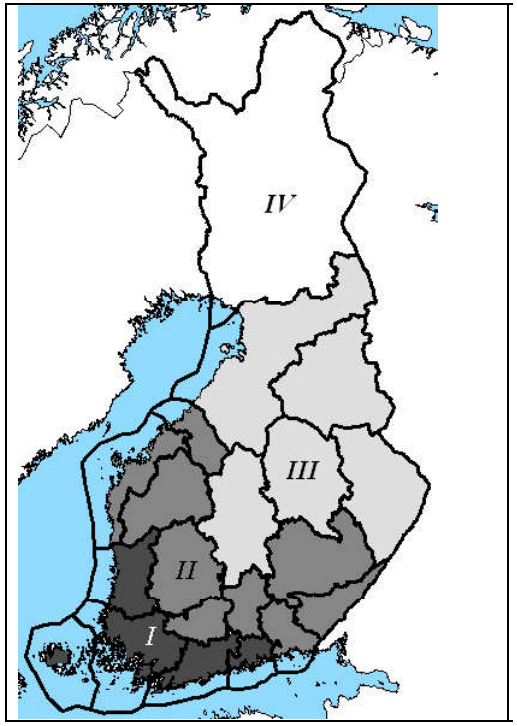
RECOVERY COILS AND ECODIRECTIVE 2018: CONTROL AND DEFROST

THE TRADITIONAL HEAT RECOVERY COIL SYSTEM SHALL BE UPDATED TO COME UP TO REQUIREMENTS OF THE ECODIRECTIVE. HIGH EFFICIENCY UNDER LOW OPERATING TEMPERATURE DEMANDS A NEW IMPROVED CONCEPT TO PREVENT FREEZING OF MOISTURE OF EXTRACT AIR.

Defrost control means that liquid temperature inside of exhaust recovery coil is maintained above the temperature which causes freezing of moisture at air side of the coil. To keep this inlet liquid temperature above -1..-2°C supply air coil is partly passed by. This insistence to reduce efficiency causes liquid temperature to sink below freezing point inside of supply air coil if the traditional 3-way valve control is used. This concerns all regions where dimensioning outside temperature is below -15..-20°C.

The map on the right shows dimensioning temperatures of outside air in Finland. The country is devided in four climate zones I-IV. Calculated diagrams (pages 3 and 5) are based on zone III and they show the consequences and procedures which are essential in order to make recovery coil system work properly.



Map on the left shows climate zones of Finlad. Temperatures used in energy and heating capacity calculations are seen in table below:

Climate zone	Dimensioning temperature	Year average temperature	Heating period average temperature
I	-26	+5	+1
II	-29	+4	0
III	-32	+2	-1
IV	-38	0	-5

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CALCULATION DATA FOR TRADITIONAL AND IMPROVED HEAT RECOVERY SYSTEM

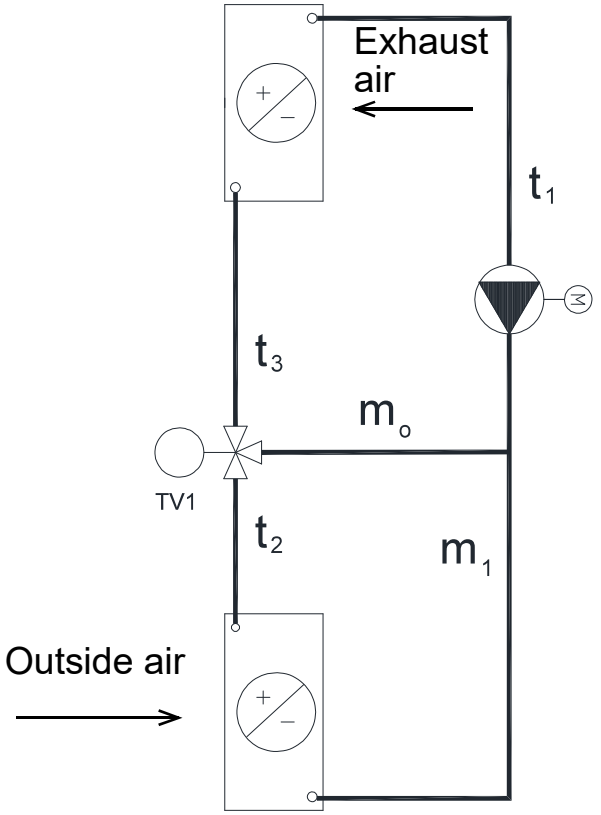
Air condition data:	
Outside air flow	1,5 m^3/s
Outside air temperature	-32°C
Exhaust air flow	1,5 m^3/s
Exhaust air	22°C 30%RH
Face velocity of coil	1,42 m/s
Efficiency (Ekodir.2018)	69,1 %
Supply air recovery coils:	
S.A. Coil type (trad.) in one stage	P40AC 12R-21T-1195A-2.0pa 5C
S.A. Coil type Stage 1	P40AC 3R-21T-1195A-2.0pa 4C
S.A. Coil type Stage 2	P40AC 9R-21T-1195A-2.0pa 5C
Exhaust air coil for traditional and improved system:	
E.A. Coil type (trad./improved)	P40AR 12R-21T-1195A-2.0pa 5C
Liquid data:	
Eth.glyk./Water	35% (weight)
Freezing point	-16,6°C
Nominal heat capacity c_p	3,52 kJ/kgK
Density	1,052 kg/dm^3
Dim. Liquid flow (Trad.system)	1,167 dm^3/s (4200 dm^3/h)
Dim.liquid flow (Improved system)	1.000 dm^3s (3600 dm^3/h
Liquid max.Δp, Coils	a.300 kPa
Parametrs of defrost handling:	
Min.exhaust air outlet temp.	0,5..2°C
Min.exhaust coil liquid temp.	-1..-2°C

TRADITIONAL SYSTEM

- ONE 3-WAY VALVE
- SUPPLY COIL IN ONE STAGE
- EFFICIENCY >= 68% (2018)
- OUTSIDE AIR TEMPERATURE -32°C

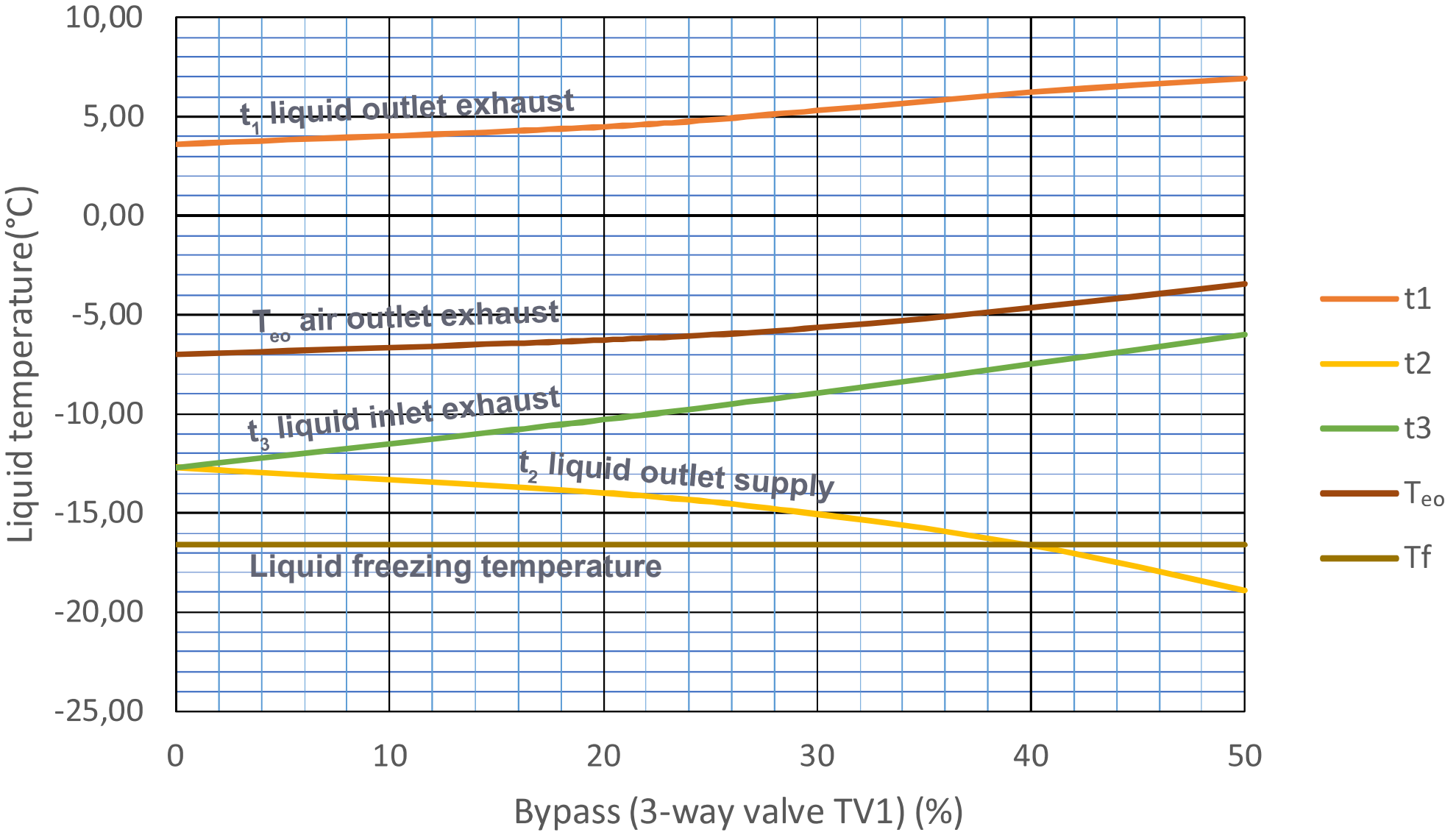
RESULTS:

- DEFROST CONTROL IMPOSSIBLE
- LIQUID IS FREEZING IN S.A. COIL



TRADITIONAL SYSTEM

E.A. coil leaving air temperature T_{eo} and liquid temperatures t_1, t_2 and t_3 at outside air temperature -32°C using 1-stage supply coil. Liquid flow without by-pass is 1,167 l/s (4200 l/h), both coils are 12 rows . Fin distance 2,0pa. T_f= liquid freezing temperature.

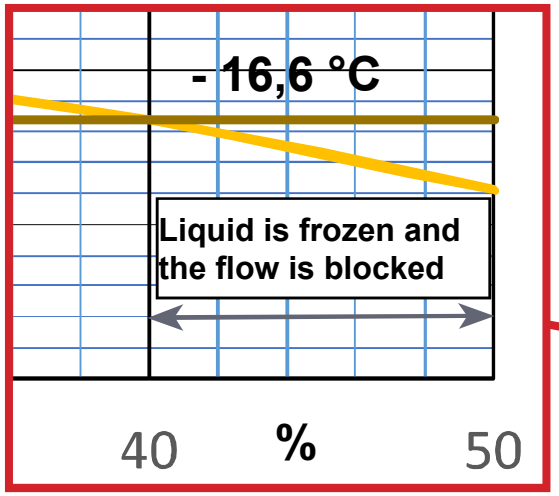


FREEZING MECHANISM BY USING TRADITIONAL DEFROSTING METHOD

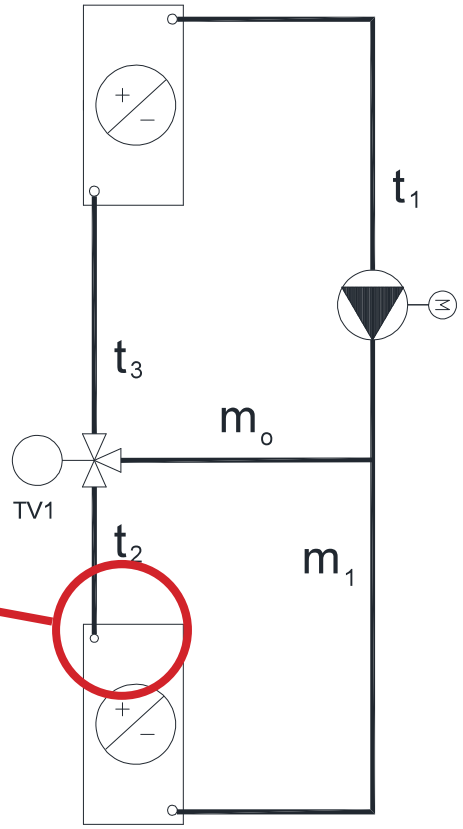
See below a view window of diagram 1 showing the area where the liquid (35% eth.glycol) inside of the supply air coil is frozen and circulation is stopped. Ice particles have blocked liquid flow at the end of coil circuits. Efficiency of the system is = 0.

- Before t_2 reaches the freezing temperature the exhaust recovery coil is already partly covered by frost and the extract air flow may have significantly decreased. When the pipe flow is prevented due to an ice block the frost at e.a. coil is melted and exhaust air flow is recovered to the normal value. Liquid inside of the supply air coil will stay frozen until outside air temperature has risen or unit has been stopped.

- If the heating coil has capacity enough the malfunction is possibly not detected. Recovery system operates at 0% efficiency. Circulation pump is running and there is no frost on exhaust air coil. Everyhing is ”O.K.”! So The Myth ” Glycol-water solution will never freeze ” has been born!



Liquid is freezing when by-pass exceeds 40%. Same time liquid inlet temperature at exhaust air coil is -7,5°C. Coil is frosted but frost will be melted after liquid flow is stopped because of blocked ice.



A 100% functioning defrost system is required whenever ventilation devices run 24 hours a day and exhaust air is moisture. Such facilities include, for example, residential buildings, hospitals, institutions, swimming halls, pool rooms, some industrial processes etc.

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IMPROVED SYSTEM

- **TWO 3-WAY VALVES**
- **SUPPLY COIL IN TWO STAGES**
- **EFFICIENCY >= 68% (2018 Ecodirektive)**
- **OUTSIDE AIR TEMPERATURE -32°C**

RESULTS:

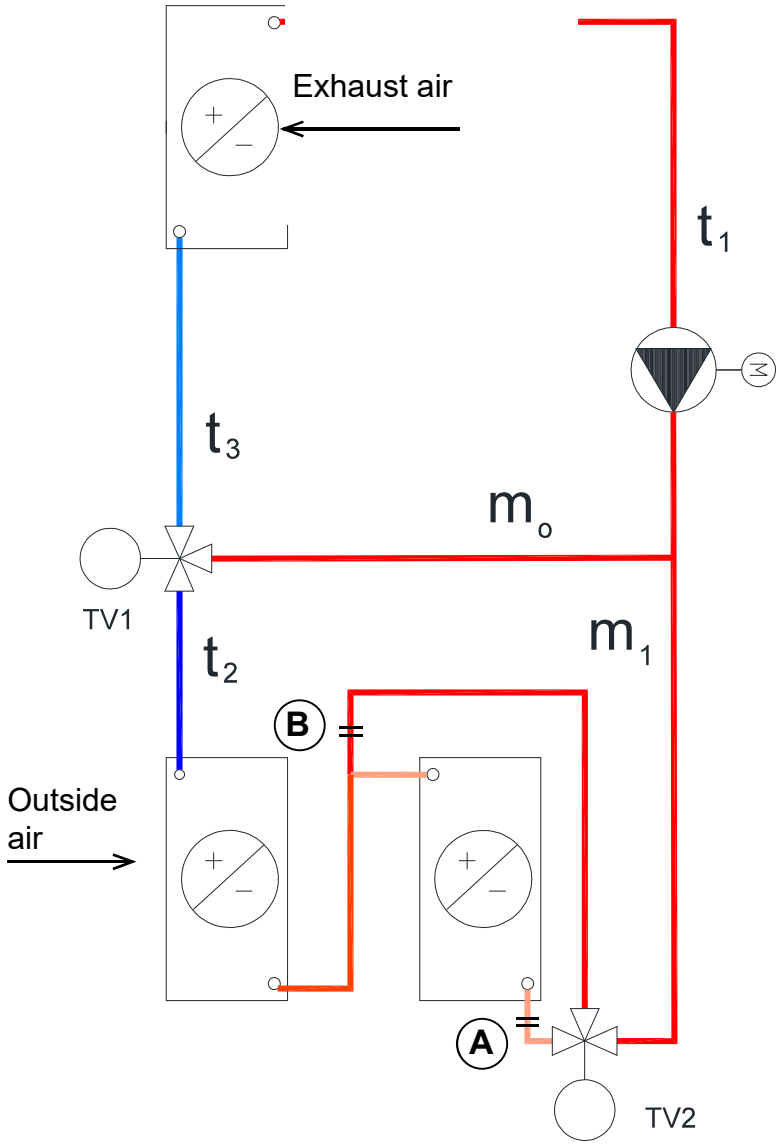
- **DEFROST CONTROL: NO PROBLEM**
- **SUPPLY COIL LIQUID OUTLET TEMPERATURE IS ALWAYS ABOBE THE FREEZING TEMPERATURE**

Function:

Supply air coil is divided in two stages. Stage 1 in air flow direction is 3-row coil and Stage 2 is 9-row coil. Principally heat transfer area of Stage 1 is a. 1/4 of total area of both stages. When temperature t_3 lowers to defrost set value (a. -1..-2,0°C) liquid flow passes proportionally by Stage 2 through valve TV2. Temperature t_3 is maintained above set value. When outside air temperature still lowers Stage 2 is totally bypassed and t_3 is controlled by TV1 as before.
By this means defrosting can be controlled at all outside air temperatures. Recommended liquid is 35% ethylene glycol-water solution. Propably 30% liquid is possible to use at all climatezones in Finland, too.

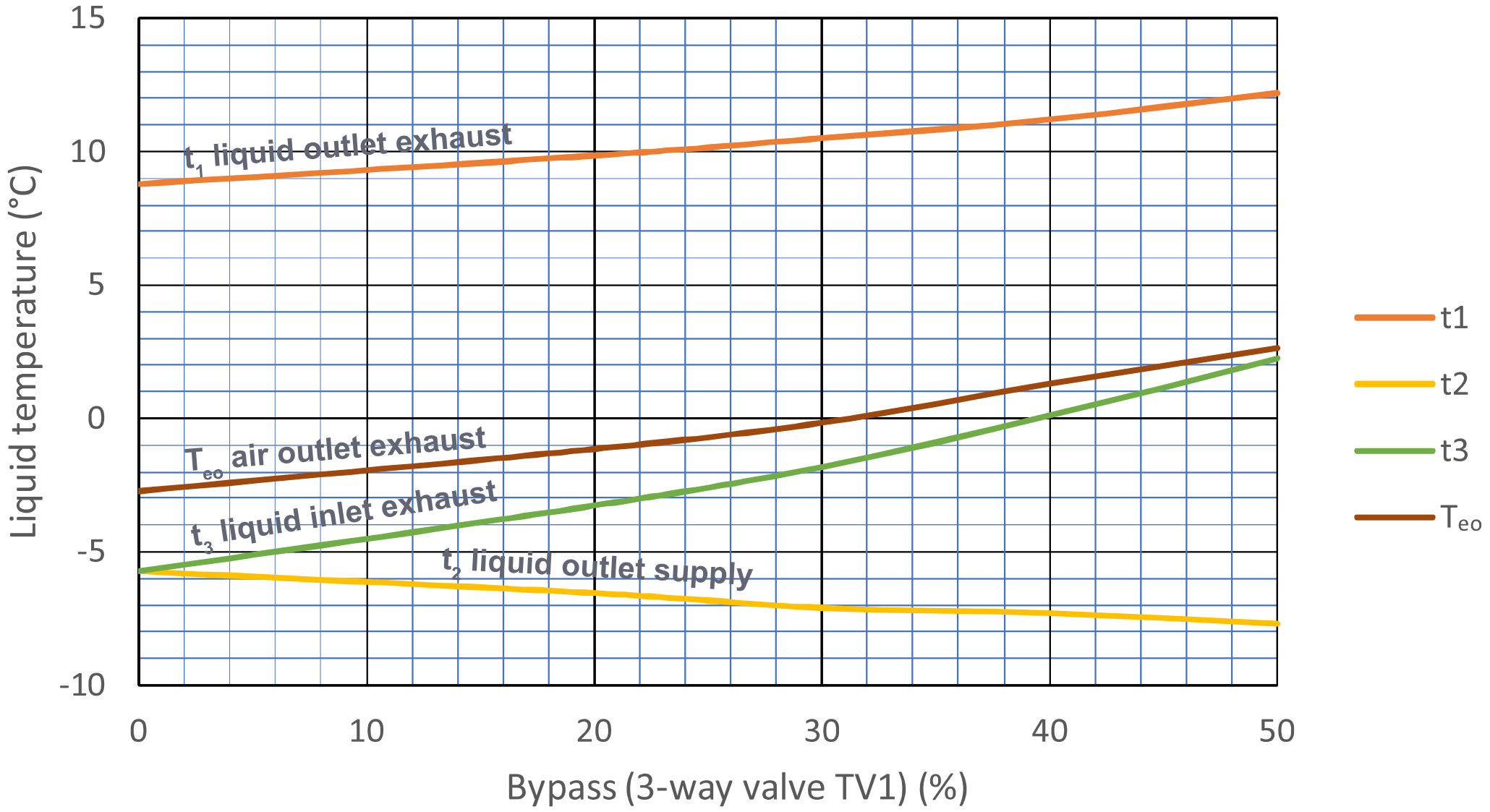
Recommended liquid flows and supply air coil pressure drop:

- Normal liquid flow: about 0,56 l/s / 1 m³/s air
- Defrost liquid flow: about 0,67 l/s / 1 m³/s air
- Supply coil Δp: > 90 kPa (Normal liquid flow)

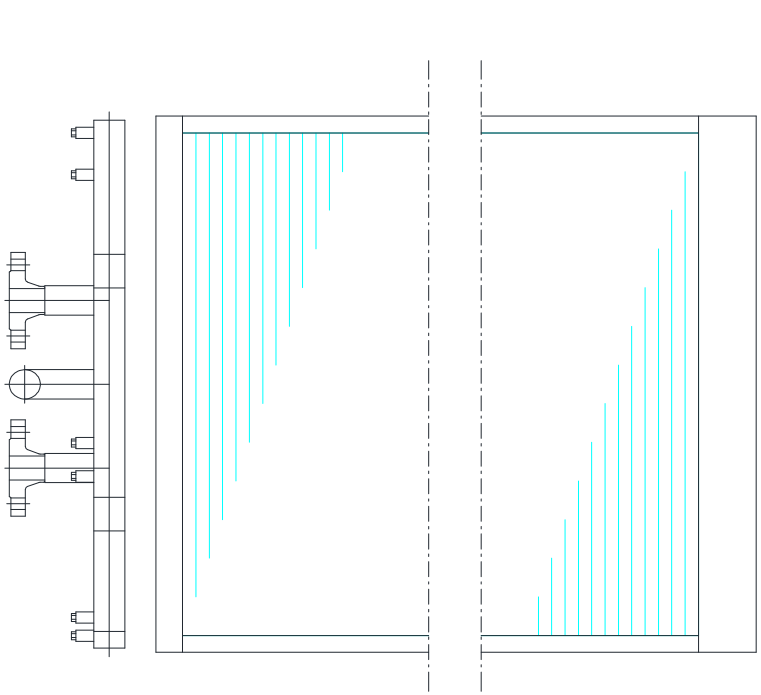


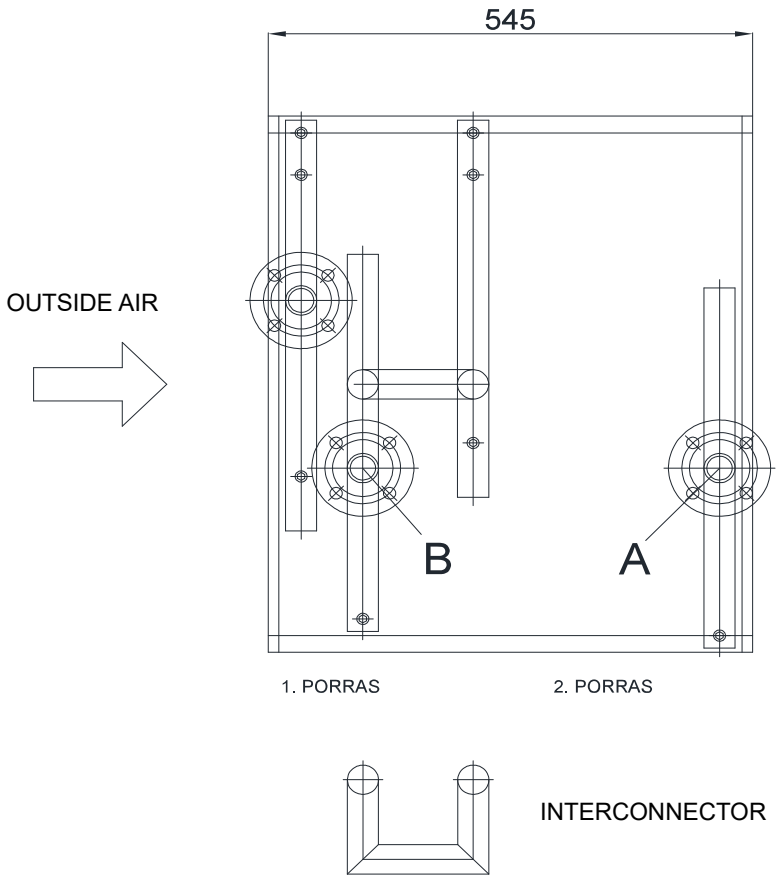
IMPROVED SYSTEM

E.A. coil leaving air temperature T_{eo} and liquid temperatures t_1, t_2 and t_3 at O.A. temperature -32°C using only 1. stage (3R) of two-stage supply air coil. Liquid flow without by-pass is 1,0 l/s (3600 l/h). Fin distance is 2.0pa. Max.pressure drop of liquid a. 260 kPa. Stage 2 is totally bypassed.



COMPACT 2-STAGE SUPPLY AIR COIL





2-stage supply air recovery coil can be built into one block. The interconnector is ready and stages are installed in a common frame.
The flange connections A and B refer to corresponding entries in the piping diagram on page 5. The 2-stage coil according to the drawing is included in Taniplan’s product range.