kamstrup

Heat sample test report 2020

Result of sampling-controlled flow sensors for heat meters in 2019

- Flow sensor technology for heat measurement
- Completed by accredited laboratory at Kamstrup A/S

Contents

Introduction

Since 1991, Kamstrup has produced and delivered ultrasonic sensors for the measurement of district heating. Today, the flow range covers from 0.6 to 1.000 m^3/h, all full bore meters. A large part of these have been installed in Danish district heating systems, but many have also been exported to the Northern, Central and Eastern European markets.

The Danish district heating market is thus among the markets that were first on the forefront of changing meter technology from mechanical meters to static meters, primarily of the ultrasonic type. Therefore, the utilities have an understandable interest in documenting that the static ultrasonic sensors are more precise and long-term stable than their mechanical competitors. In particular, the precision and long-term stability are among the most important parameters when selecting meters.

All Danish district heating utilities are committed to establish a control system that is built in such a way that it is secured that meters in operation do not exceed the permitted usage tolerances. For this purpose, the heat utilities divide their meter populations into lots, take down meters from the lots on the basis of sample tests and send these to an accredited laboratory for control.

This report is a follow-up on the reports from the years 1997 up to and including 2019. The report represents the results for the tested meters in 2019 where sample tests have been performed on 98 lots of ultrasonic sensors. They represent a total of 2058 meters in operation.

Sample tests are taken in accordance with ISO 2869 AQL4, inspection level II, which secures that less than 4 % of the lot deviate from the sample test limits.

For the lot to obtain an extension of the operational period for 6/9[1] years, Danish regulation requires that the measurement results are within the original verification limits. The lot can have its operation period extended for 3/6[1] years if the sample test does not meet the original verification limits, but is within the operation control limit. If this is not met either, the whole lot must be taken down and controlled in accordance with the verification limits and exchanged or refurbished within a year.

Results from the ultrasonic sensors are presented, partly for the year, partly accumulated from 1997, in the form of curves showing where measuring errors are found on the various measurement points.

How have the measurements been performed?

Sensors are taken down by Danish district heating utilities and sent to Kamstrup's accredited meter laboratory.

The flow sensor sizes of ultrasonic sensors are 1.5 m^3/h. The numbers are not corrected for any deviations caused by special operating conditions in the individual district heating utilities.

It should be noted that all tested lots represent ordinary laboratory work for the district heating utilities, and the meters have thus not been take down especially for this report. Samples are taken out according to MV² 07.01-01 edition 4 and CLM.VARME.01, edition 1, version 2.2 from 2019-12-18.

Term	MV²	DS	CEN	PTB
Minimum volume flow rate	Q_i	$Q_{V\,min}$	q_i	Q_{min}
Maximum volume flow rate	Q_p	$Q_{V\,max}$	q_p	Q_n

The metrological directive, MV² 07.01-01, is issued by DANAK (the Danish Accreditation Fund, www.danak.dk) that belongs under the Danish Safety Technology Authority, which is part of the Ministry of Industry, Business and Financial Affairs. MV² 07.01-01 describes the construction of and the requirements for a control system for meters in operation.

The designations used are stated in MV² 07.01-01 edition 4.

Measurement limits and tolerances, dynamic range, MV² 07.01-01 edition 4. Combined meter / flow sensor.

Combined meter / flow sensor (volume measurement only)	Maximum acceptable limits for measurement inaccuracy	
	New and reverified meters	Meters in operation
1. $q \le 3 \times q_i$	±5 %	±10 %
2. q 0.1 x q_p - 0.11 x q_p	±3 %	±6 %
3. $q > 0.9 \times q_p$ to $1.0 \times q_p$	±3 %	±6 %
Meters larger than q_p 3.0 m^3/h Applies to flow 1-2-3	±3 %	±6 %

The meters are calibrated in the same three measuring points as stated in the table above. The calibrations are performed at a water temperature of 50 ±5 °C.

The metrological guide CLM.VARME.01, edition 1, version 2.2 from 2019-12-18 describes in detail the implementation of self-inspection of heat meters. It describes best practice that is based on many years of experience at the Danish Center for Legal Metrology (CLM). It takes its starting point in guideline no. 9464 of 20 June 2018 from the Danish Safety Technology Authority about the device owner's self-inspection of water, electricity and heat meters in operation included in the act no. 582 of 28 May 2018 from the Danish Safety Technology Authority about the use of measuring instruments for measuring the consumption of water, gas, electricity or heat.

Table 1: Households **Complete meter** **As a minimum, the meters are controlled with the three different flows stated below with associated temperature differences.**	Verification error limit	Centre point	Usage tolerance
1. Lower test point 1 x q50:1 ≤ q ≤ 1.2 x q50:1 at 38 K ≤ ΔΘ ≤ 42 K	± 6.3 %	± 9.5 %	± 12.6 %
2. Centre test point 0.1 x q_p ≤ q ≤ 0.11 x q_p at 16 K ≤ ΔΘ ≤ 22 K	± 5.0 %	± 7.5 %	± 10.0 %
3. Upper test point 0.9 x q_p ≤ q ≤ 1.1 x q_p at 8 K ≤ ΔΘ ≤ 10 K	± 5.2 %	± 7.8 %	± 10.4 %

Tabel 1 Measurement limits and tolerances, dynamic range as of 2019.

The controls are performed at a water temperature of 50 °C ± 5 °C, unless otherwise stated in the type approval. However, 40 °C ± 3 °C can be used if the operating conditions justify this. The tolerances are set at a $\Delta\Theta_{min}$ of 3 K.

In legislation, the accuracy requirements are set as "floating values" that depend on the selected measuring points. The stated values thus only apply to the defined measuring points.

Sample test results

The measuring results are from sampling-controlled Kamstrup meters in 2019.

Table 2 shows the results of ultrasonic sensors, divided into 3 error groups according to Verification error limit, Centre point and Usage tolerance (see Table 1).

Ultrasonic meters are 1.5 m^3/h with the dynamic range q_i:q_p 1:100.

This composition reflects the total meter population.

At the same time, the composition shows the field of application when the meters' dynamic range has been taken into account.

	Usage tolerance	Centre point	Verification error limit	Total number of meters
Kamstrup ultrasonic sensors	10	31	2017	2058

Tabel 2

Table 3 shows the measuring results from table 1 converted into consequences for the underlying meter lots.

Table 2 shows the length of operation extension that the meter lots have obtained.

	Taken down within 1 year	3/6[1] years of extension	6/9[1] years of extension	Total number of lots
Kamstrup ultrasonic sensors	4	4	90	98

Tabel 3

Figure 1 shows in % the number of lots that have obtained an operation extension of 1 year, 3/6[1] years and 6/9[1] years.

Kamstrup ultrasonic sensors (1.5 m^3/h).

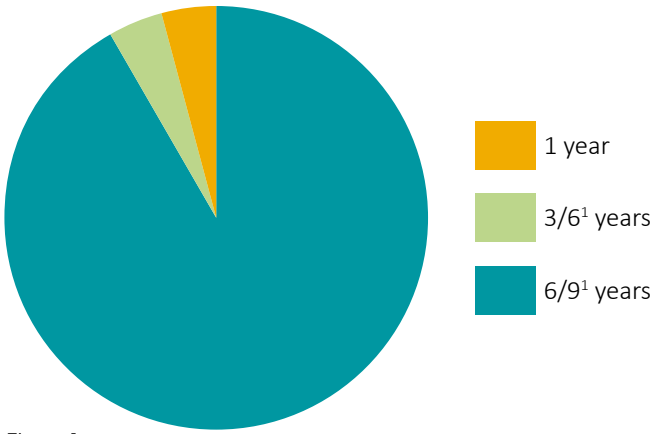


Figure 1

How good are ultrasonic sensors after 6/9[1] years of operation?

The measuring results for the ultrasonic sensors are shown for the actual measurement points.

The numbers are based on the tested meters in the yearly report.

The accumulated results of the tested meters from 1997 up to and including this report appear in the postscript.

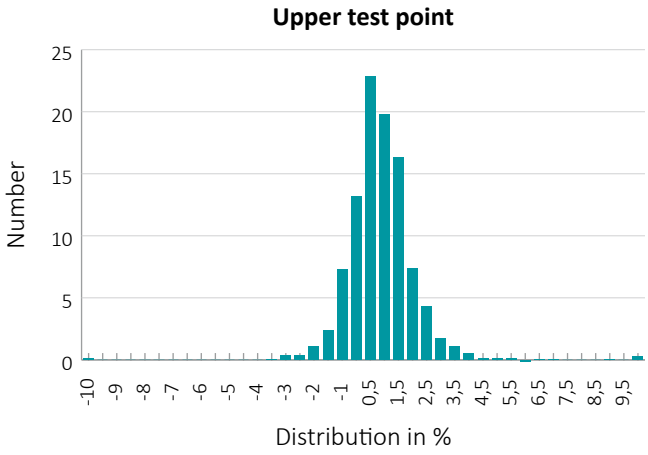


Figure 2

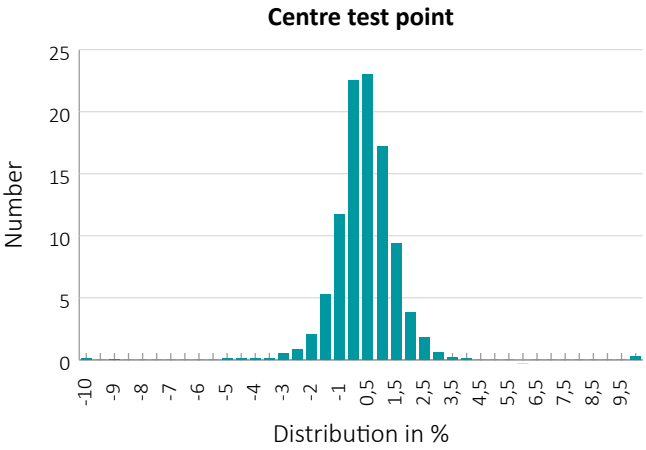


Figure 3

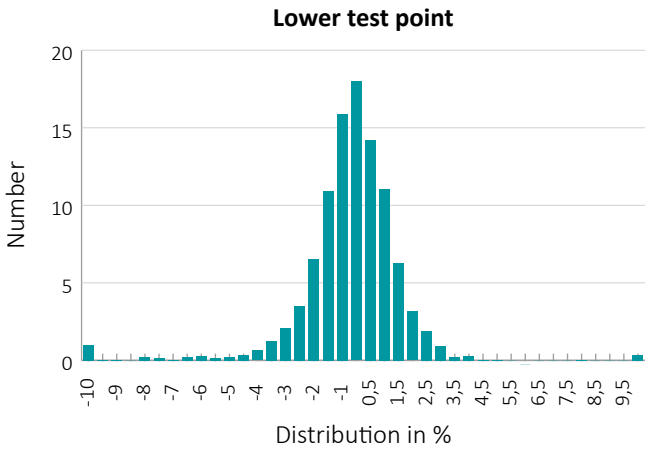


Figure 4

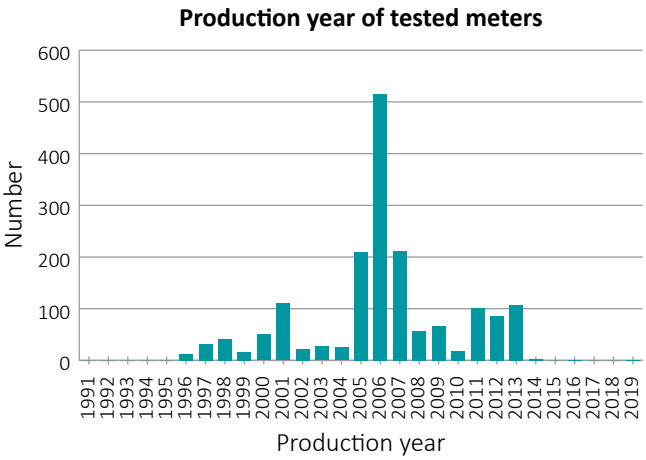


Figure 5

Conclusion

As it appears from table 1, the measuring results of the ultrasonic sensors show stability over the last year as 98 % lie within the very strict limit values.

The calculation is based on lots that have been subject to a sample test in 2019 and here, it is shown very clearly that 91.8 % of the ultrasonic sensors have obtained an operation extension of additional 6/9[1] years. In the picture is also the fact that several ultrasonic sensors have now been subject to their third sample test and are thus on the way towards a total operating time of 15 or 18 years.

Despite the fact that several of the ultrasonic sensors are between 12 and 27 years old, the measuring results are so good that only 4 lots had to be taken down after 1 year.

The long-term stability of the ultrasonic principle has been documented through the results of the latest years. The long-term stability and the long life of ultrasonic sensors ensure the lowest possible meter costs for the consumer and the heat utility.

The reliability and the stability of the meters are important factors as they ensure that the supplied energy is measured correctly and that billing is thus taking place on the correct basis. A long-term stable meter that does not, over time, measure more and more inaccurately at the same time secures the heat utility against an always creeping billing loss.

Postscript

Accumulated results of the sample tests from 1997 up to and including the conclusion of this report.

The ultrasonic sensors that have been measured for control purposes in this report are of Kamstrup's first, second and third generation ultrasonic sensors. From 1997 to the conclusion of the report, 51,877[3] ultrasonic sensors have been subject to sample tests.

The ultrasonic sensors that are produced today have been improved in many areas, which additionally ensure the long-term stability, especially in q_i that, from experience, can be problematic.

We will continuously collect results from the control measurements and in that way continue to expand the documentation of the accuracy and stability of Kamstrup's ultrasonic sensors.

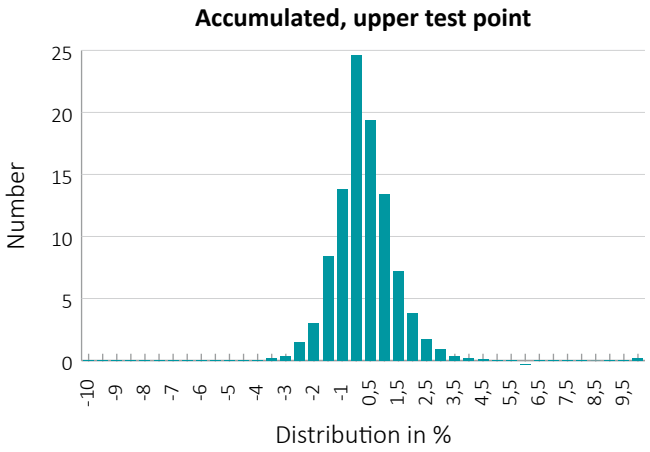
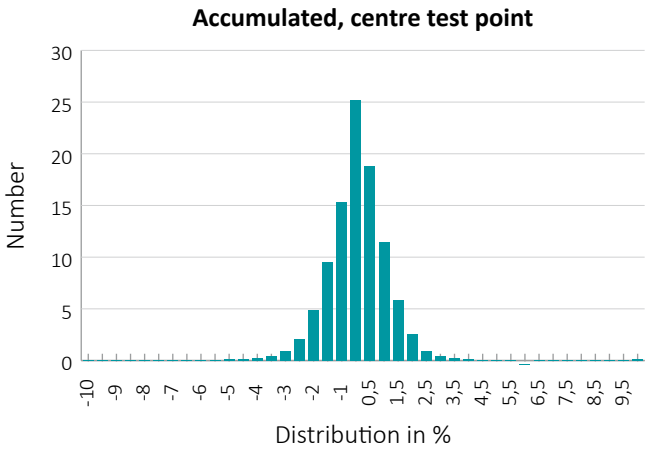


Figure 6



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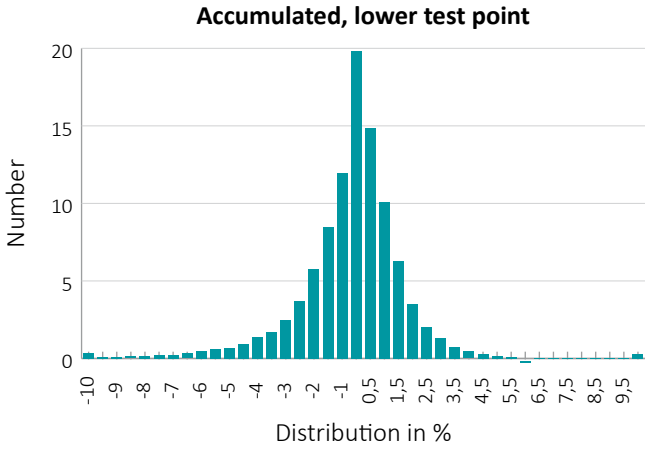

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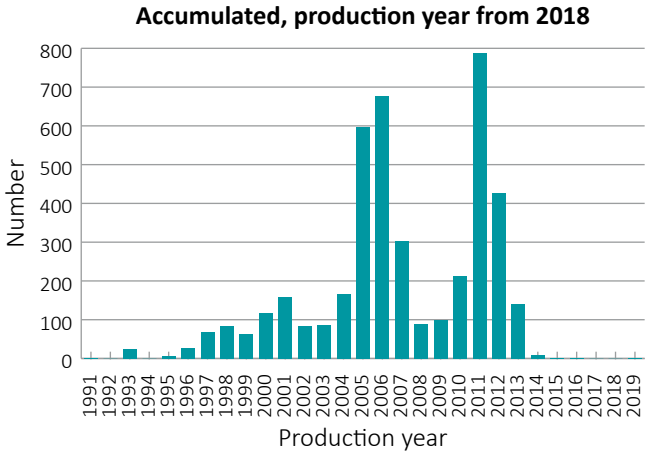

Figure 9

Notes

1) 6/9 - 3/6 = Transition from MV[1] 07.01-01 edition 4 to act no. 582 of 28 May 2018, CLM.VARME.01, edition 1, version 2.2 of 18-12-2019.

2) MV = Revoked, Metrological instruction on control system for meters in operation and for reverification of meters. (MV 07.01-01, edition 4).

3) Previous reports have included a larger number based on a wrong summation.

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