

- Chilling applications

Waterbased Secondary refrigerant	Con. %	Freezing point °C	Temperature °C	Density kg/m <sup>3</sup>	Specific heat J/kg K	Thermal cond. W/m K	Dynamic viscosity mPa s
<b>Salts</b>							
HYCOOL	30	-20	-10	1206	2930	0,497	3,82
Calcium chloride	21	-20	-10	1199	2985	0,529	4,5
Potassium carbonate	31	-20	-10	1322	2886	0,518	6,32
Potassium acetate	28	-20	-10	1156	3220	0,467	5,74
<b>Alcohols</b>							
Methyl alcohol	25	-20	-10	970	3969	0,43	5,37
Ethyl alcohol	30	-20	-10	970	4162	0,394	11,67
<b>Glycols</b>							
Ethylene glycol	36	-20	-10	1058	3490	0,415	8,02
Propylene glycol	39	-20	-10	1045	3735	0,385	20,89

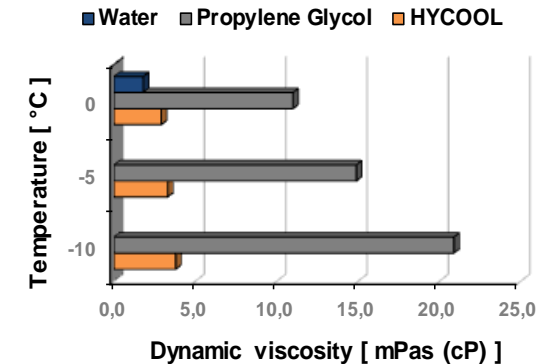
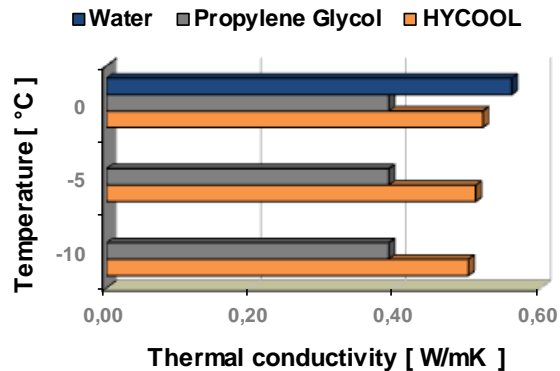
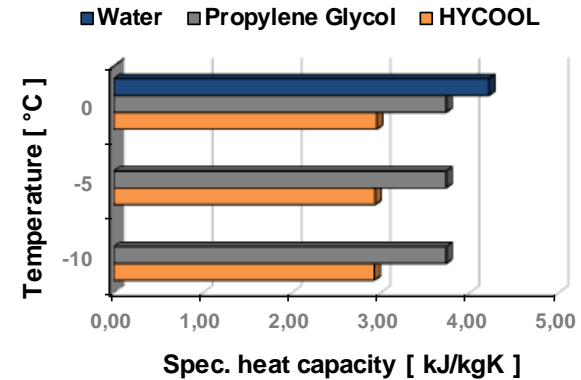
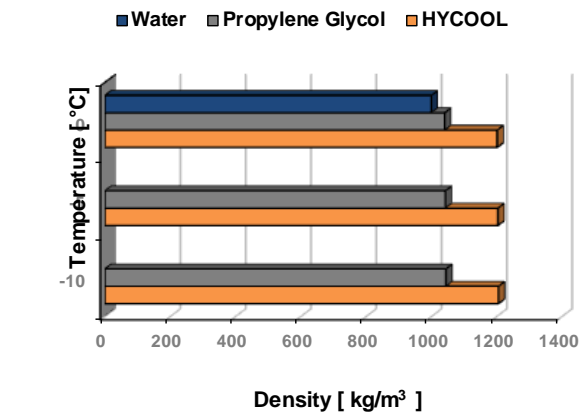
Åke Melinder, KTH  
1997

- Freezing applications

Waterbased Secondary refrigerant	Con. %	Freezing point °C	Temperature °C	Density kg/m <sup>3</sup>	Specific heat J/kg K	Thermal cond. W/m K	Dynamic viscosity mPa s
<b>Salts</b>							
HYCOOL	46	-45	-35	1347	2500	0,416	16,84
Calcium chloride	29	-45	-35	1300	2653	0,485	22,33
Potassium carbonate	OBS Eutecticum -37,5°C ( Freezing point )						
Potassium acetate	41	-45	-35	1242	2792	0,408	50,55
<b>Alcohols</b>							
Methyl alcohol	44	-45	-35	958	3379	0,347	18,47
Ethyl alcohol	60	-45	-35	936	3138	0,272	37,71
<b>Glycols</b>							
Ethylene glycol	56	-45	-35	1096	2839	0,341	81,57
Propylene glycol	56	-45	-35	1071	3286	0,311	591,82

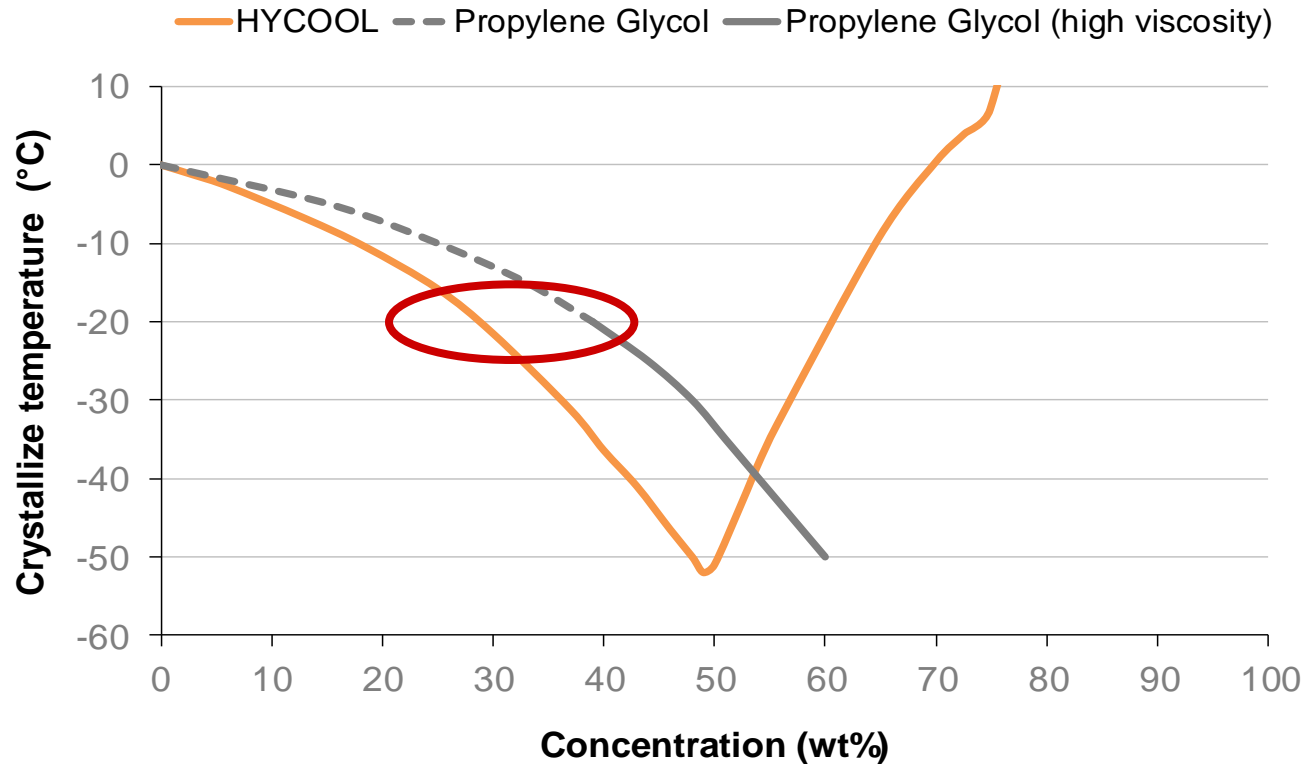
Åke Melinder, KTH  
1997

- Thermodynamic properties (freezing point  $-20^{\circ}\text{C}$ )



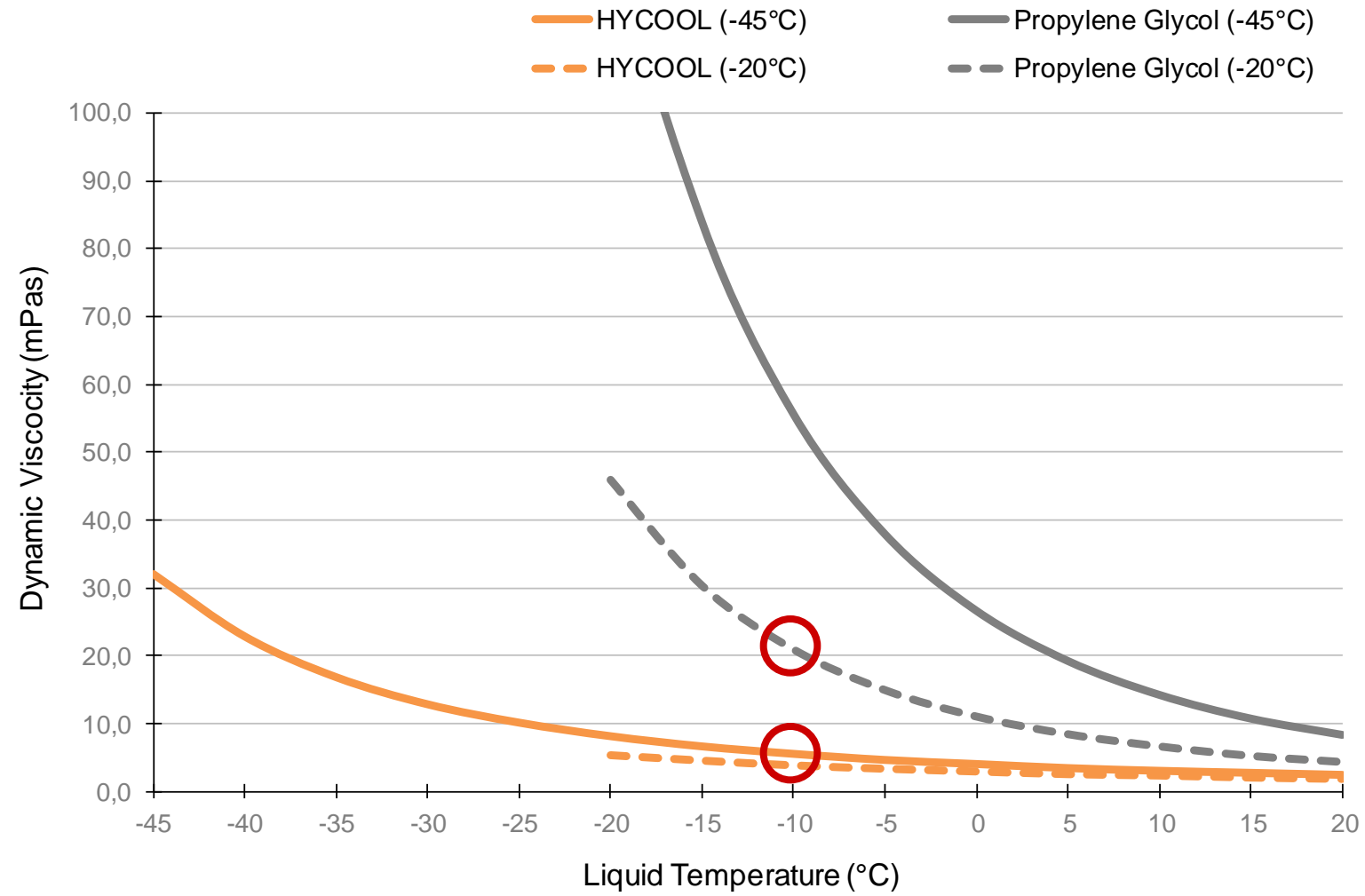
# HYCOOL – Crystallize temperature

ADDCON



- Compared with glycols in a secondary cooling system HYCOOL will save up to 15-20% of both investment and running costs

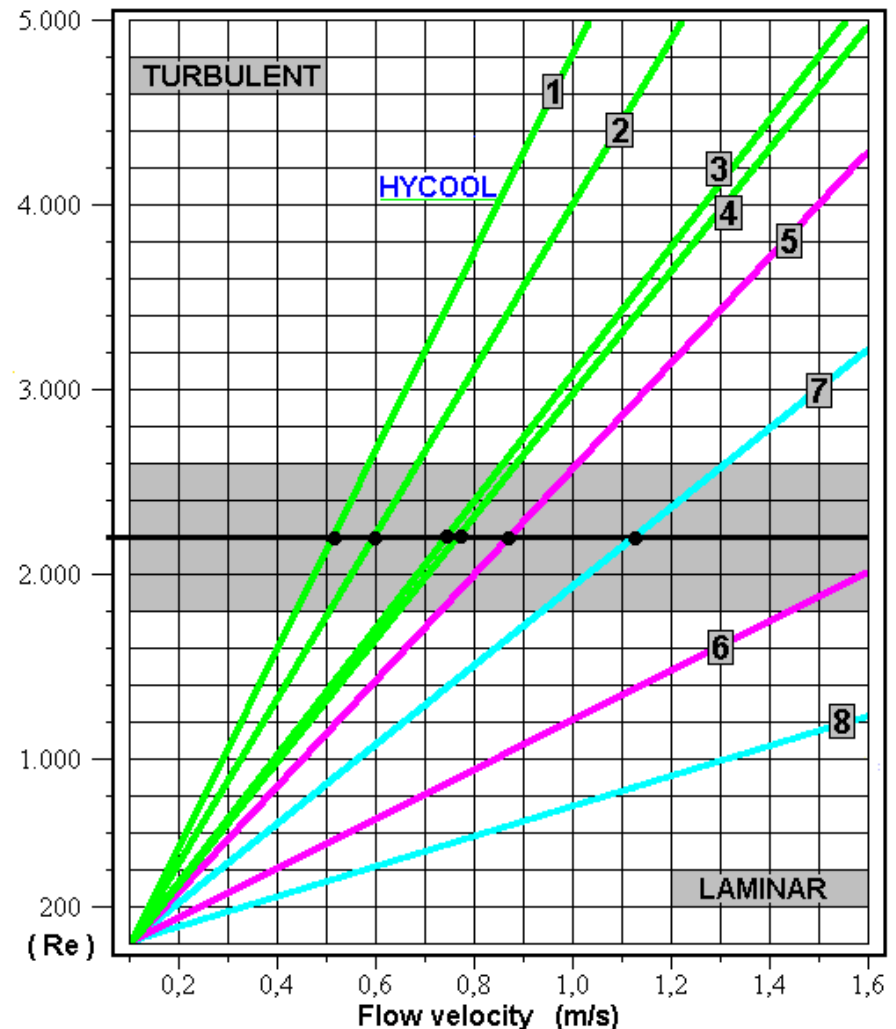
# HYCOOL – Dynamic viscosity



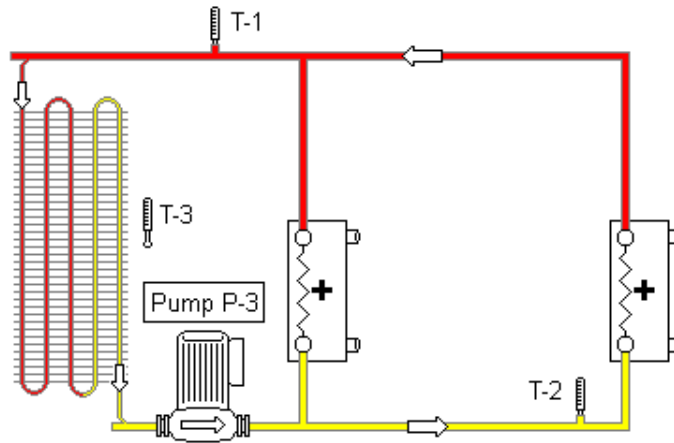
## Laminar / Turbulent flow

- Reynolds number and type of flow in a copper pipe with inner diameter of 15,0 mm
- All secondary refrigerants have:
  - Freezing point  $-20^{\circ}\text{C}$
  - Working temperature  $-10^{\circ}\text{C}$

- 1 = HYCOOL (potassium formate)
- 2 = Calcium chloride
- 3 = Potassium carbonate
- 4 = Potassium acetate
- 5 = Methyl alcohol
- 6 = Ethyl alcohol
- 7 = Ethylene glycol



# Efficiency Test



Pump P-3 is a continuously adjustable pump.

**HYCOOL -5° C**   **HYCOOL -8° C**   **Propylene glycol -8° C**

AIA M109-30\*

AIA M109-40

AIA M109-40

AIA XP80-13

AIA XP80-13

AIA XP80-14\*

Outdoor 30° C

Outdoor 30° C

Outdoor 30° C

38° / 32° C

38° / 32° C

38° / 32° C

6,6 l/s

7,2 l/s

6,3 l/s

30 kPa

30 kPa

40 kPa

0,35 kW

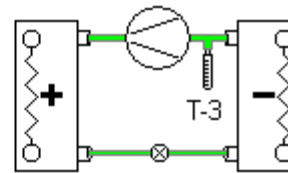
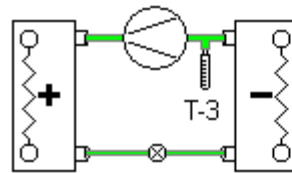
0,39 kW

0,45 kW

# Efficiency Test

Compressor unit 2  
Capacity 50 kW

Compressor unit 1  
Capacity 50 kW



**HYCOOL -5° C** **HYCOOL -8° C** **Propylene glycol -8° C**

**BITZER 6J-22\***

**BITZER 6H-25**

**BITZER 6H-25**

**HFC R-404a**

**HFC R-404a**

**HFC R-404a**

**-10,4° C**

**-12,4° C**

**-13,7° C**

**+40,6° C**

**+40,2° C**

**+40,8° C**

**43,0 kW**

**45,0 kW**

**48,0 kW**

**COP 2,32**

**COP 2,22**

**COP 2,10**