PROCESS AUTOMATION

Flowmeters on the test rig

The voluntary check of one's own measuring systems by independent institutions has been a tradition at systec Controls since the beginning of the company foundation. Finally, the users of the devices should be absolutely sure that the respective measuring system really keeps the promises of the technical data. The fact that the systems are usually even better than ‚guaranteed' was also shown by the test of the deltawave by the Research Laboratory and Inspection Authority for Environmental Engineering and Water Engineering (Versuchsanstalt und Prüfstelle für Umwelttechnik und Wasserbau VPUW) at the university of Kassel/Germany.

Testing section and test item (above).

The objective of the measurements was to test the deltawave transit-time ultrasonic meter with regard to deviations from the reference, especially regarding a variation of the sound paths involved. The setup and the calibration of the water level measurement and the calibration measurements as well as the data acquisition of all devices were carried out by employees of the VPUW. The evaluation of the measured data was also realised by the research laboratory. The tests were attended by the VPUW Director Dr.-Ing. R. Hassinger and Dipl.-Ing. Ralf Feldner as a laboratory engineer.

The examination candidate

The deltawave operates according to the method of transit-time difference and uses several ultrasound paths located on top of each other. This is also a special feature of the device: The measurement with several sound paths allows deltawave to be used also in flume flows. The deltawave was tested with 2 x 6 ultrasonic transducers, arranged vertically on top of each other on both sides, and the corresponding electronics. In the top view, the transducers are diagonally displaced.

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For testing, the VPUW used a 2m wide, up to 80cm deep tipping trough which can be inclined up to 4%. It was adjusted without any fall. The side-walls are partially equipped with glass, so that the measuring path can also be seen from the side.

The feeding pipe to the tipping trough is equipped with an electromagnetic flowmeter DN 600, mounted downstream of a very long inlet section (> 20 x D). The type Autozero 3000 highly accurate electromagnetic reference flowmeter has a measuring uncertainty of well below 1% of the measured value, as specified by the manufacturer. With this autozeroing flowmeter the link to to the signal converter is digital (RS485), which means that no measured voltages or analogue values are transmitted. Therefore, it is not susceptible to interference.

The water levels in the tipping trough were measured with a type HTD ultrasonic echo sounding instrument and an EA94 signal converter. Its special sensor concept eliminates influences of temperature and atmospheric humidity on the sound velocity. For this device, the manufacturer specifies a measuring uncertainty of ± 1mm.

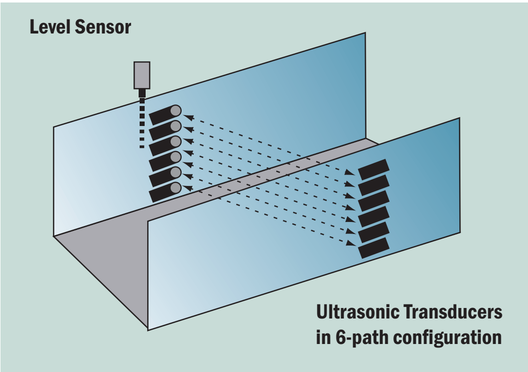
Detailed test sequences

The tipping trough is fed from a tank with clear water and a long inlet section of 10m (= 5 x w). The trough was used without an additional interior trim; i.e. bottom and side-walls were smooth, and other baffles, except several small metal angles on the bottom, were not present. Due to the acceleration of the flow from the supply tank into the trough, there was a homogeneous distribution of velocity up to the measuring path. That's why relatively constant speeds can also be expected in the vertical profile.

Due to the acceleration of the flow from the supply tank, the turbulence is damped a little. The smooth surround of the flow section causes only a reduced stirring-up of the turbulence due to friction on the walls. The wall

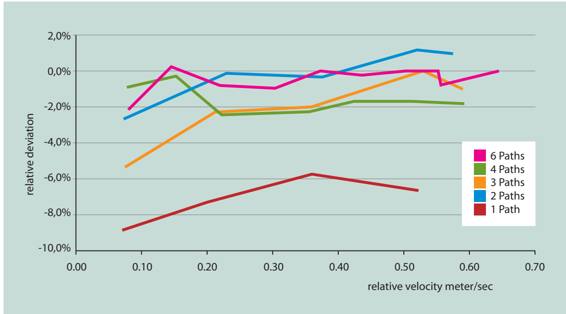
and bottom boundary layers up to the measuring point have only reached a size of approx. 10-20 mm. The disturbance of the surface was low, so that the measurement of the water level was possible under very good conditions. In the tipping trough, a still almost block-shaped velocity field could be observed.

A different number of measuring paths - 1, 2, 3, 4, 6 paths - was used and their measuring data checked at different flow rates, but always at about the same water level (700mm depth of water). The comparison measurements were carried out for different flow rates (0.07 to 0.6 m/s). For each measuring phase, control phases of several minutes each were chosen, during which constant stationary conditions can be expected. For these control periods, the average flow rates were determined and registered from the registered pulses. The differences were calculated as relative deviations and indicated in %. The greater number of measurements shows very small deviations between the reference system and the deltawave. Systematic errors can only be recognised with the measurement with one single ultrasound path.



Drawing of the test arrangement.

Generally, the deviations are more in the negative range, which means that the deltawave indicates flow rates which are slightly too low. The measurements with 6 paths are particularly good; even when using the 2-path-measurement an excellent accuracy could still be obtained. On an average, the 6-path-measurement shows a deviation of only approx. -0.3% with regard to the reference measurement setup, with 2 paths it is -1%. The increase of the relative errors for low flow rates is normal and due to the fact that the measuring uncertainty contains constant parts.



Relative deviation

The particularities of the test results:

- deltawave offers a high accuracy even at low flow rates (e.g. 4-path-measurement: v = 0.077 m/s, deviation = -0.84%,
- many electromagnetic flowmeters would deliver a much worse accuracy (4%) even when fully filled,
- electromagnetic flowmeter accuracy is ≤ 1% with 6-path-measurement from v = 0.10 m/s on,
- electromagnetic flowmeters reach this accuracy only when fully filled, when partially filled (only a few devices can actually measure, the others only operate when fully filled) the accuracy is only 3 to 5%,
- deltawave reaches a high accuracy already with a few paths.

The result

For judging the all in all positive results, it must be added that the hydraulic conditions were nearly ideal and deliberately not disturbed. Even if, in the practical application in normal, fully developed trough flows, the non-uniformity of the flow is much greater than during this test, so deltawave has proved that by using the multipath technology it has significant accuracy advantages and offers, altogether, the best prerequisites for practical use in waste water or cooling ducts or for monitoring turbines and pumps.

6-Path Measuring, all pathes active

Measurement	Focused flowrate [litres /sec]	Level [meter]	Reference magmeter [litres /sec]	Velocity [meter/sec]	deltawave [litres /sec]	Rel. deviation [%]
1	107	0.692	107.9	0.078	105.6	-2.13
2	198	0.691	198.3	0.143	198.7	0.20
3	300	0.691	301.3	0.218	298.9	-0.80
4	400	0.679	409.5	0.302	405.7	-0.93
5	500	0.680	504.2	0.371	504.2	0.00
6	600	0.694	603.6	0.435	602.0	-0.27
7	700	0.696	700.9	0.504	700.2	-0.10
8	750	0.684	755.7	0.552	755.4	-0.04
9	775	0.696	774.3	0.556	768.4	-0.76
10	890	0.691	889.7	0.644	890.1	-0.04

2-Path Measuring, pathes 2 and 4 active

Measurement	Focused flowrate [litres /sec]	Level [meter]	Reference magmeter [litres /sec]	Velocity [meter/sec]	deltawave [litres /sec]	Rel. deviation [%]
13	100	0.706	102.5	0.73	99.7	-2.69
14	300	0.685	312.6	0.228	312.0	-0.17
15	500	0.692	516.4	0.373	514.9	-0.29
16	750	0.710	741.0	0.522	749.3	1.12
17	850	0.676	777.2	0.575	785.0	1.00

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