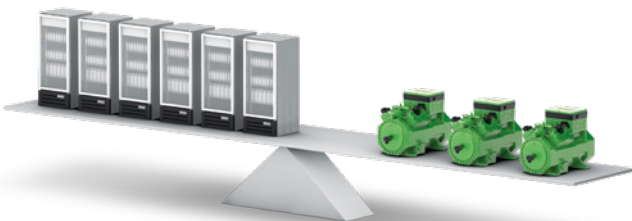


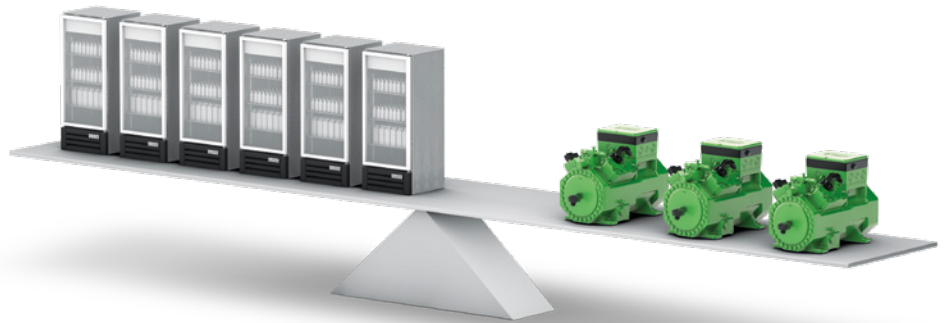
FRIGOTAKT G4 – CONTROL SOLUTION WITH ONLINE MODELLING

Advantages for planners and installers

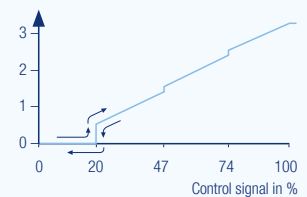
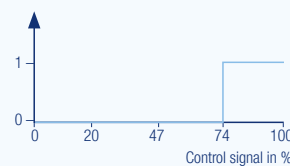
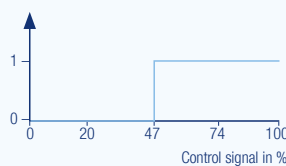
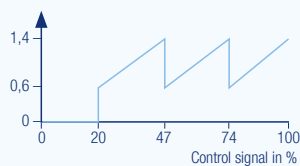


CO₂-REFRIGERATION SYSTEMS – THE CONTROL TASK!

The refrigerant mass flows of the cold locations must always correspond to the displacement of the compressors.



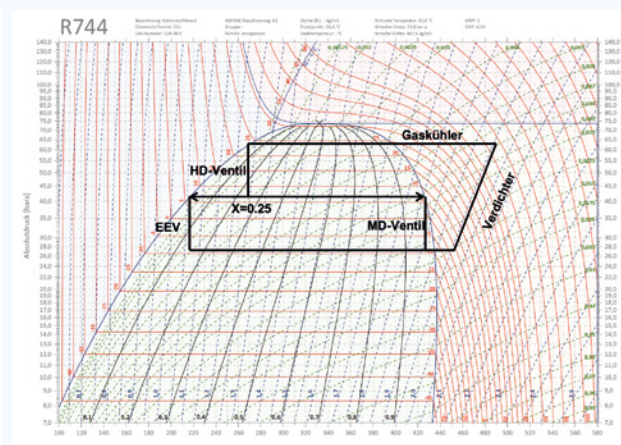
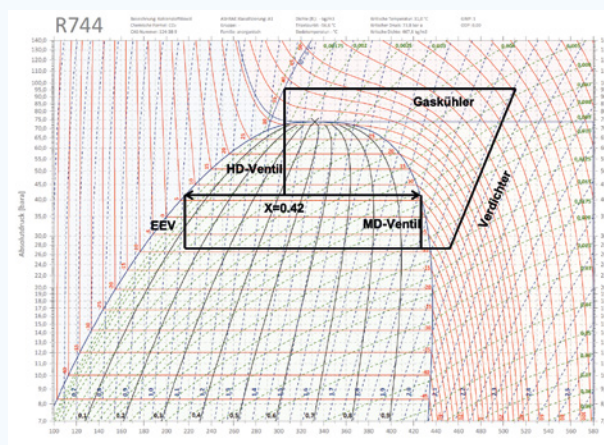
THE CLASSICAL COMPRESSOR RACK



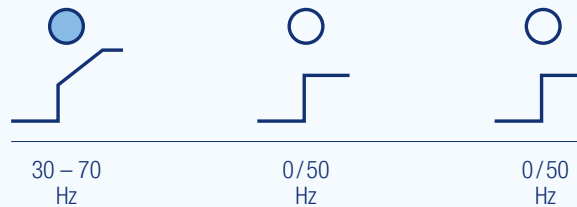
- Nominal load is simple.
- All compressors are running.
- Two compressors connected (on-off).
- The lead compressor is speed-regulated by a frequency converter.
- Typical range 30 Hz – 70 Hz, i.e., 60% – 140%
- Caution: The control characteristic of the rack is not continuous – difficult with low partial load.

ATTENTION PARTIAL LOAD

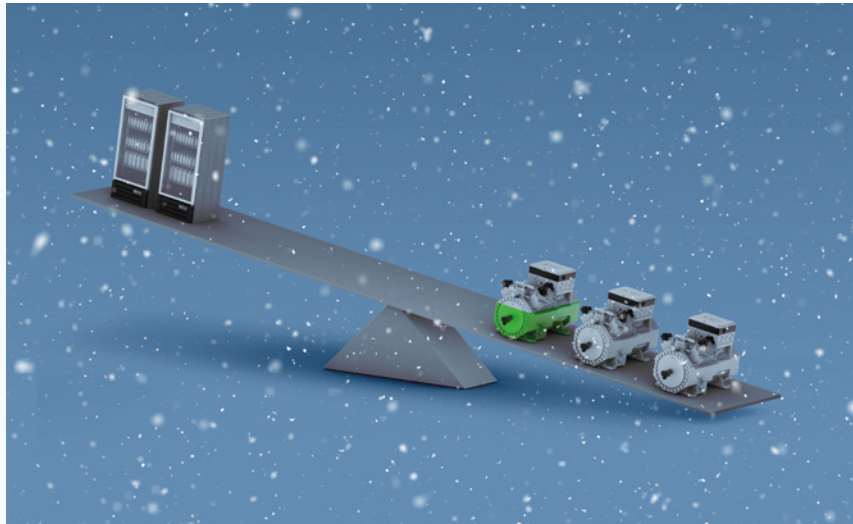
During subcritical operation the COP rises by up to 250%! A much lower drive power is required for the required refrigerating capacity.



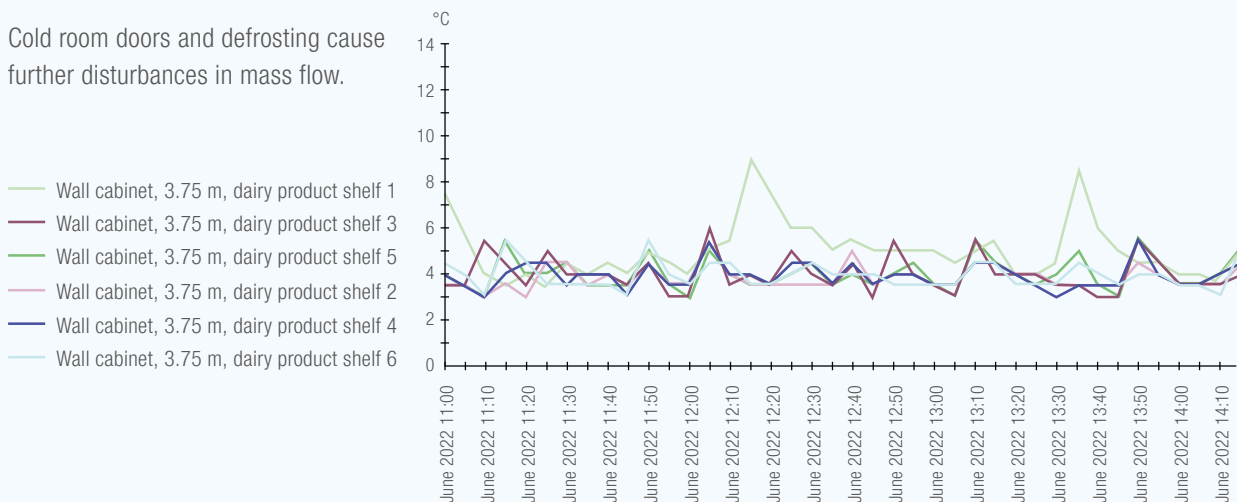
In subcritical operation the VSD compressor alone can cover the load.



During winter and at night, cooling demand of the cold locations is reduced to 10% of the nominal load. The VSD compressor starts to cycle, therefore the control starts to swing.



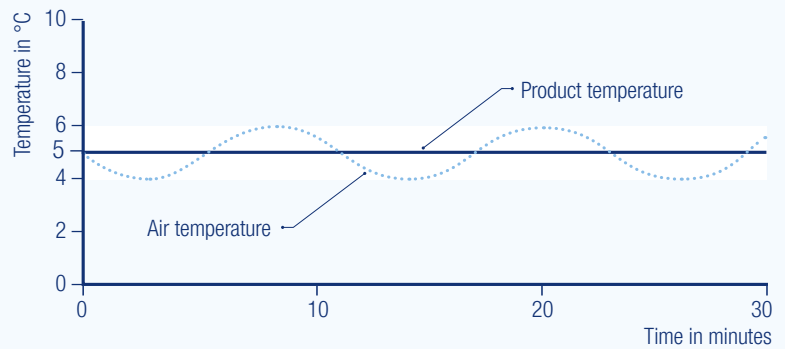
Cold room doors and defrosting cause further disturbances in mass flow.



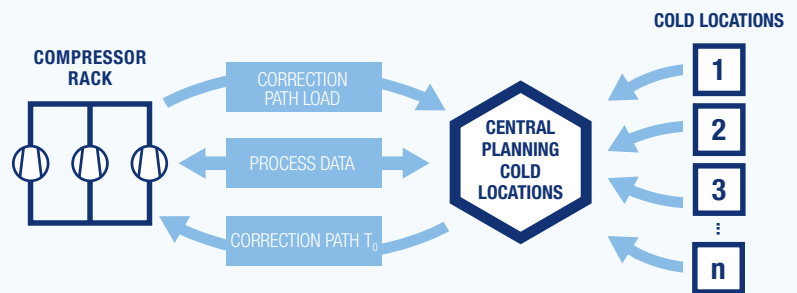
CONCLUSION: Stable control is hardly possible with conventional procedures (e.g., PID control).

FRIGOTAKT G4 – THE CONTROL SOLUTION FOR SOPHISTICATED CO₂ REFRIGERATION SYSTEMS

Frigotakt-G4 exploits the slow change of the product's temperature, due to its water content, and the constant coordination of rack and cold location controls.

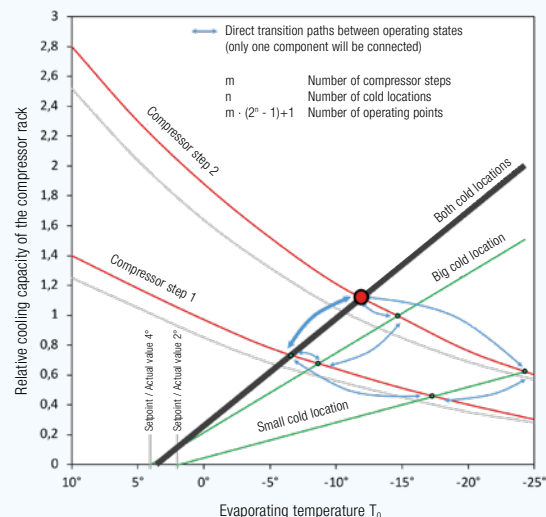
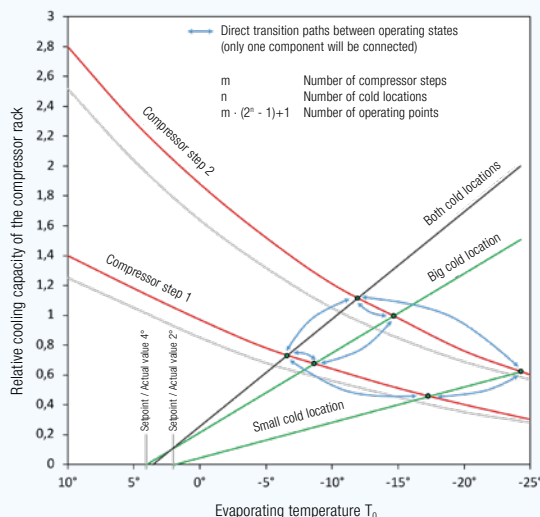


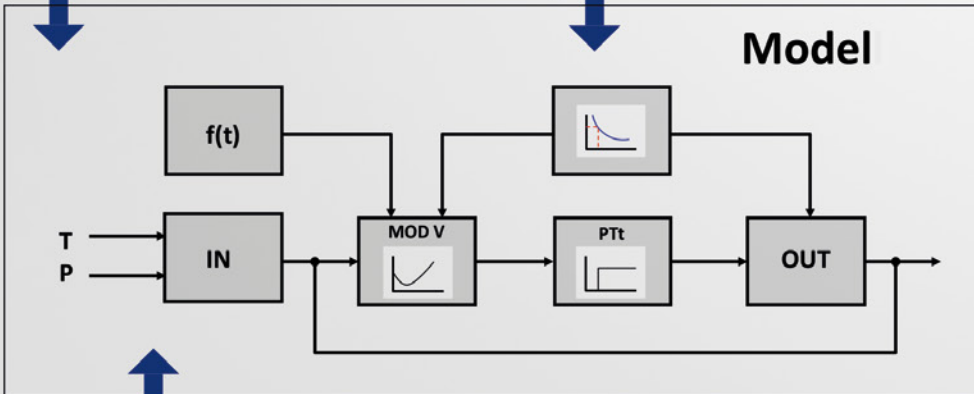
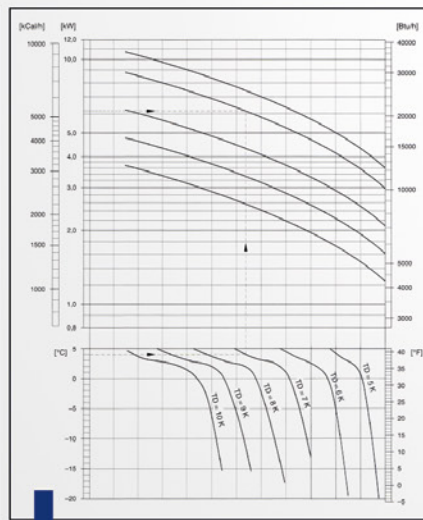
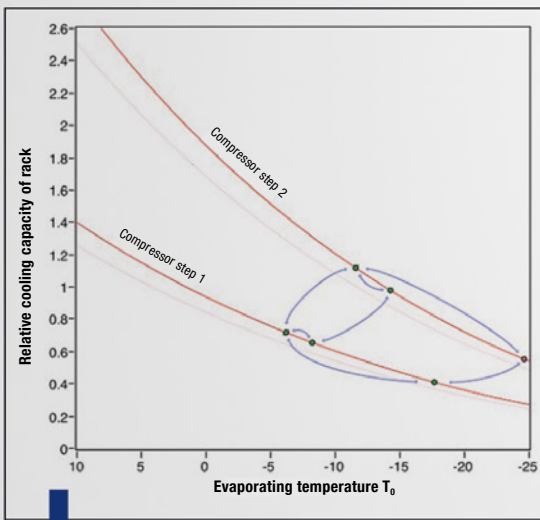
All possible variants for compressor and cold location sequences will be precalculated for the next planning period (approx. 10 minutes) by simulation.



Mass flows of the cold locations can be controlled according to the plan because:

1. The actual displacement of each compressor is derived from the characteristics according to the operating point.
2. The mean temperatures of the products must correspond to the setpoint and
3. Cold locations with higher and lower capacity are skilfully combined, particularly with regard to night operation.





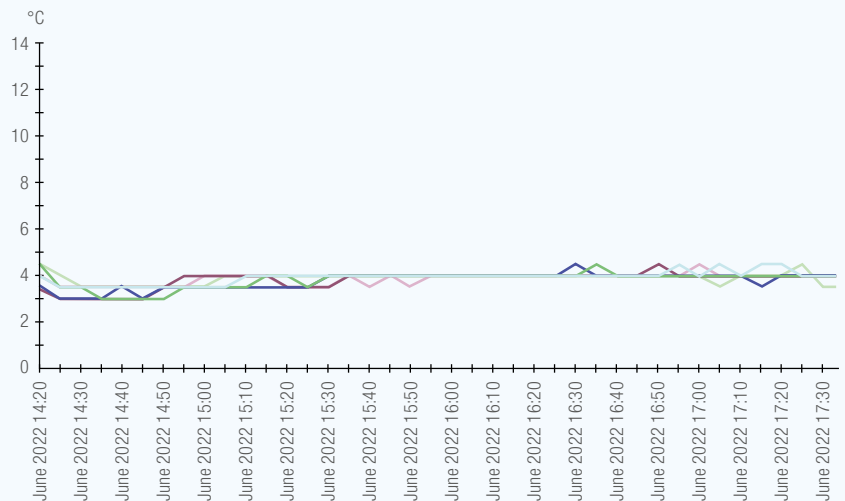
$$\begin{pmatrix} 1 & 1 & 1 \\ 2 & 0 & -1 \end{pmatrix} \cdot x = \begin{pmatrix} x + y + z \\ 2x - z \end{pmatrix} = \begin{pmatrix} 5 \\ 13 \end{pmatrix}$$

$$\frac{\partial^2 \psi}{\partial \psi^2} = a \cdot \frac{\partial \psi}{\partial t} \quad f'(x_0) = \lim_{x \rightarrow x_0} \frac{f(x) - f(x_0)}{x - x_0}$$

FRIGOTAKT G4 HELPS TO IDENTIFY CRITICAL COLD LOCATIONS

The aim is to eliminate oscillation of the control.

- Wall cabinet, 3.75 m, dairy product shelf 1
- Wall cabinet, 3.75 m, dairy product shelf 3
- Wall cabinet, 3.75 m, dairy product shelf 5
- Wall cabinet, 3.75 m, dairy product shelf 2
- Wall cabinet, 3.75 m, dairy product shelf 4
- Wall cabinet, 3.75 m, dairy product shelf 6

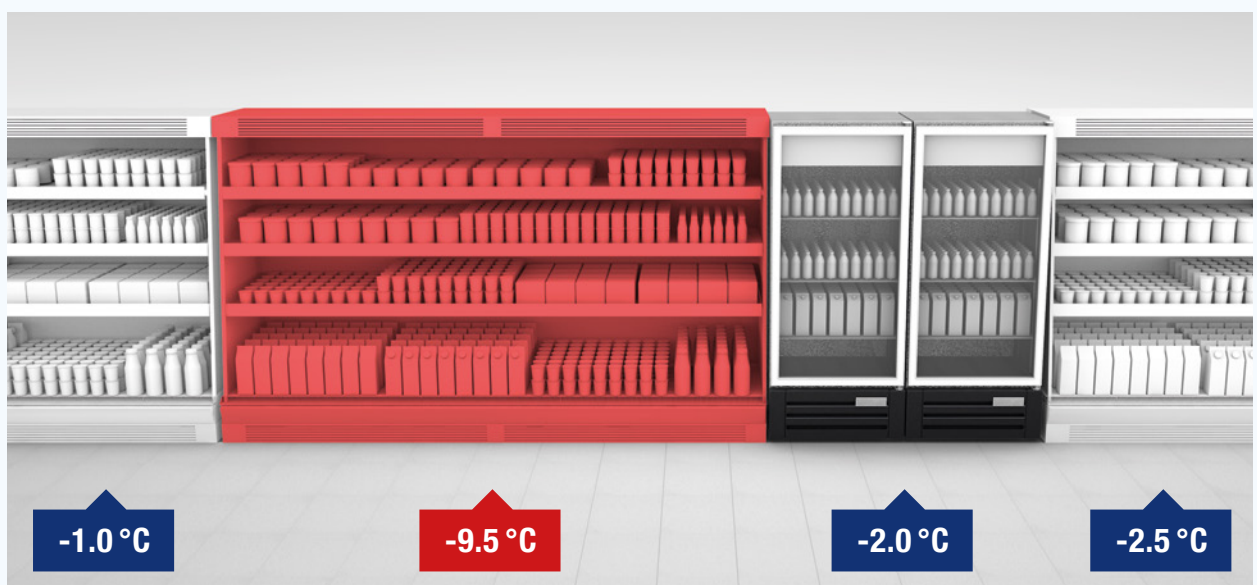


Problematic cold locations need a significantly lower evaporating temperature.

The required individual T0 values per cold location are displayed.

Significant efficiency enhancement possible through identification of critical cold locations.

| Cold location | Required To | Product temperature |
|---|-------------|---------------------|
| Dairy product shelf 1, pilot module | -1.0 °C | 5.5 °C |
| Dairy product shelf 1, slave module – 1 | -9.5 °C | 6.0 °C |
| Convenience | -2.0 °C | 3.5 °C |
| Sausage shelf pilot module | -2.5 °C | 4.0 °C |
| Sausage shelf slave module – 1 | -2.5 °C | 4.5 °C |



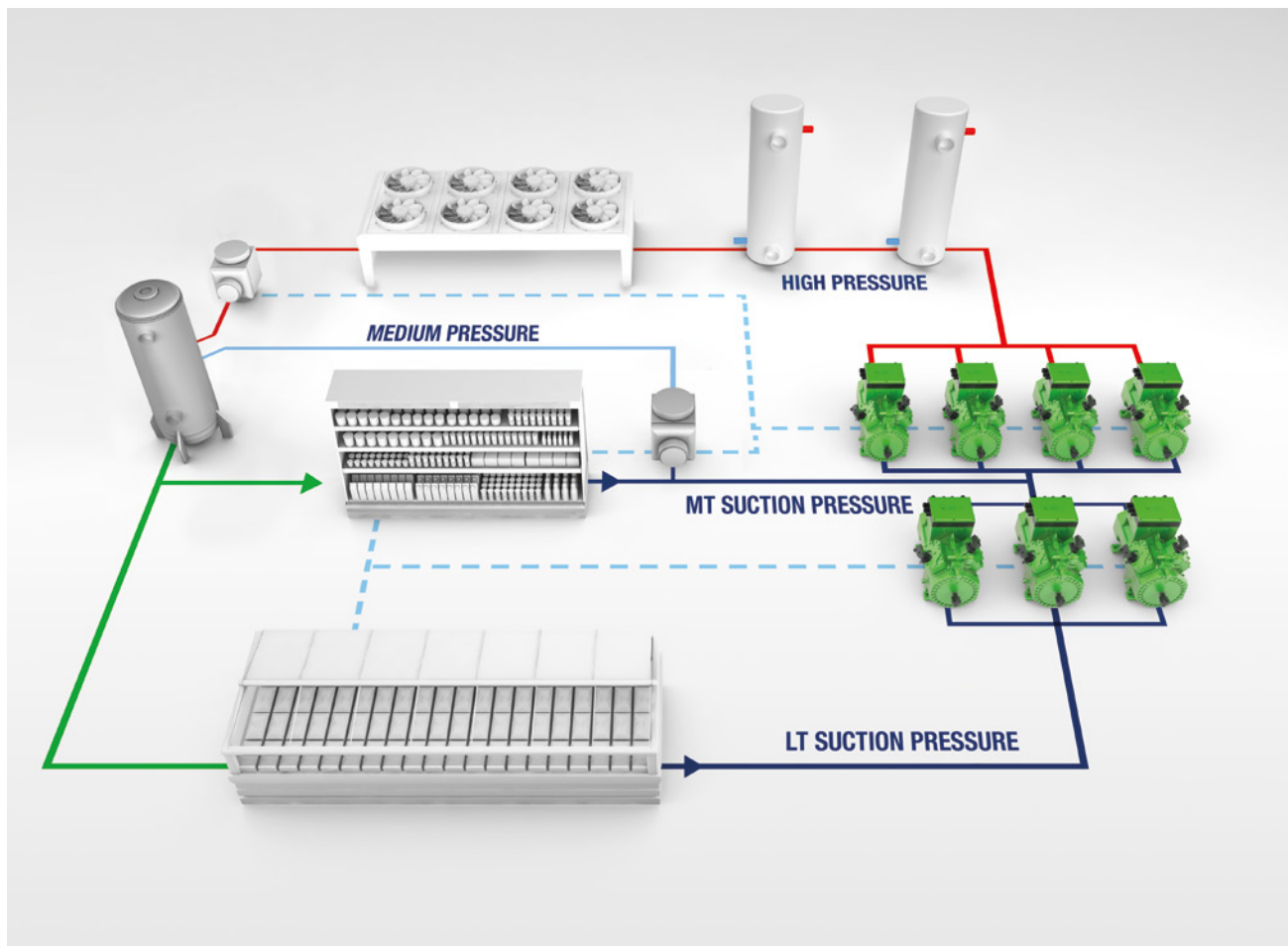
FRIGOTAKT G4 IMPROVES THE CONTROL DYNAMICS OF SOPHISTICATED CO₂ PLANTS

- The ideal operating point in terms of energy is constantly precalculated.
- This means that Frigotakt G4 can achieve fewer compressor cycles and higher efficiency at the same time.
- Additionally, planners and installers will receive indications on how to enhance efficiency, e.g., for cold locations with unnecessary low evaporation temperatures.

FRIGOTAKT G4 considers

- Heat recovery
- Heat pump operation
- Parallel compressors
- Ejectors

... and in this way stabilises control behaviour in a significantly expanded range of application.



Frigotakt G4 stabilises the control of sophisticated CO₂ systems and always finds the most favourable operating point in terms of energy.



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