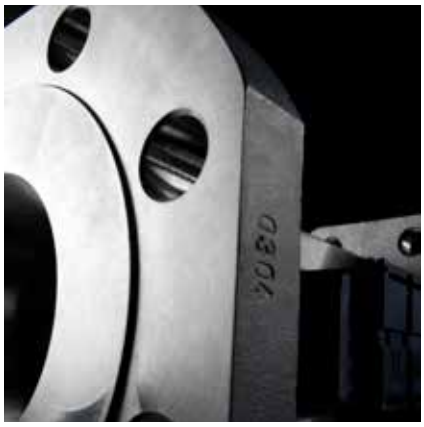
Report

Sample-Testing of Flow Meters 2012



Selecting flow meter technology for energy metering

Carried out by accredited laboratory at Kamstrup A/S

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Kamstrup

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Preface

Since 1991 Kamstrup has produced and supplied more than 2,200,000 ultrasonic, full-flow meters, with flow ranges from 0.6 - 1000 m^3/h, for measuring energy consumption in district heating. The majority have been installed in Danish district heating systems. However, many have also been installed in Northern, Central and Eastern Europe.

The Danish district heating market is amongst the leaders with regard to change in meter technology from mechanical meters to static meters, primarily of the ultrasonic type. Thus, the plants are naturally interested in documentation stating that static ultrasonic meters are more accurate and long-term stable than their mechanical competitors. Accuracy and long-term stability are two of the most important parameters when choosing meters.

Every Danish district heating utility is obliged to establish a control system, which is built up in a way that ensures that meters in operation do not exceed the tolerance limit. For this purpose, the heating power plants group their meters in batches, dismount them for sampling and send them to an accredited laboratory for testing.

This report is a follow-up to the reports from the years 1997 up to and including 2012. The report represents results from 2012 based on samples of 173 lots of ultrasonic meters. These lots represent a total of 3,290 meters.

Samples are taken according to AQL4, inspection level II, ensuring that less than 4% of the batch deviates from the test result.

For the batch to obtain a prolongation of the operating period by an additional 6 years, the measuring results must lie within the original verification limits. The operating period of the batch can be prolonged by an additional 3 years, if the test does not observe the original verification limits, but lies within the operating control limit. If the operating control limit is not observed, the entire batch must be removed and tested according to the verification limits and replaced or renovated within one year.

Results of the ultrasonic meters, partly for the year and partly accumulated from 1998, are represented in the form of graphs showing where the measuring errors are placed at the different measuring points, and comparisons are drawn between mechanical and ultrasonic meters as to measuring errors and extension of the operating period for the individual lots.

How have the measurements been carried out?

The meters have been dismounted by Danish district heating utilities and sent to Kamstrup's accredited measuring laboratory.

The flow meter sizes for mechanical meters are 0.6 - 1.0 and 1.5 m^3/h, whereas the ultrasonic meters all are 1.5 m^3/h.

The figures are not corrected for deviations, if any, owing to special operating conditions at the individual utilities.

It should be noted that all the batches tested represent daily laboratory work undertaken for the heating power plants. No meter has been removed specifically for inclusion in this report.

Samples are selected according to MDIR* 07.01-01.

All measurements are made according to MDIR 07.01-01.

Descriptions	MDIR*	DS**	CEN	PTB
Minimume volume flow rate	Q_{min}	q_{vmin}	q_i	Q_{min}
Maximum volume flow rate	Q_{max}	q_{vmax}	q_p	Q_n

* *The measuring metrological directive, MDIR 07.01-01, is published by the Danish Accreditation and Metrology Fund under the Danish Safety Technology Authority and The Ministry for Economy and Business Affairs. MDIR 07.01-01 describes the construction of and demands for a control system for meters in operation.*

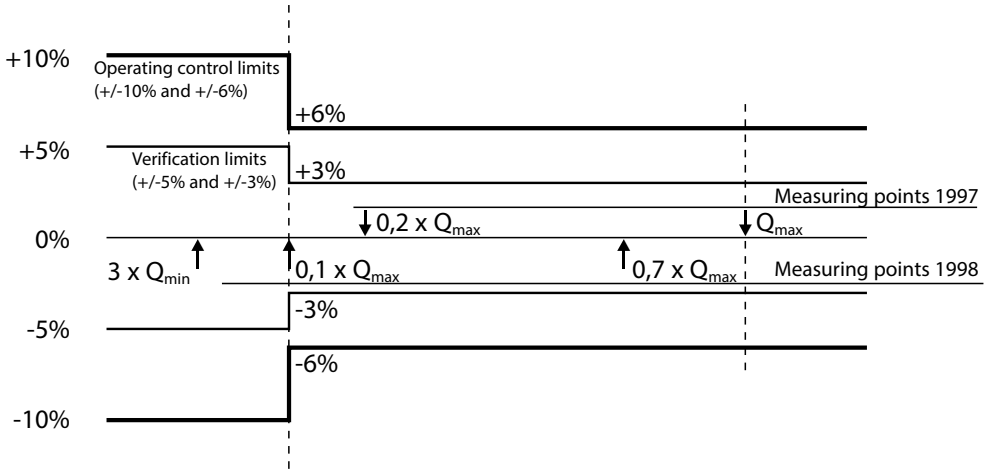
** *DS is an abbreviation of Dansk Standard (Danish Standard).*

Terms are used as in MDIR 07.01-01 paragraph 6.2.

The class descriptions used (class B and C) are according to PTB.

Measuring limits and tolerances for 1997:			
Flow:	0.2 x Q_{max} and Q_{max}	3%/3%	Verification limits
		6%/6%	Operating control limits
Measuring limits and tolerances as from 1998 (incl.):			
Flow:	3 x Q_{min} 0.1 x Q_{max} and 0.7 x Q_{max}	5%/3%/3%	Verification limits
		10%/6%/6%	Operating control limits

Fig.1: Verification limits, operating control limits and measuring points under Danish legislation (MDIR 07.01-01).



Results

Table 1 shows the results for both mechanical and ultrasonic meters, divided into 3 error groups.

One showing the number of meters with errors larger than the operating control limits (twice verification limits).

The next one showing errors smaller than the operating control limits but larger than the verification limits, and the last one shows where the error is smaller within the verification limits.

The mechanical meters comprise the meter sizes 0.6 - 1.0 and 1.5 m^3/h, all with dynamic class B, whereas all ultrasonic meters are 1.5 m^3/h with dynamic class C.

This composition reflects all meters and at the same time it represents a comparable field of application, when the large dynamic range of the ultrasonic meters is taken into account.

Table 1: Measuring results 2012 – number of meters

	Error > operating control limits	Operation control limits > error > verification limits	Error < verification limits	Total number of meters
Mechanical meters	17	27	72	116
Kamstrup's ultrasonic meters	42	114	3.134	3.290

Table 2 shows the measuring results from table 1 converted into consequences for the underlying batches.

Thus, table 2 shows the working period the batches have been prolonged by.

Table 2: Prolongation of the working period for the batches 2012 – number of batches

	Removed within a year	3 year's prolongation	6 year's prolongation	Total number of batches
Mechanical meters	8	3	0	11
Kamstrup's ultrasonic meters	6	26	141	173

Fig. 2 and 3 show, as a percentage, the number of batches, which have had the working period prolonged by 1 year, 3 years and 6 years.

Fig. 2:
Mechanical meters, (all 0.6 - 1.0 - 1.5 m^3/h)

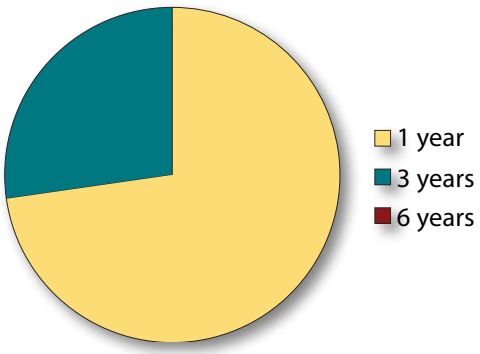
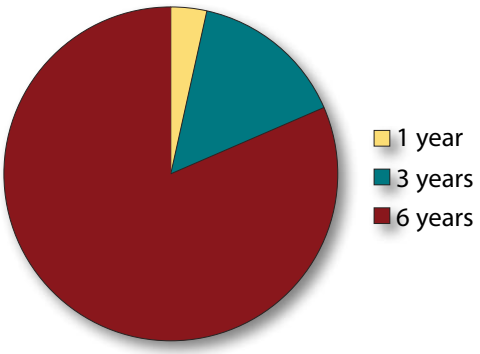


Fig. 3:
Kamstrup ultrasonic meters, (1.5 m^3/h)



How good are the ultrasonic meters in 6th operating year?

The measuring results of the ultrasonic meters are shown for 2012 in the actual measuring points.

Results for the accumulated figures as from 1998 to 2012 can be seen in fig. 7, 8 and 9 on page 8.

Results from sampling in 2012

The 2012 figures are based on results from 3.290 meters.

Fig. 4: 0,7 x Q_{max} 2012, Kamstrup ultrasonic meters

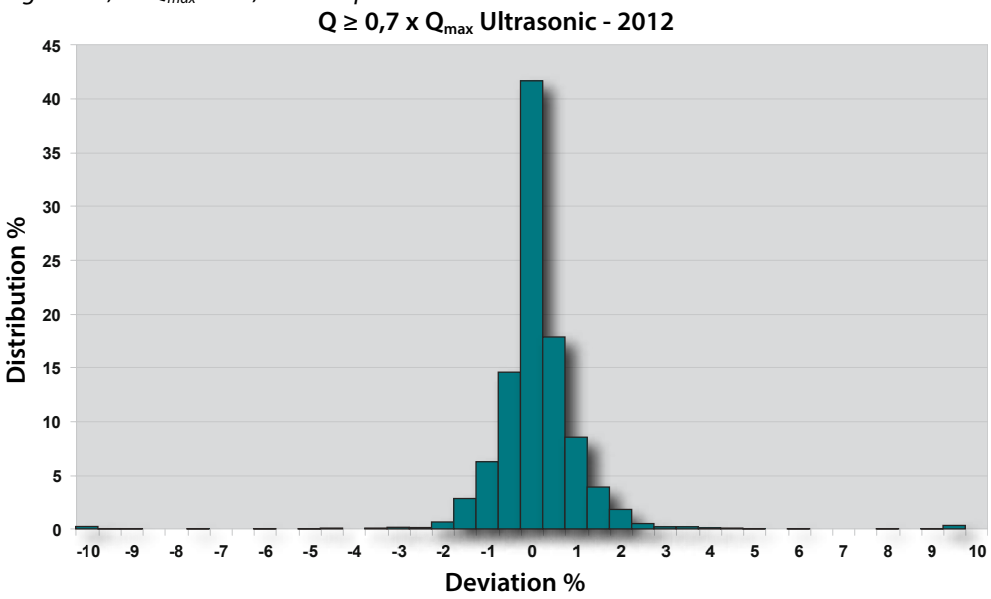


Fig. 5: 0,1 x Q_{max} 2012, Kamstrup ultrasonic meters

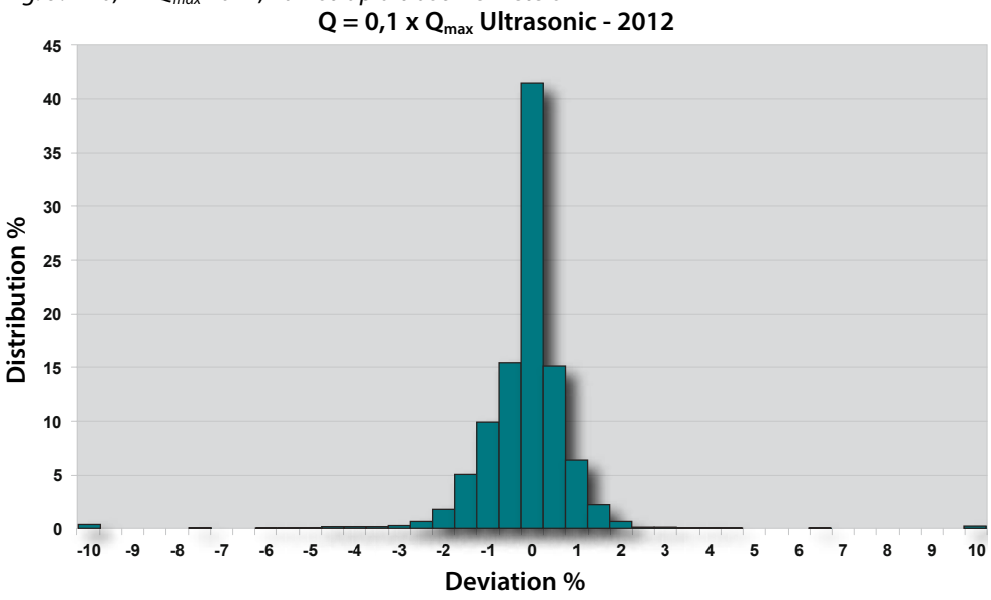
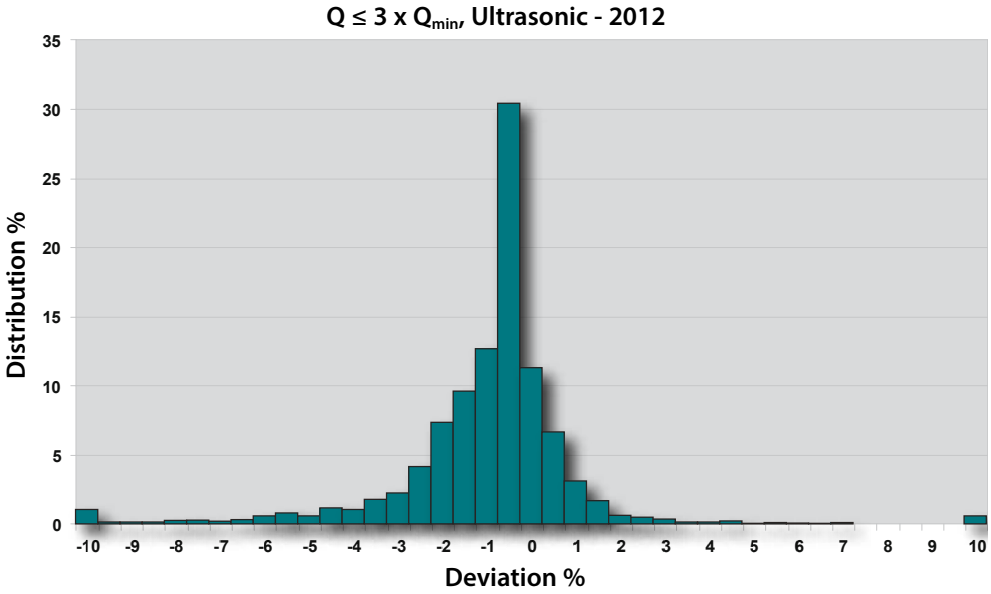


Fig. 6: 3 x Q_{min}, 2012, Kamstrup ultrasonic meters



Conclusion

As can be seen from table 1, the measuring results for ultrasonic meters have been stable for a number of years with 95,3% (3,134 meters) of values falling within the strictest limits. Whereas the results indicate that only 0% (0 meters) of the mechanical meters attained the same level.

Calculated on the basis of the sample batch, the picture is quite clear – 82% of the ultrasonic meters may remain installed for an additional period of 6 years. However, this applies to only one batch of the mechanical meters.

Additionally, a large number of ultrasonic meters have been tested for a second time, following the second period of installation, and found to be of such a quality that they may remain installed yet again. This means that the next test will be carried out when the meters have been in operation for a period of 15 or 18 years.

Despite the fact that several of the ultrasonic meters are between 12 and 22 years old, the measuring results are so good that only 6 batches among the oldest failed.

The results for the mechanical meters are much poorer indicating that the older the meter, the more likely it is to be imprecise.

These tests confirm that the long-term stability of the ultrasonic measuring principle cannot be questioned. The longevity and long-term stability of the ultrasonic meter makes it the most economical meter type for both the consumer and the utility. If the meter becomes more erroneous with time, then the utility will steadily loose money due to inaccurate invoicing.

Meters used for billing energy must be accurate and stable, so that the measured values can be relied upon and the ensuing invoice taken to be 100% correct.

Epilogue

The ultrasonic meters tested in connection with this report represent Kamstrup's 1st, 2nd and 3th generation of ultrasonic meters. The ultrasonic meters produced by Kamstrup A/S today have been improved in many ways, particularly in respect to long-term stability especially in qmin, which is notoriously difficult.

We will constantly collect results from control measurements and continue to document the accuracy and stability of Kamstrup's ultrasonic meters.

Fig. 7

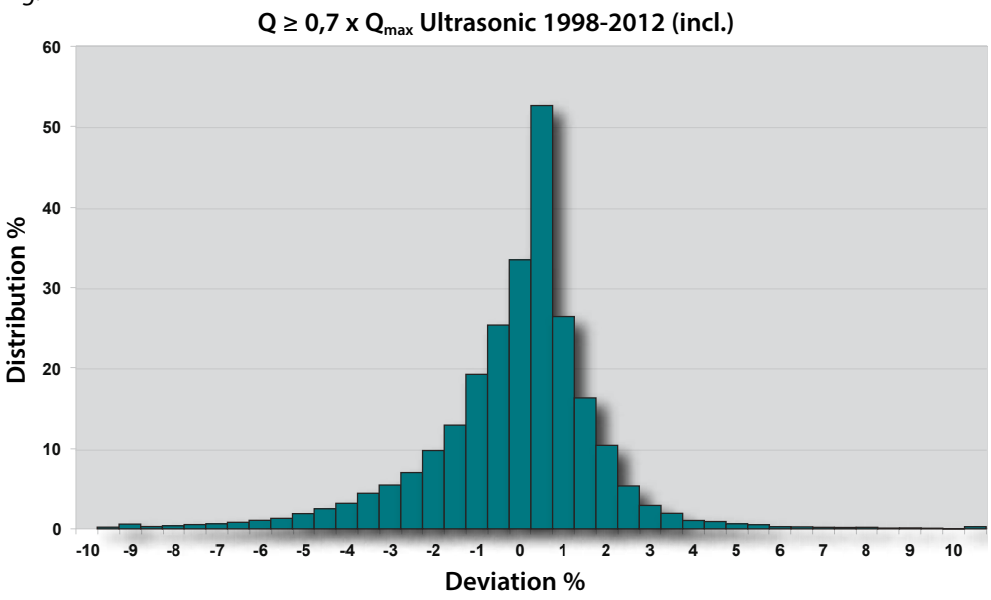


Fig. 8

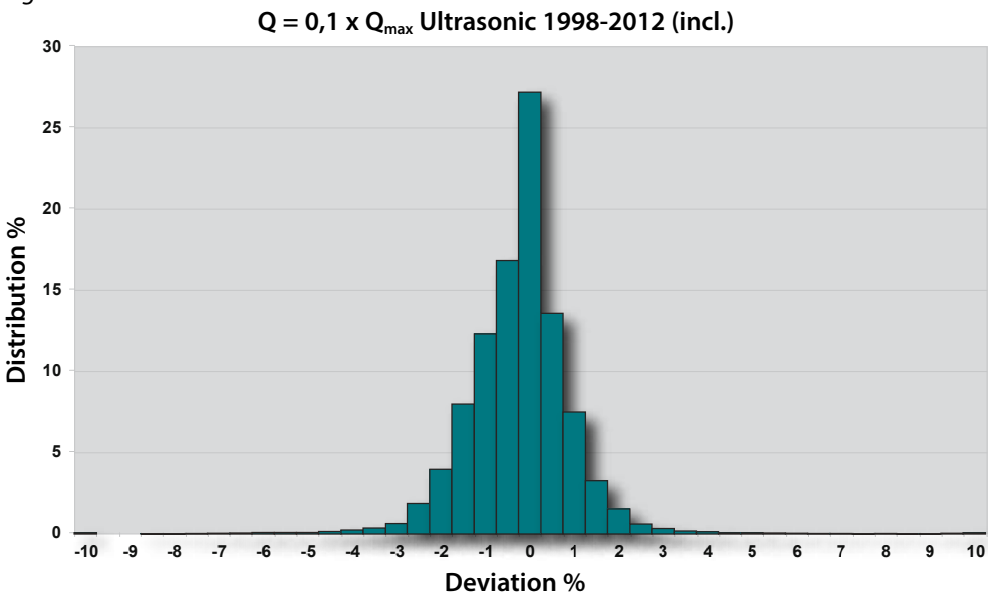


Fig. 9