



EMATEM

European Metrology Association
for Thermal Energy Measurement

Thermal Energy Metering: Italian market, Verification Methods and Performance Comparison

SUMMARY



01 // ISOIL Industria S.p.A. – Company profile

02 // Thermal Energy demand in Italy

03 // Influence of Glycol on Thermal Energy Meter Accuracy

01

ISOIL Industria SpA –
Company profile

The objective of improving since 1958



ISOIL Industria S.p.A.
registered and sales offices
Cinisello Balsamo – MI - Italy



Hemina S.p.A.
R&D, Calibration and
production facilities
Montagnana – PD - Italy



Production – Calibration –
Sales offices
Belo Horizonte - Brazil



Sales offices
Hong Kong



Sales offices
Singapore



Sales offices
United States

Around the meter lifecycle



What we are good at

ISOMAG
The friendly magmeter

Complete range of electromagnetic flowmeters from DN3 to DN3000, up to 250 bar and 180°C, including insertion solutions for large pipelines and cost-effective solutions.

ISOFLUX
The ultrasonic meter

Ultrasonic flow and thermal energy meters, available in full-bore and clamp-on versions for flexible and non-invasive installation.

ISONRG
Managing energy

Thermal energy calculators and meters, also with integrated control valve to measure, manage and optimize energy performance.

ISOD@M
Managing data

Data loggers and integration software enabling monitoring, analysis and smart decision-making in water and district heating/cooling networks.



LIBRA UNI CEI EN ISO/IEC 17025 Laboratory

The calibration laboratory consists of plants and devices for the calibration of measuring instruments for the following physical quantities:

- Volume (totalized)
- Volume flow
- Mass (totalized)
- Mass flow
- Thermal Energy



CALIBRATION LINES	NOMINALS DIAMETERS
Line 1	DN3
Line 2	DN6, DN10
Line 3	DN15 to DN25
Line 4	DN32 to DN50
Line 5	DN65 to DN100
Line 6	DN125 to DN300
Line 7	DN300 to DN700
Line 8	DN300 to DN3000

CALIBRATION LINE	CALIBRATION METHOD		
	GRAVIMETRIC STATIC WEIGHT (VOLUME AND MASSA)	DIRECT COMPARISON (MASTER METER) (VOLUME)	VOLUMETRIC PROVING TANKS (VOLUME)
Line 1	•	•	
Line 2	•	•	
Line 3	•	•	
Line 4	•	•	
Line 5	•	•	
Line 6	•	•	
Line 7		•	
Line 8			•



Stainless steel piezometric tower for the calibration of large DNs



Calibration line up to DN3000



Calibration lines from DN03 to DN800

LIBRA UNI CEI EN ISO/IEC 17025 Laboratory

From end of 2025 LIBRA Laboratory has been accredited also for **Thermal Energy** quantity.

- Q: 0,015 m³/h – 1000 m³/h
- Line 1-6
- Fluid: Water
- Methods:
 - Gravimetric (PS) calibration for flow sensor
 - Comparison with sample thermostatic bath
 - Accredited software for calculation



Settore / Calibration field		(SPO-03) Energia termica						
Strumento Instrument	Misurando Measurand	Condizioni Additional parameters		Campo di misura Measurement range		Incertezza Uncertainty	Metodo/Procedura Method / Procedure	Sede Location
Contatori di energia termica (11)	Energia termica	Portata in volume : da 0,015 m ³ /h a 1 000 m ³ /h Temperatura dell'acqua: da 0 °C a 150 °C Volume: da 2 L a 26 000 L	Differenza di temperatura (Δθ) (12)	≥ 3 K < 40 K	≥ 10 kJ ≤ 21·10 ³ MJ	0,7 + 20 · Δθ ^{-1,5} (13)	Metodo interno. Taratura con metodo per pesata statica, utilizzando acqua come liquido termovettore (14)	A
				≥ 40 K ≤ 150 K		0,7 %		



Stainless steel piezometric tower for the calibration of large DNs



Calibration line up to DN3000



Calibration lines from DN03 to DN800



Membro degli Accordi di Mutual Riconoscimento EA, IAF e ILAC
Signatory of EA, IAF and ILAC Mutual Recognition Agreements



Certificato di Accreditamento Accreditation Certificate

Accreditamento n. **02255 Inspection REV. 000**
Accreditation n.:

Emesso da **Dipartimento Certificazione e Ispezione**
Issued by

Si dichiara che **ISOIL Industria S.p.A.**
We declare that
Metron Organismo di Ispezione

On site Subsequent Verification for:

- Water Meter (MI-001)
- Thermal Energy Meter (MI-004)

✓ D.M. 93/2017 

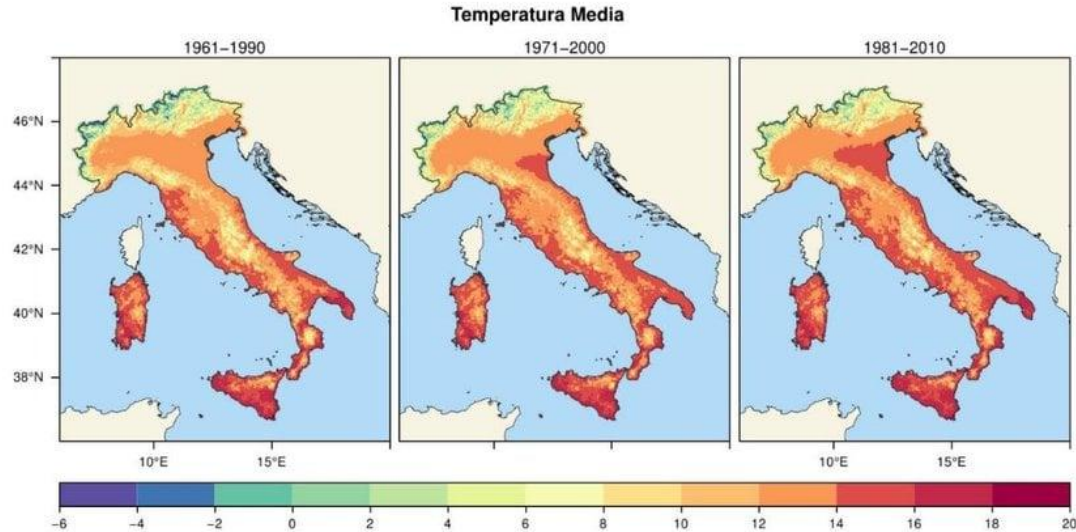


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Thermal Energy demand in Italy

The $\Delta\theta$ between North/Sout

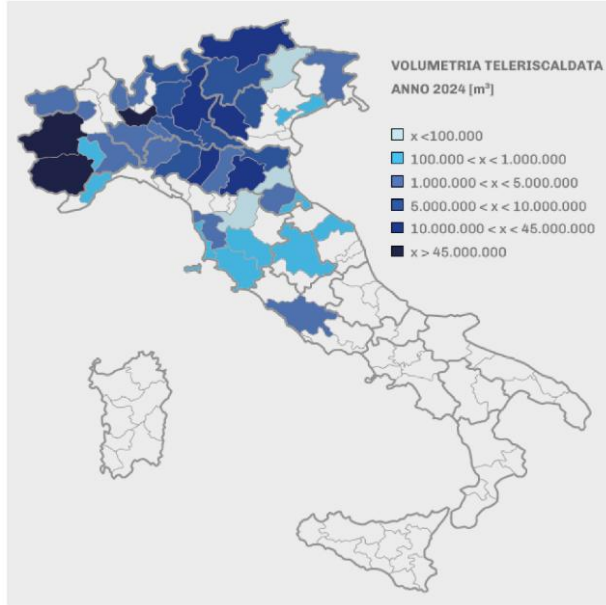
Italy – the $\Delta\Theta$ between North/South



North: Tmin -5°C / Tmax +35°C
Heating operation: Oct. ... Apr.

South: Tmin 8°C / Tmax +40°C
Heating operation: Dec. ... Mar.

Italy – the $\Delta\Theta$ between North/South



District Heating national distribution

Indice del grado di raffrescamento giornaliero (2001-2021) - province italiane



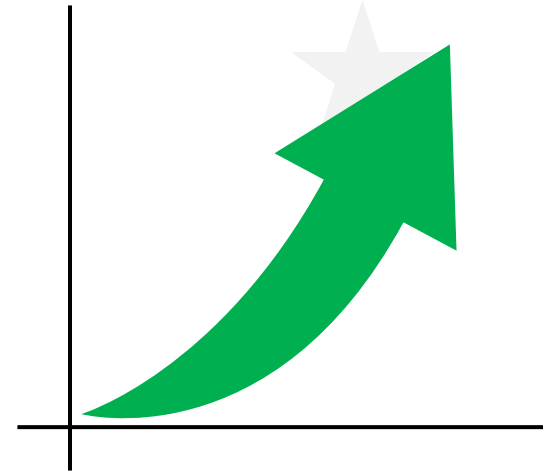
Cooling Degree Days Italian map

Italy – the $\Delta\Theta$ between North/South

€ Custody transfer applications

❄ Glycol & additives use

↻ Bivalent HVAC systems



ISOIL Industria SpA

Experimental analysis on influence of Glycol
on Thermal Energy Meter Accuracy.

The Thermal Energy Meters

The thermal energy meters:

- ✓ Measuring principle: **Mechanical, Ultrasonic and Magnetic**
- ✓ Accuracy: **class 2** (Commercial meters)
- ✓ Fluid: **Water (not designed/adjusted for glycole!)**
- ✓ Flow-rate range: $q_s=3,0\text{m}^3/\text{h}$ $q_p=1,5\text{m}^3/\text{h}$ $q_p/q_i=25$
- ✓ Temperature: $\Delta\theta_{\min}=3\text{K}$, $\theta_{\min}=0^\circ\text{C}$, $\theta_{\max}=100^\circ\text{C}$

The test program

Mode	Liquid temp. (θ_o)	Temperature diff. ($\Delta\theta$)	Test flow rate (q)
Heating	50°C	3K	Low (0,12 m ³ /h)
			High (3,0 m ³ /h)
		40K	Low (0,12 m ³ /h)
			High (3,0 m ³ /h)
Cooling	15°C	3K	Low (0,12 m ³ /h)
			High (3,0 m ³ /h)
		10K	Low (0,12 m ³ /h)
			High (3,0 m ³ /h)

Equation model and coefficient correction



Experimental investigation of thermophysical properties of propylene glycol based secondary fluids for ground source heat pumps and indirect refrigeration systems



$$k_{w-PG\%}(c_p, \rho)$$

T (°C)	ρ (kg m ⁻³)			C_p (J kg ⁻¹ K ⁻¹)		
	WT	WT/PG 25.4%	WT/PG 39.3%	WT	WT/PG 25.4%	WT/PG 39.3%
5	998.55	1024.30	1039.06	4.2491	4.1124	3.8230
10	998.30	1022.80	1036.67	4.2447	4.1299	3.8560
15	997.65	1021.10	1034.13	4.2409	4.1439	3.8836
20	996.82	1019.21	1031.44	4.2374	4.1548	3.9064
25	995.70	1017.13	1028.60	4.2340	4.1627	3.9250
30	994.28	1014.85	1025.61	4.2303	4.1677	3.9398
35	992.73	1012.37	1022.47	4.2263	4.1702	3.9516
40	990.86	1009.70	1019.18	4.2216	4.1704	3.9607
50	986.37	1003.78	1012.15	4.2069	4.1587	3.9637

SCHEDA TECNICA

NOME PRODOTTO: MPG ANTIGELO BLU
CODICE PRODOTTO: 162410
ARTICOLI CORRELATI: 162402, 162409



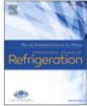
Essen-Germany



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journal homepage: www.elsevier.com/locate/ijrefrig



Experimental investigation of thermophysical properties of propylene glycol based secondary fluids for ground source heat pumps and indirect refrigeration systems

Étude expérimentale des propriétés thermophysiques du propylène glycol pour les pompes à chaleur indirectes

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Department of Energy Technology, KTH Royal Institute of Technology,

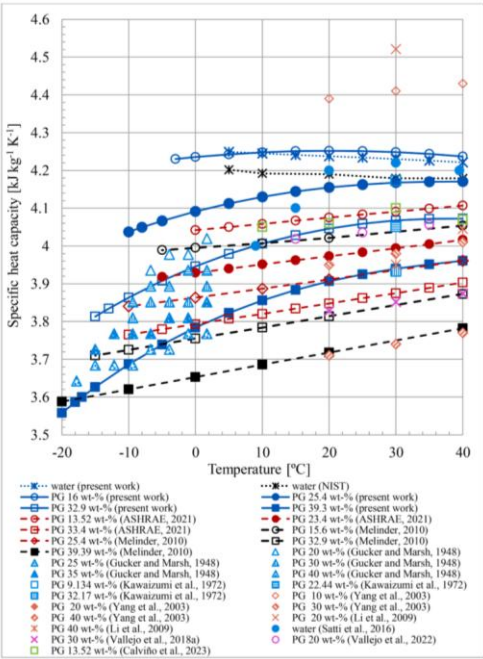
ARTICLE INFO

Keywords:
Propylene glycol
Secondary fluid
Indirect refrigeration system
Ground source heat pump

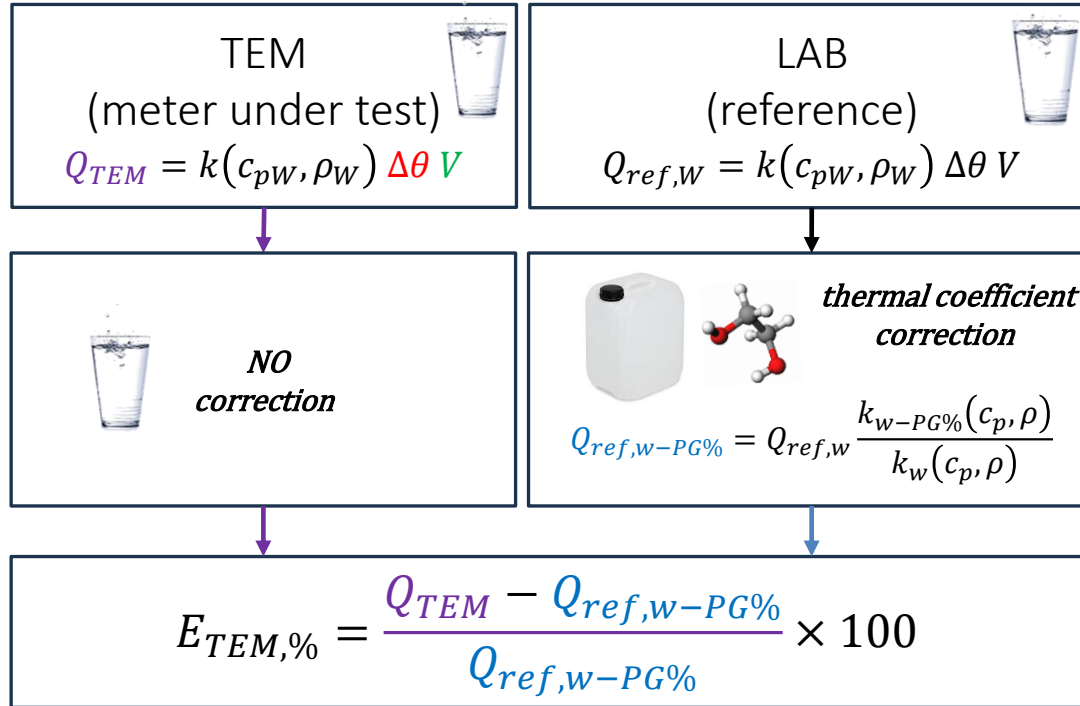
Mots clés:
Propylène glycol
Fluide secondaire
Propriétés thermophysiques
Système frigorifique indirect
Pompe à chaleur géothermique

ABSTRACT

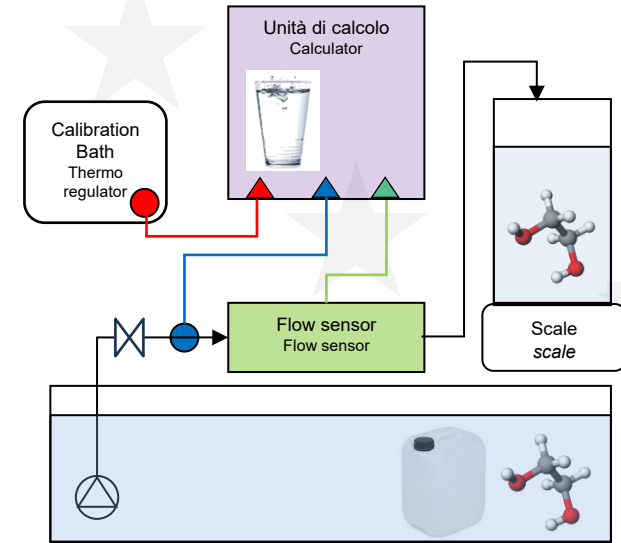
More than 1000 references are cited in this paper. The paper compares the thermophysical properties of propylene glycol based secondary fluids with water and other secondary fluids. The paper also compares the thermophysical properties of propylene glycol based secondary fluids with water and other secondary fluids. The paper also compares the thermophysical properties of propylene glycol based secondary fluids with water and other secondary fluids.



Equation model and coefficient correction



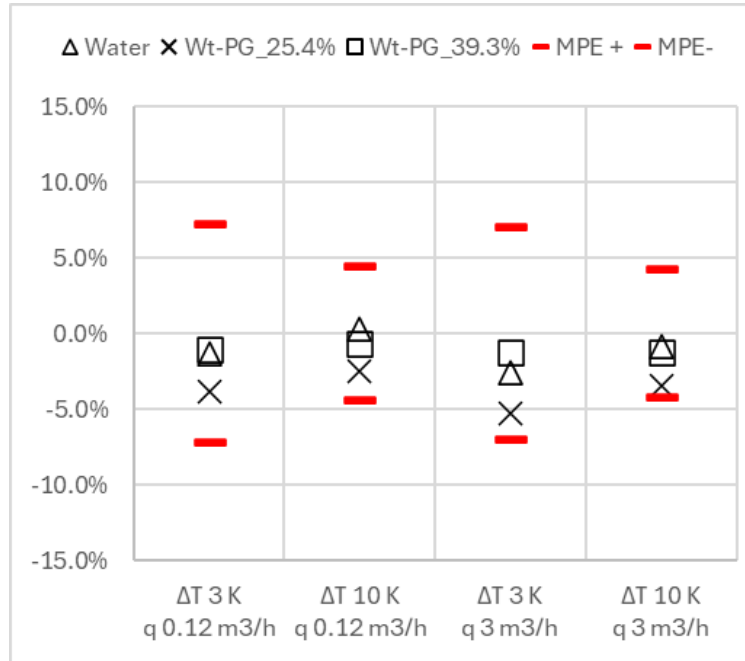
Gravimetric method standing start/stop



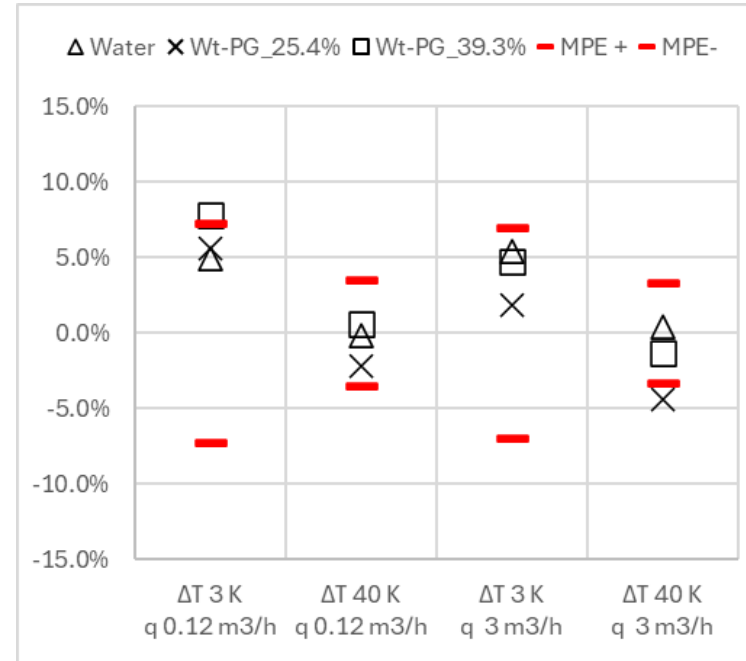
Tests were performed at the IEC/ISO 17025 accredited laboratories LAMI of the University of Cassino and Libra Division of HEMINA ISOIL Industria in Montagnana, Italy

Thermal Energy Meter: MAGNETIC

Cooling ($\theta_{out}=15\text{ }^{\circ}\text{C}$)



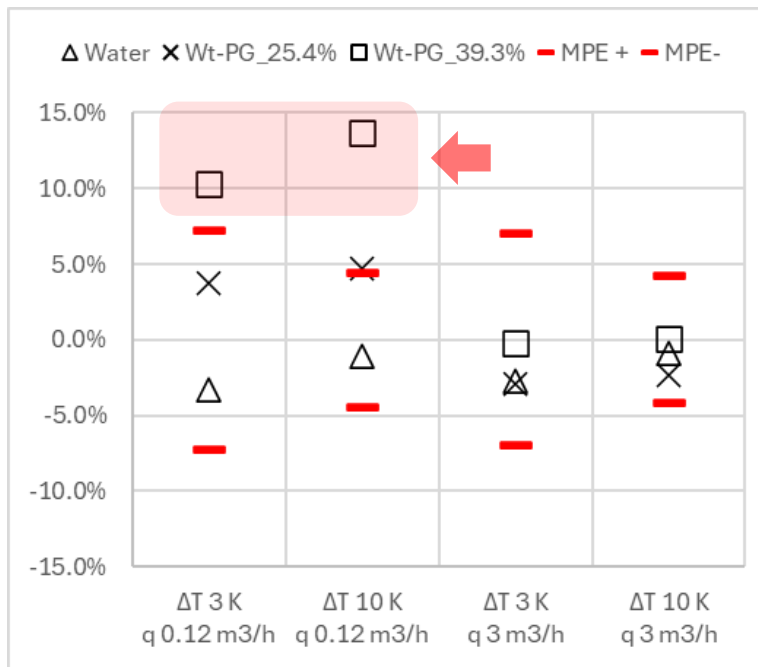
Heating ($\theta_{out}=50\text{ }^{\circ}\text{C}$)



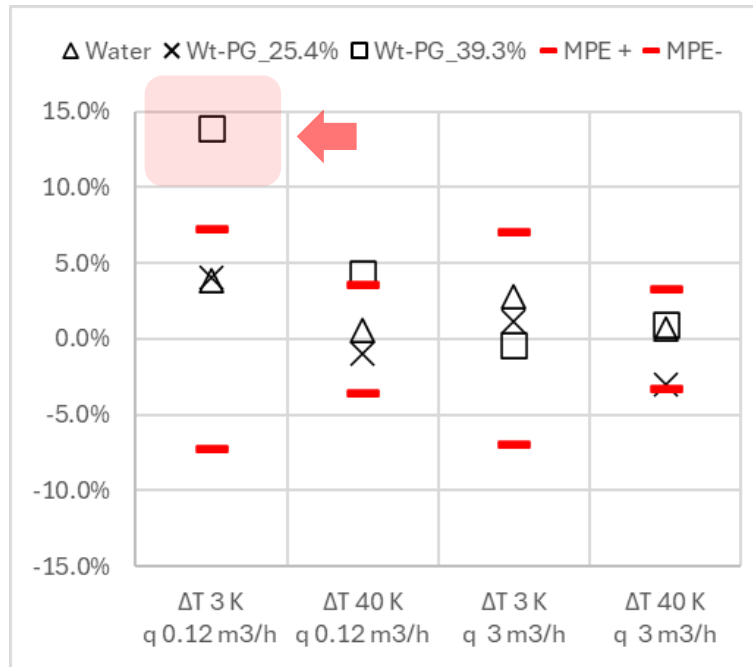
Measured Energy relative errors. Δ - water $\times$ - water+PG 25,4% $\square$ - water+PG 39,3%

Thermal Energy Meter: ULTRASONIC

Cooling ($\theta_{out}=15\text{ }^{\circ}\text{C}$)



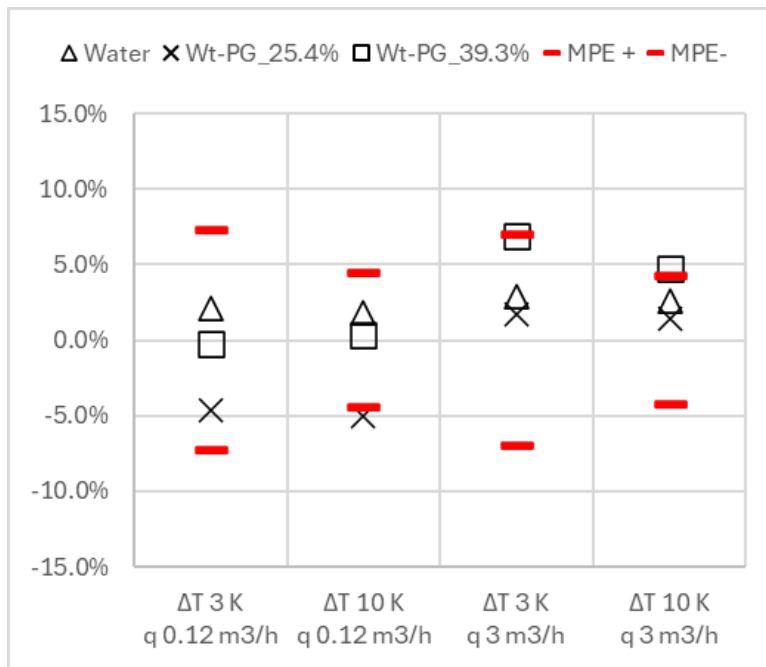
Heating ($\theta_{out}=50\text{ }^{\circ}\text{C}$)



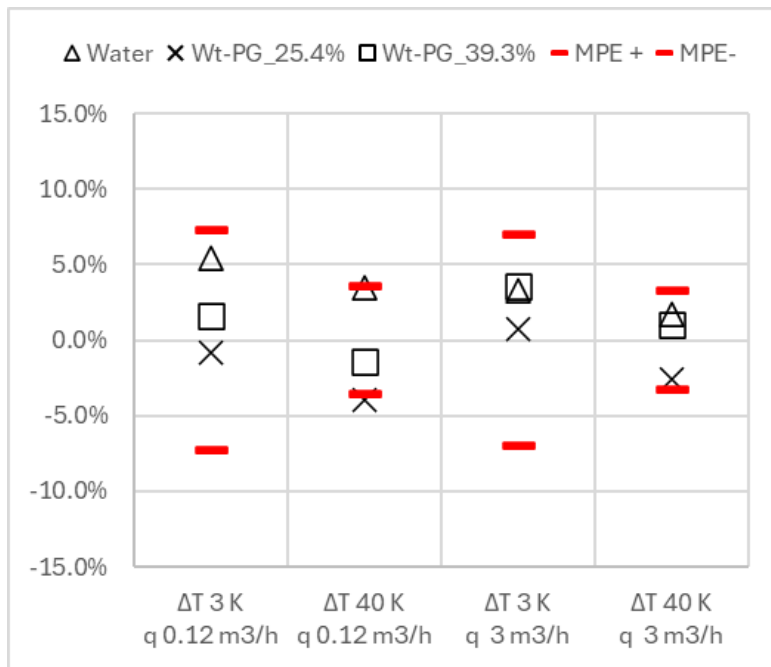
Measured Energy relative errors. Δ - water $\times$ - water+PG 25,4% $\square$ - water+PG 39,3%

Thermal Energy Meter: MECHANIC

Cooling ($\theta_{out}=15\text{ }^{\circ}\text{C}$)



Heating ($\theta_{out}=50\text{ }^{\circ}\text{C}$)



Measured Energy relative errors. Δ - water $\times$ - water+PG 25,4% $\square$ - water+PG 39,3%

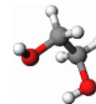
CONCLUSION

The Thermal Energy Meters (for water application)



- Mechanical, Ultrasonic and Magnetic
- Accuracy: **class 2** (Commercial meters)
- Flow-rate range: $q_s=3,0\text{m}^3/\text{h}$ $q_p=1,5\text{m}^3/\text{h}$ $q_p/q_i=25$
- Temperature: $\Delta\theta_{\min}=3\text{K}$, $\theta_{\min}=0^\circ\text{C}$, $\theta_{\max}=100^\circ\text{C}$

The conveying liquid (PG - glycole)



- PG/WT=25,4% (kg/kg)
- PG/WT=39,3% (kg/kg)
- Heating 50°C
- Cooling 15°C

	Thermal Energy Meter	Flow sensor sub unit
Mechanical	HIGH sensitivity to (Cp, Re)	HIGH sensitivity to (Re)
Ultrasonic	HIGH sensitivity to (Cp, Re)	HIGH sensitivity to (Re)
Magnetic	HIGH sensitivity to (Cp) MEDIUM sensitivity to (Re)	MEDIUM sensitivity to (Re)

THANK YOU FOR YOUR ATTENTION

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