The value of volume-based average temperatures

Volume-based average temperatures provide the right foundation for motivational tariffs and data analytics

Advanced analytics and motivational tariffs are key tools for increasing your system efficiency. But to identify the optimisation potential, you need the right foundation. The E8...E11 registers in Kamstrup heat meters enable calculation of volume-based average temperatures, which accurately show what you deliver to and receive from the consumers.

Stable temperatures in the distribution network and the cooling effectiveness in consumer installations are fundamental focus areas when optimising your system. But to pinpoint opportunities for minimising heat loss and improving efficiency, you need an accurate picture of what goes on in your network.

The right foundation for motivational tariffs and data analytics

A datagram with the current temperature that is, for example, collected once a day does not provide the right foundation for data analytics as the system temperature is closely connected with the flow that varies significantly during the day.

Volume-based average temperatures are more representative of the heat you exchange with the consumers because they are calculated from samplings based on the volume of water measured by the meter. Therefore, the flow is accounted for in the calculation.

The E8...E11 registers in Kamstrup heat meters allow you to calculate volume-based average temperatures in an easy and efficient way. This improves the quality of your data analysis and can serve as an accurate basis for motivational incentives directed at the consumers. With a financial incentive, consumers are encouraged to follow a more energy-efficient behaviour.

Advanced analytics

The analytics tool Heat Intelligence is based on data from the E8...E11 registers. It combines heat meter data with a digital GIS* model of your distribution network to visualise how heat spreads throughout the system.

Heat Intelligence shows detailed information on flow, inlet and outlet temperatures and temperature deviations offering you a new level of insight into your system. This allows you to document your quality of delivery, map your heat loss, monitor your network load – and act accordingly.

* Geographic Information System

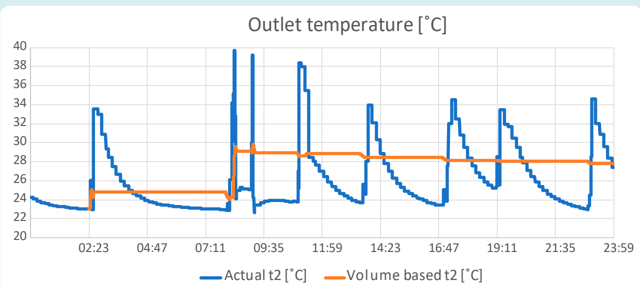

Figure 1: The graph shows the outlet temperatures [t2] and the volume-based temperature [t2] over a period of 24 hours.

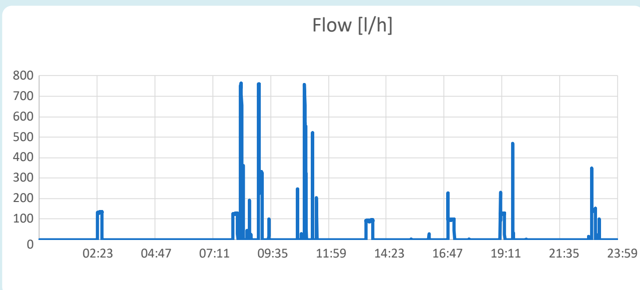

Figure 2: The graph shows flow variations in the same system seen over the 24-hour period.

What are E8...E11

E8...E11 are separate registers consisting of a sum of products between volume and temperature, also known as volume temperatures. The volume temperatures are indirect values of volume-based average temperatures, ***<t>***, which can be found using equation 1. The product of the different volume temperatures can be seen in table 1. ***E10*** and ***E11*** can also be used to check the hardware by comparing the volume-based average temperatures.

Register	**Product** [m³ °C]
E8	*V1 · t1*
E9	*V1 · t2*
E10	*V1 · t3*
E11	*V2 · t3*

Table 1: Products of the volume-temperature registers ***E8***...***E11***.

Reading requirements

To achieve an acceptable accuracy of the volume-based average temperatures, a minimum volume change, Δv_{min} is required. The minimum volume change depends on the display resolution and must be a factor of 100 larger than the display resolution as seen in table 2. It is also required that the volume is collected together with ***E8...E11***.

Display resolution	**Correction factor Y**	ΔV_{min} [m³]
0000.001	10	0000.100
00000.01	1	00001.00
000000.1	0.1	000010.0
0000001	0.01	0000100

Table 2: Correction factor Y as a function of display resolution and volume ***V*** and minimum volume change ΔV_{min}.

Volume-based average temperature equation

The volume-based average temperature, $\langle t \rangle$, can be found using the following equation:

$$\langle t \rangle = \frac{\Delta E}{\Delta V \cdot Y} \qquad \{1\}$$

ΔE is the change in volume temperature, ***ΔV*** is the change in volume, and ***Y*** is a correction factor that depends on the display resolution, see table 2. Therefore, it is necessary to collect the volume at the same time as the volume temperatures.

Calculation example

The volume-based average temperature of both inlet $\langle t1 \rangle$ and outlet $\langle t2 \rangle$ for the year 2018 is wanted. ***E8*** and ***E9*** are therefore collected during the annual reading, see table 3. The volume change ΔV=2973.9 [m³] is larger than the minimum requirement of ΔV_{min}=10.0 [m³] and the calculation is thus valid. The correction factor is set to ***Y***=0.1 using table 2.

Date of reading	***V1*** [m³]	***E8*** [m³ °C]	***E9*** [m³ °C]
01/01/2018	5342.6	48236	18654
01/01/2017	2368.7	20123	7651

Table 3: Reading of V1, E8 and E9.

Absolute temperature offset also helps to provide a more precise picture

The volume-based average temperatures in inlet $\langle t1 \rangle$ (equation 2) and outlet $\langle t2 \rangle$ (equation 3) are then:

$$\langle t1 \rangle = \frac{\Delta E8}{\Delta V1 \cdot Y} = \frac{E8_{2018} - E8_{2017}}{(V1_{2018} - V1_{2017}) \cdot Y} = \frac{48236\ m^3\ °C - 20123\ m^3\ °C}{(5342.6\ m^3 - 2368.7\ m^3) \cdot 0.1} = \mathbf{94.53}\ °C \qquad \{2\}$$

$$\langle t2 \rangle = \frac{\Delta E9}{\Delta V1 \cdot Y} = \frac{E9_{2018} - E9_{2017}}{(V1_{2018} - V1_{2017}) \cdot Y} = \frac{18654\ m^3\ °C - 7651\ m^3\ °C}{(5342.6\ m^3 - 2368.7\ m^3) \cdot 0.1} = \mathbf{36.99}\ °C \qquad \{3\}$$

Kamstrup A/S
Industrivej 28, Stilling
DK-8660 Skanderborg
T: +45 89 93 10 00
F: +45 89 93 10 01
info@kamstrup.com
kamstrup.com

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