Trigas DM
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Trigas FI
Flow Measurement & Calibration

How much do you trust the accuracy specifications of flowmeters?

Flowmeters are often chosen according to the specifications, as listed in the documents supplied by the manufacturers. Later, under actual operating conditions, customers are often disappointed with the measuring results, which are obviously not within the stated specifications. What is the reason for this? Are the suppliers giving wrong statements?

“I wouldn’t say that they are lying to their customers”, says Tom Trigas, general manager of the TrigasFI laboratories. “We have many flow measurement devices from different suppliers, working with different physical measuring principles here for calibration every day. In general, they are keeping within the published specifications. But the customers often only look at the figure for “accuracy” and don’t read the small “small print” which is often used to qualify (and in some cases, quantify) this number.”

But the differences under actual operating conditions can be significant. And here comes the differentiation between a “highly accurate device in standard conditions” and a “highly accurate device in your application”.

(Read, why the second one is worth its price.)

The example below is coming from the TrigasFI calibration laboratory. Calibrations are performed on DAkkS certified test benches according to the ISO 17025 norms. Devices of different measuring principles would have fitted into this evaluation, but to make the comparison more valid, two turbine flowmeters were selected. One is the DM-16 turbine flowmeter of TrigasDM and the other one a competitive product with the same price level. (The brand can be announced, but is not relevant, because similar results were found at different brands. Let’s call it turbine2.)

Turbine 2 is specified in the manufacturer’s leaflet for hydraulic oil applications. Accuracy should be better than 2% OR (Of Reading) for viscosities between 0… 100 mm^2/s. It has a 4… 20 mA outputs, which is scaled by the producer from 0…120 l/min.

The tests were made within this range at 10 mm^2/s and 50 mm^2/s.

And here are the results:

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Analog output flowmeter 2

at 10 mm²/s

Analog output flowmeter 2

at 50 mm²/s

FLOW METER CALIBRATION REPORT

Customer:
Customer Ref:

TrigasFI Job No.:
Other Ref:

DUT (Device Under Test)
Manufacturer:
Model No.:
Serial No.:
Tag Number:

TEST PARAMETERS
Calibration Fluid: oil blend
Accuracy Spec.: +/- % F.S.
Meter Density: 0.8225 kg/l
Ambient Pressure: 0.960 bar

MEASUREMENT RANGE:

	Flow l/min	Output mA
Min:	0.000	4.000
Max:	120.000	20.000

Set Point (% FS)	Meter Rate (l/min)	Meter Temp (°C)	Meter Viscosity (mm²/s)	DUT Out. (mA)	DUT Out. (l/min)	% Deviation Of Reading	% Deviation Full Scale
100.1	120.092	21.944	10.48	19.833	118.747	-1.120	-1.121
62.9	75.507	22.264	10.38	14.070	75.526	0.025	0.016
40.2	48.273	22.430	10.33	10.481	48.610	0.698	0.281
25.6	30.703	22.564	10.29	8.125	30.941	0.773	0.198
16.5	19.762	22.585	10.29	6.656	19.919	0.790	0.130
10.3	12.313	22.564	10.29	5.649	12.370	0.468	0.048
6.6	7.872	22.574	10.29	5.041	7.807	-0.816	-0.054
4.2	5.050	22.636	10.27	4.659	4.941	-2.166	-0.186
2.6	3.171	22.616	10.28	4.393	2.948	-7.041	-0.447
1.6	1.966	22.657	10.26	4.191	1.430	-27.274	-0.447

FLOW METER CALIBRATION REPORT

Customer:
Customer Ref:

TrigasFI Job No.:
Other Ref:

DUT (Device Under Test)
Manufacturer:
Model No.:
Serial No.:
Tag Number:

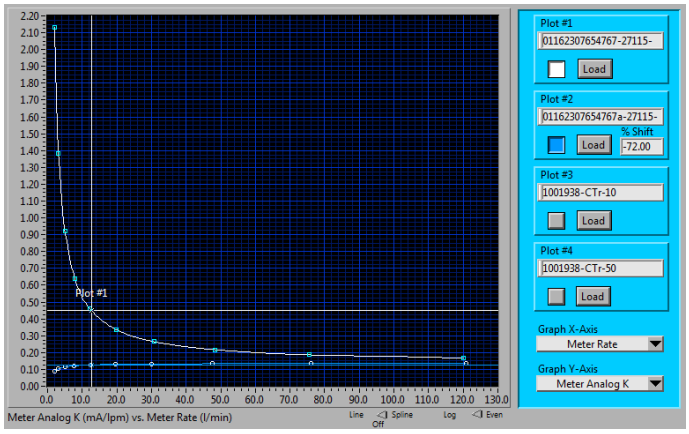
TEST PARAMETERS
Calibration Fluid: oil blend
Accuracy Spec.: +/- % F.S.
Meter Density: 0.8590 kg/l
Ambient Pressure: 0.960 bar

MEASUREMENT RANGE:

	Flow l/min	Output mA
Min:	0.000	4.000
Max:	120.000	20.000

Set Point (% FS)	Meter Rate (l/min)	Meter Temp (°C)	Meter Viscosity (mm²/s)	DUT Out. (mA)	DUT Out. (l/min)	% Deviation Of Reading	% Deviation Full Scale
100.7	120.842	27.481	52.55	20.205	121.537	0.575	0.579
63.3	75.963	28.502	50.20	14.195	76.466	0.662	0.419
39.7	47.661	28.572	50.05	10.372	47.790	0.270	0.142
25.1	30.080	28.692	49.78	7.988	29.910	-0.566	-0.350
16.4	19.690	28.672	49.83	6.569	19.270	-2.133	-0.535
10.4	12.534	28.602	49.98	5.586	11.892	-5.119	-0.598
6.4	7.661	28.482	50.25	4.926	6.943	-9.372	-0.614
4.2	4.981	28.272	50.72	4.566	4.244	-14.802	-0.597
2.6	3.138	27.901	51.57	4.323	2.422	-22.814	-0.569
1.6	1.972	27.771	51.87	4.172	1.290	-34.600	-0.569

At a low viscosity of 10 mm²/s (blue curve) flowmeter 2 stays within the 2% accuracy limit at above 90% of the range. But at the low flowrates deviations increases up to 30%. This may be acceptable if the customer is not running the device in the lower 10% range.



But performance becomes worse as the viscosity increases to 50 mm²/s (white curve). Below 75% of the range the deviations rise above 2% and up to 34%.

And the higher the viscosity is, the worse the deviations. This is probably not what a customer expected. It means that if he operates the device at two different viscosities, his measuring results will vary between 70% (at about 12% of the range) and 2% (at 100% of the range).

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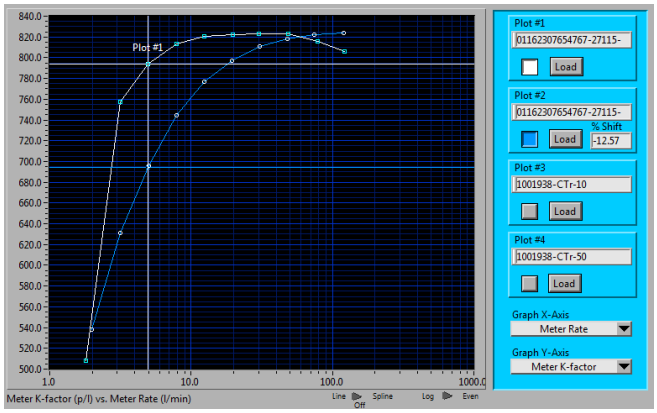
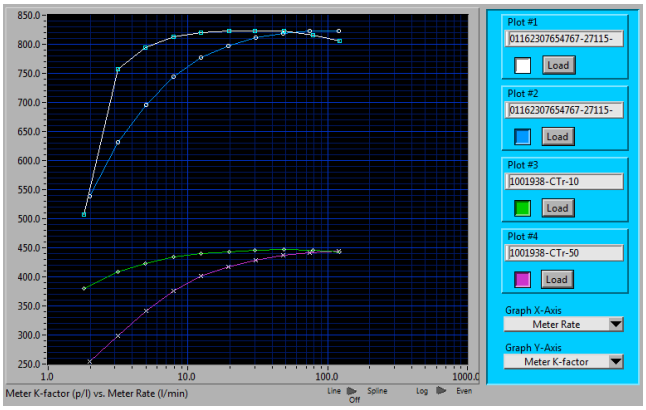
Making the comparisons using the analogue output of the flowmeter, can be argued that is not a valid criterion for judging the performance and quality of the flowmeter, because there is an additional A/D conversion involved.



Therefore, another measuring cycle was taken by using the raw frequency of the flowmeter to avoid any scaling errors.

The results were better, but still we see deviations between the 10 mm²/s curve and the 50 mm²/s curve of minimum 2% up to 12%.



The TrigasDM turbine DM-16 with the same measuring range was compared to this (green and red curve).

The raw frequency output for the DM-16 showed also similar deviations at the low flowrates, but a better performance at higher rates. Still this is not an ideal solution for an oil application.

If the customer knows that he has a media with changing viscosities (because of the use of different media or just because of certain temperature changes), his flowmeter should be able to recognize and respond to the changes.

For turbines in oil applications of varying viscosity, TrigasDM is applying a special UVC calibration. Multiple calibration curves are generated within the viscosity range that the customer expects during operation. The data are then combined into a Universal Viscosity Curve (UVC) which is used by the electronics to compensate in real time for changing viscosities.

Of course, it can be argued that UVC principles could also have been applied on flowmeter 2 to improve its measuring results. Although the producer of this flowmeter is not offering this option, in order to maintain the fairness of the comparison, this process was also applied at flowmeter 2.

The results of both devices with applied UVC curve are shown in this diagram:

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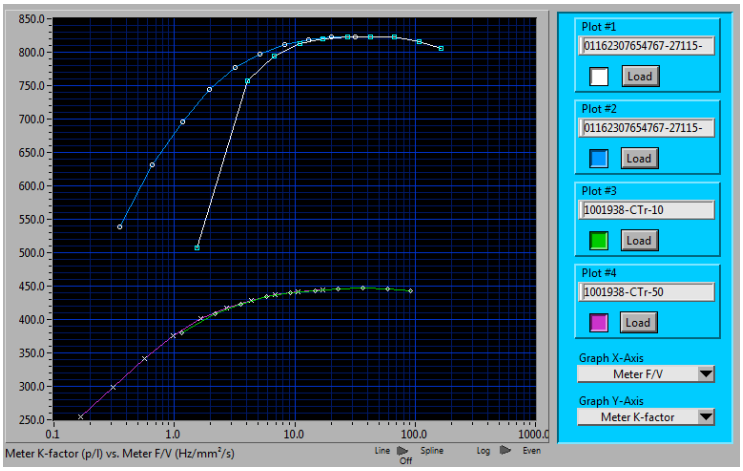
As we see, flowmeter 2 could be quite fairly compensated in the higher flow ranges. But in the lower ranges, it was not predictable.

The DM turbine instead shows a perfect stable curve, independent of the viscosity.



Obviously the UVC calibration is only one of the features that speaks in favour of this device. The highly precise construction of the DM-turbine makes it more responsive to viscosity shifts and consequently more predictable when UVC principles are applied. Additionally, because of its proprietarily blade design, it also generates a surprisingly low pressure loss.

The UVC correction, when applied using the TrigasDM Lysis/TriLIN Electronics, generates both frequency and analog outputs which are linearized and compensated for viscosity and consequently directly proportional to actual volumetric or mass flowrate.

Conclusion:

Customers, who are looking for flowmeters for an oil application should talk to their suppliers in detail about the accuracy at changing viscosities.

“This is also referring to other physical measuring principles, which are so-called *viscosity independent*”, adds Tom Trigas finally. “As we see in our lab every day, there is no flow metering device on the market that is truly process condition independent. If it is not viscosity, it is density or temperature or pressure or vibrations or mounting stresses or a number of other influences. Most flowmeters can be driven outside their limits of accuracy by relatively normal changes in operating conditions. So, it’s better to ask twice for the conditions of accuracy than to be disappointed later.”

On the other hand, high modern turbines, which are designed for applications with changing viscosities, within by the customer defined viscosity ranges, meet all the requirements of high technology flowmeters related to a long-life, high accuracy and reliability.

By: Anita Renc, Director Sales and Marketing TrigasDM GmbH / TrigasFI GmbH