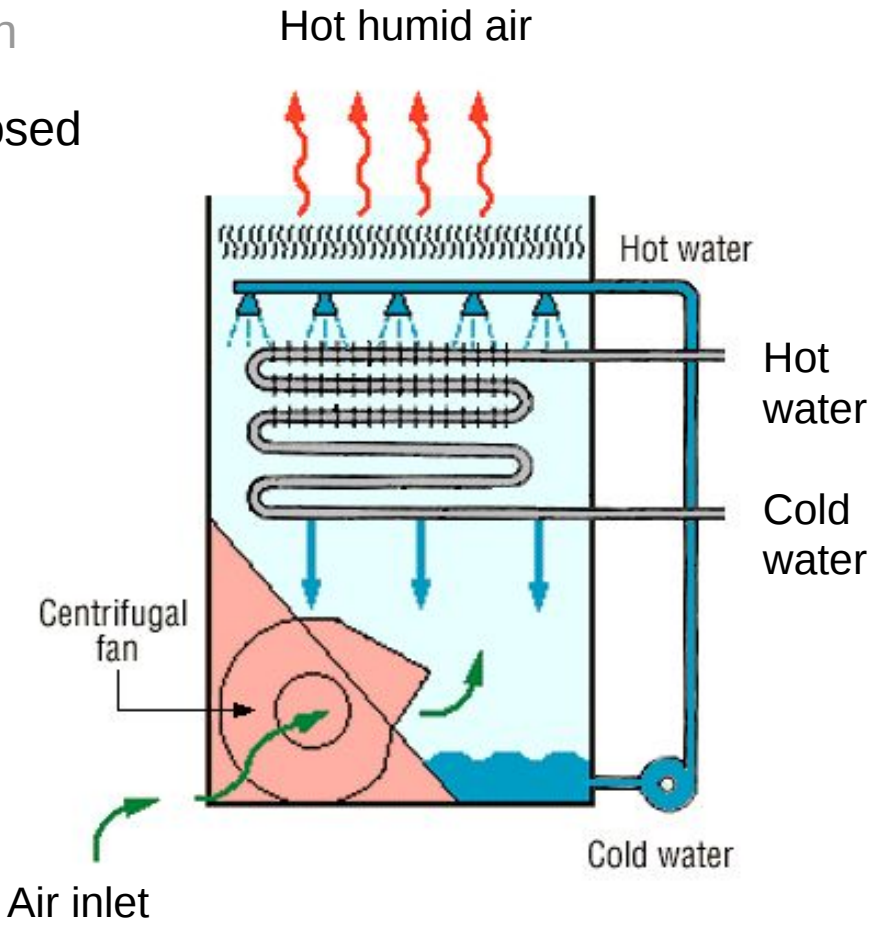
Vapor compression chiller

COOLING TOWERS (Condenser)

Direct contact or open

Indirect contact or closed





Source:betterbricks.com/articles/cooling-towers

Vapor compression chiller

COOLING TOWERS (Condenser)

Typically: T_{middle}=cte (27-29°C) -> heat rejected depends on water mass flow rate and load

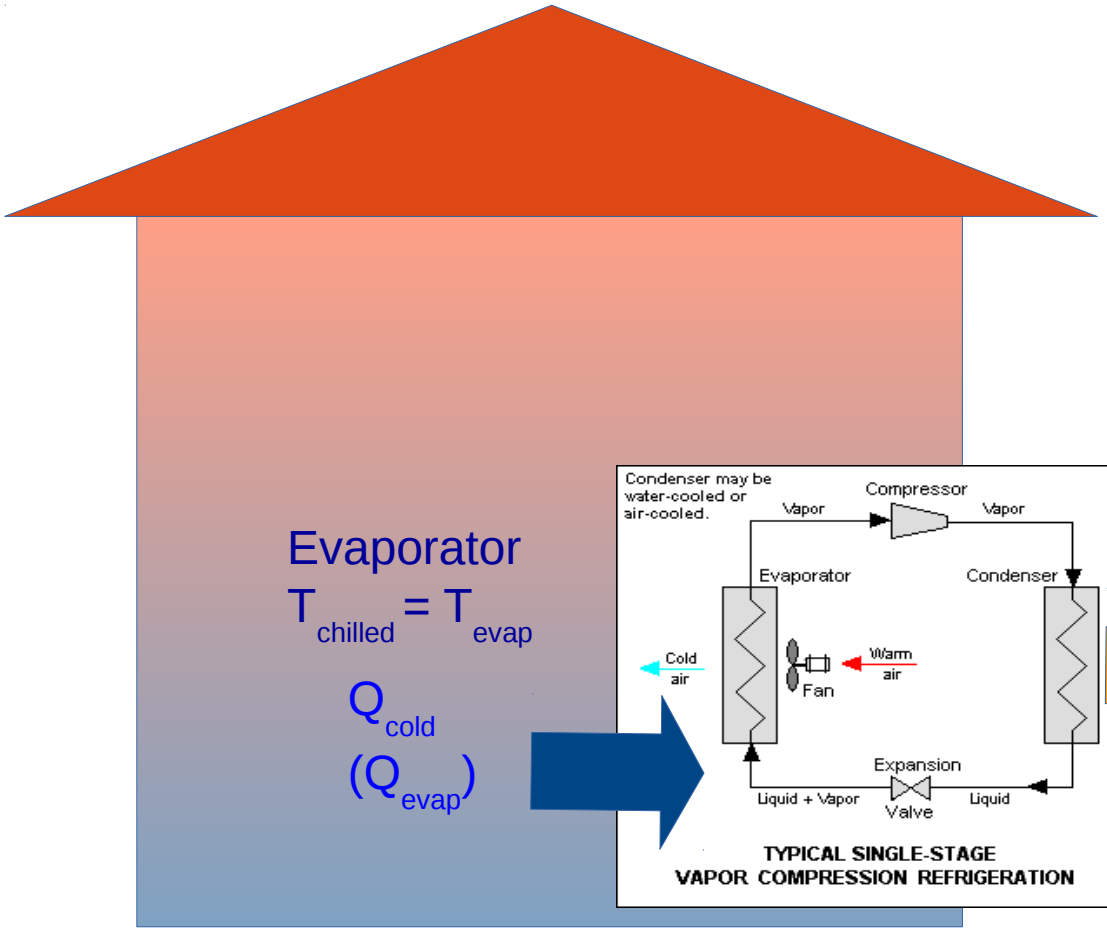
Variable speed fans: reduce electrical consumption (3% of cooling power)

Evaporative cooling -> use of water 2% of mass flow „lost“

Mantainance requirements:

- Frequent cleaning
- Chemical treatment (legionella)

System layout



Evaporator

$T_{chilled} = T_{evap}$

Q_{cold}

(Q_{evap})

$T_{middle} = T_{middle}$

Q_{cond}

Vapor compression chiller

Typical Figures

Reciprocating compressors:

- COP = 2.0-4.7
- Cooling capacity = 10-500 kW

Screw compressors:

- COP = 2.0-7.0
- Cooling capacity = 300-2000 kW

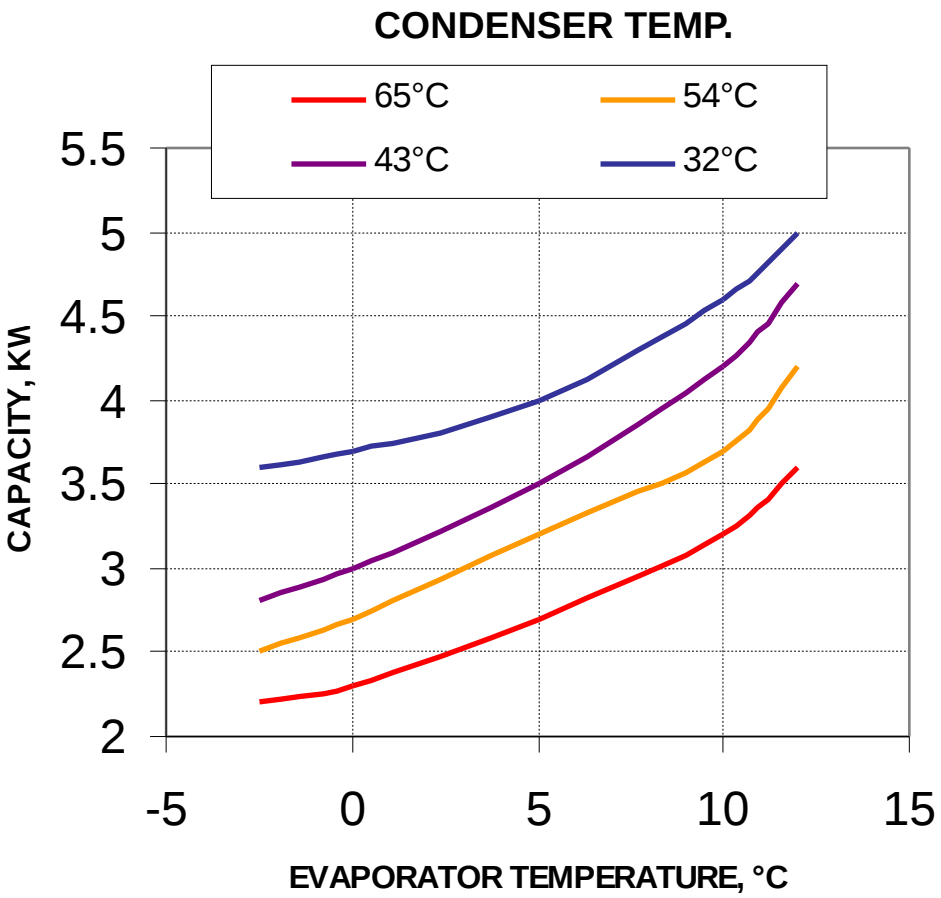
Centrifugal compressors:

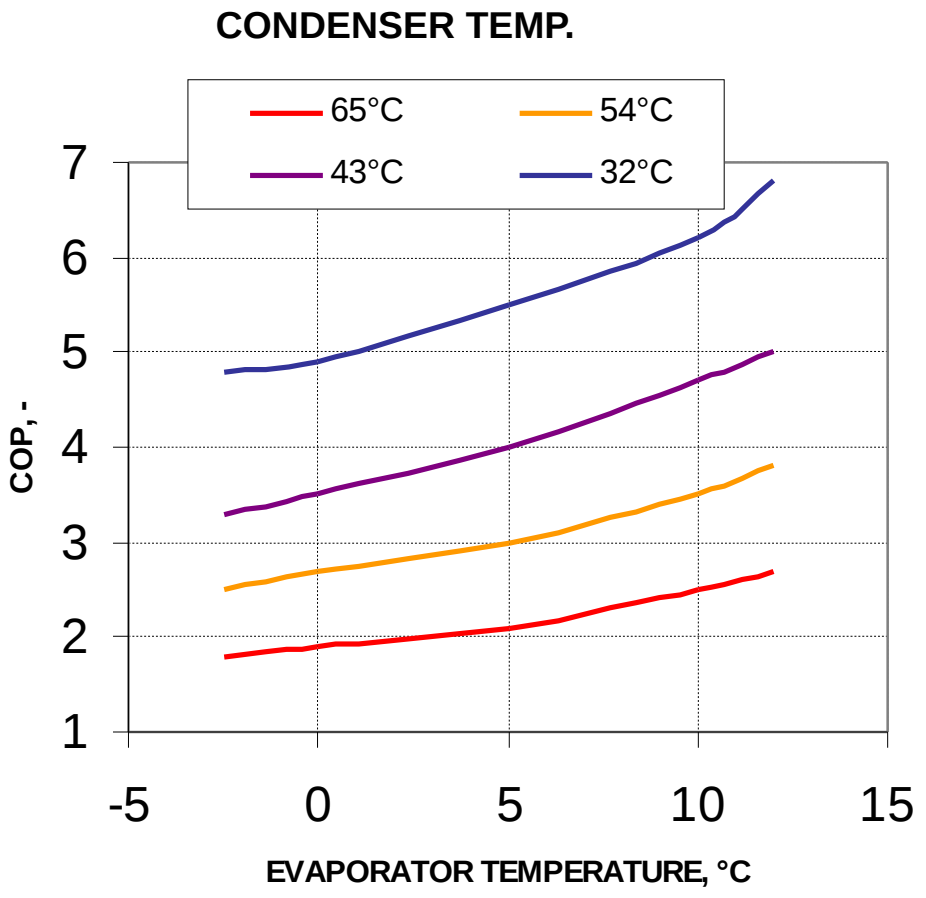
- COP = 4.0-8.0
- Cooling capacity 300-30000kW

$T_{middle} = T_{air} = T_{cond}$

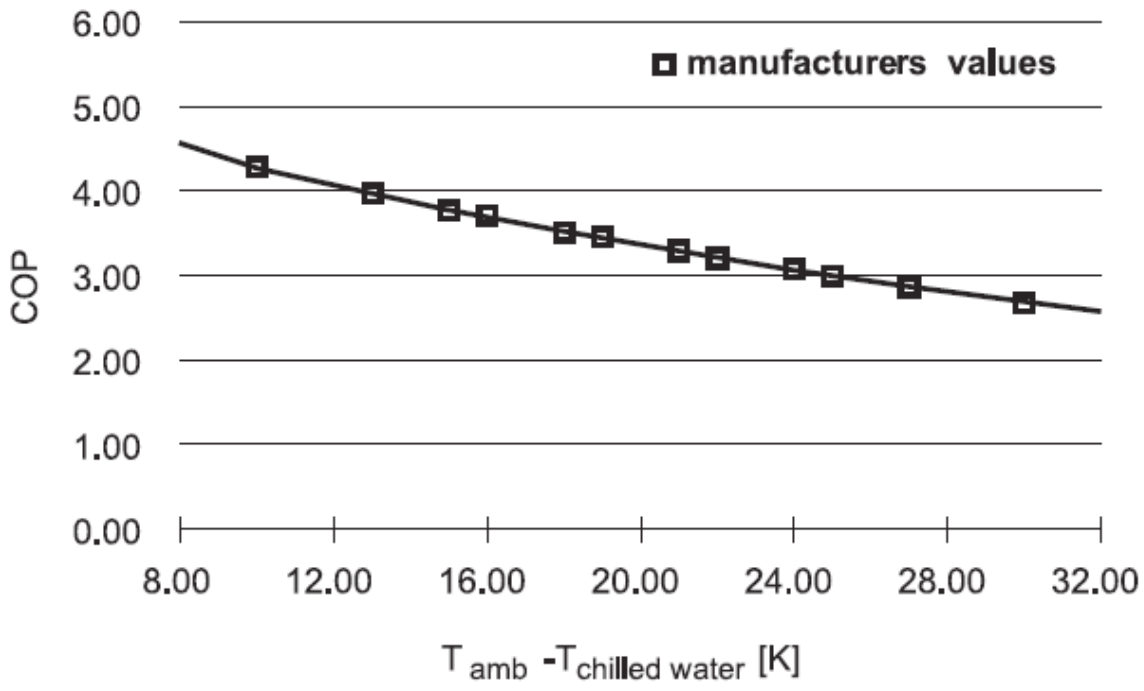
$T_{chilled\ water}\ (T_{chilled}) = T_{evap} \ldots$

Vapor compression chiller Performance





Vapor compression chiller Performance



$T_{cond} - T_{evap}$

Commercial data, 150kW

Source: Henning, 2003

References

- Henning, H.M. (Ed.) 2003. Solar-Assisted Air-Conditioning in Buildings - A Handbook for Planners. Springer-Verlag/Wien (Austria). 2003.