

USE OF THE FP-30x1(N) FLOW COMPUTER IN THE APPLICATION WITH USING GLYCOL

Using FP-30x1(N) flow computer it is possible to compute flow and energy for liquids other than water. In such system, values are based on density and enthalpy user tables. The manufacturers of liquids based on glycol for heating/cooling applications usually do not supply detailed specification on density and enthalpy depending on temperature. Below there is an example of preparing the tables based on manufacturer information. ERGOLID EKO manufactured by BORYSZEW S.A. is used as a liquid in described application.

		ERGOLID EKO koncentrat	ERGOLID EKO -35°C	ERGOLID EKO -25°C	ERGOLID EKO -20°C	ERGOLID EKO -15°C
Nazwa handlowa		ERGOLID EKO koncentrat	ERGOLID EKO -35°C	ERGOLID EKO -25°C	ERGOLID EKO -20°C	ERGOLID EKO -15°C
% stężenie glikolu		80	50	42	37	33
pH		7,5-9,0	7,5-9,0	7,5-9,0	7,5-9,0	7,5-9,0
Lepkość kinematyczna [cm ² /s] [mm ² /s]	-10°C	168,42	34,80	22,95	17,20	16,01
	10°C	30,79	12,49	7,84	6,68	4,94
	20°C	22,08	6,21	4,70	3,86	3,15
	50°C	6,02	2,14	1,61	1,31	1,18
Gęstość wg norm (20°C)		1,05	1,041	1,036	1,034	1,03
Gęstość z KJ		1,0535	1,0444	1,0413	1,0368	1,0335
Temperatura krystalizacji/zestalenia [°C]		**	≤ -35/ ≤ -42	≤ -25/ ≤ -32	≤ -20/ ≤ -26	≤ -15/ ≤ -20
Temperatura wrzenia [°C]		120	106	104,5	104	103
Temperatura zapłonu [°C]		-	112	-	-	-
Ciepło właściwe [kJ/kgK] (warunki standardowe)		2,93	3,58	3,70	3,77	3,84
Rezerwa alkaliczna (nie niższa niż)		8	8	8	8	8
Rozszerzalność ciepła w temp 0-80°C [%]		-	5,49	5,24	4,92	4,73



Parameters and assumptions

In application is used 37% glycol mixture (ERGOLID EKO -20°C):

Density: 1034 kg/m³ @ 20 °C
Thermal expansion: 4.92% in range 0 to 80 °C

Specific heat: 3.77 kJ/kg·K
Freezing temp.: -25 °C

Assumptions:

- Working temperature for application: from -20 °C to +80 °C.
- Density table is extrapolated linear in range -25 °C .. +100 °C based on specified density and thermal expansion.
- Enthalpy table is extrapolated linear in range -25 °C .. +100 °C based on specified on specific heat and enthalpy at -25 °C is assumed equal 0 kJ/kg.

Density and enthalpy

Density:

The density at 20 °C is equal to $\rho_{20°C} = 1034 \text{ kg/m}^3$. The thermal expansion is equal to 4,92% (in the temperature range from 0 °C to 80 °C). Based on given parameters, the density of the liquid can be determined at any temperature.

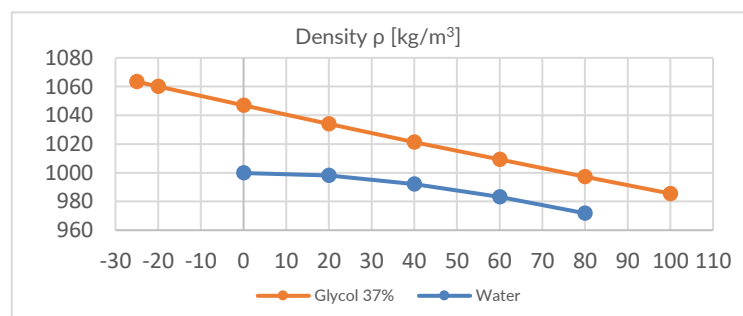
$$V_T = V_{20°C} \cdot (1 + \alpha \Delta T) = V_{20°C} \cdot (1 + \alpha \cdot (T - 20°C))$$

The value of the coefficient of thermal expansion is given for the temperature range from 0 °C to 80 °C: $\alpha = \frac{4,92\%}{(80°C - 0°C) \cdot 100\%}$.

Using the formula $\rho_T = \frac{m}{V_T}$ it is possible to determine the formula:

$$\rho_T = \frac{\rho_{20°C}}{1 + \alpha \cdot (T - 20°C)} \left[\frac{\text{kg}}{\text{m}^3} \right]$$

T [°C]	DENSITY	
	Glycol 37% ρ [kg/m ³]	Water ρ [kg/m ³]
-25	1063.4	
-20	1060.1	
0	1046.9	999.8
20	1034.0	998.2
40	1021.4	992.2
60	1009.2	983.2
80	997.2	971.8
100	985.5	



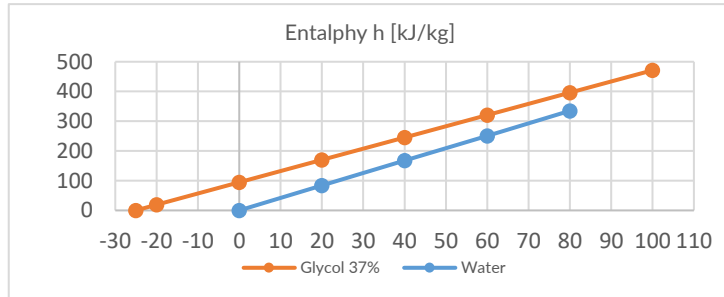
Water parameters are given only for comparison purposes.

Enthalpy:

Specific heat for standard conditions (standard conditions assumed as 20 °C) is equal to $c=3,77 \text{ kJ/kg}\cdot\text{K}$. For temperature -25 °C , an enthalpy value of 0 kJ/kg was assumed. Based on given parameters, the enthalpy of the liquid can be determined at any temperature.

$$h_T = c \cdot \Delta T = c \cdot (T - (-25^\circ\text{C})) = c \cdot (T + 25^\circ\text{C}) \quad \left[\frac{\text{kJ}}{\text{kg}} \right]$$

ENTHALPY		
T [°C]	Glycol 37% h [kJ/kg]	Water h [kJ/kg]
-25	0.00	
-20	18.85	
0	94.25	0.06
20	169.65	83.96
40	245.05	167.62
60	320.45	251.23
80	395.85	335.00
100	471.25	



Water parameters are given only for comparison purposes.

• **Additional information**

Up to 16 user media tables can be defined in FP-30x1(N) flow computer. The characteristics are implemented into device in the form of a .txt or .csv file via an external data memory (pendrive).

The file with the characteristics must start with the word #medium, followed by the name of the characteristic (up to 12 characters) and its symbol (capital Latin letters other than: B, D, E, G, P, W, Z). Then begins an array consisting of pairs of numbers: temperature in °C and respectively density in kg/m³. The density table ends with the # sign. Next, an enthalpy table is defined consisting of pairs of numbers: temperature in °C and enthalpy in kJ/kg. The enthalpy table ends with # sign, followed by an optional comment. Both tables must be ordered in order of increasing temperature values.

The medium characteristics are stored in the characteristics database. To view the contents of the database and to add or remove characteristics, select the Media manager item from the Main Menu. If a new characteristic is to be added, connect pendrive with the prepared file to the USB port on the front panel of the device. New medium can also be added during configuring the system.

Detailed information are in the FP-30x1(N) flow computer Operating Manual.

• **Implemented tables**

The tables for FP-30x1(N) flow computers have to be prepared in text format:

```
#medium glycol_37 F
-25 1063.4
-20 1060.1
0 1046.9
20 1034.0
40 1021.4
60 1009.2
80 997.2
100 985.5
#
-25 0.00
-20 18.85
0 94.25
20 169.65
40 245.05
60 320.45
80 395.85
100 471.25
#
```

Notes:
Tables prepared based on ERGOLID EKO -20C manufactured by BARYSZEW S.A.
Working range: -20C to +80C
Metronic AKP Sp. J.
2018-09-21

In similar way the tables for Glycol 50%, Glycol 42%, Glycol 33% were prepared.

#medium glycol_50 F

-40	1085.7
-20	1070.4
0	1055.5
20	1041.0
40	1026.9
60	1013.2
80	999.8
100	986.8

#

-40	0.00
-20	71.60
0	143.20
20	214.80
40	286.40
60	358.00
80	429.60
100	501.20

Notes:

Tables prepared based on ERGOLID EKO -35C
manufactured by BARYSZEW S.A.
Working range: -35C to +80C
Metronic AKP Sp. J.
2018-09-21

#medium glyco_42 F

-30	1071.1
-20	1063.9
0	1049.8
20	1036.0
40	1022.6
60	1009.5
80	996.8
100	984.4

#

-30	0.00
-20	37.00
0	111.00
20	185.00
40	259.00
60	333.00
80	407.00
100	481.00

Notes:

Tables prepared based on ERGOLID EKO -25C
manufactured by BARYSZEW S.A.
Working range: -25C to +80C
Metronic AKP Sp. J.
2018-09-21

#medium glycol_33 F

-20	1054.9
0	1042.3
20	1030.0
40	1018.0
60	1006.2
80	994.7
100	983.5

#

-20	0.00
0	76.80
20	153.60
40	230.40
60	307.20
80	384.00
100	460.80

#

Notes:

Tables prepared based on ERGOLID EKO -15C
manufactured by BARYSZEW S.A.
Working range: -15C to +80C
Metronic AKP Sp. J.
2018-09-21

- Information from the Manufacturer

All functions of the recorder are subject to modifications for the benefit of technical progress.

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Version: 210312EN