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Air velocity interlaboratory comparison measurement between Jormita OY and Testing Centre, University of Tartu 2013

Report

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1. Introduction

The purpose of the interlaboratory comparison between Jormita OY and Testing Centre, University of Tartu was to compare the air velocity standards of both laboratories in the range of (0.1…20) m/s. The calibrations of Pitot tube, hot wire anemometer and rotating vane anemometer have been carried out between 16.04.2013 to 29.05.2013.

2. Participants

Name of laboratory	**Address**
Jormita OY	Kirjokannenkatu 11, 20660 Littoinen, Finland
Testing Centre, University of Tartu (TCUT)	Ravila 14A, 50411 Tartu, Estonia

3. Range of comparison

Air velocity standards were compared to each other in the range (0.1…20) m/s.

4. Reference equipment used in the comparison

Laboratory	**Reference equipment**
Jormita OY	Wind tunnel Alnor 2.2 Schiltknecht 612a projection manometer (to compare micromanometers) Swema 3000md micromanometer (for hot wire and Pitot tube measurements) DPM TT550S micromanometer (for orifice plate measurements at low speeds) Swema hot wire SWA-31 Pitot tube LIFA Barometer Alnor Thermohygrometer Rotronic HP-101A Thermometer Dostmann P655
TCUT	<u>Wind tunnel standard:</u> Wind tunnel Westenberg Engineering WK 91535 Differential pressure meter Schiltknecht ManoAir 500 mod. 2 Micromanometer Furness FC012 Thermohygrometer Almemo FHA646-E1C Barometer Almemo FD A612-MA Pitot tube Almemo FD 9912-33MS <u>Rotating arm standard:</u> Rotating arm (prepared at TCUT) Sweep generator Г3-112/1 Tapeline (II class) Stopwatch Hot wire anemometer Testo 405-V1

For air velocities (0.1…0.5) m/s the rotating arm standard was used at TCUT. The wind tunnel standard combined with the micromanometer was used in the air velocity range (0.6…4) m/s and at higher velocities the differential pressure meter was used (at TCUT).

5. Transfer standards

Instrument	Air velocity range
Pitot tube Airflow L-type	(1…20) m/s
Hot wire anemometer Swema SWA-31	(0.1…20) m/s
Rotating vane anemometer Almemo FV A915 SMA1	(1…20) m/s

6. Stability of the transfer standards

For Pitot tube the long-term instability has not been taken into account.
In all the cases the relative uncertainty of the long-term instability of the hot wire anemometer was less than 1.5 %.
For rotating vane anemometer the instability was studied by comparing the results of the first and second measurements at TCUT. In all the cases the stability was better than 0.04 m/s. Assuming rectangular distribution the standard uncertainty of the long-term instability $u_{stab} = \frac{0.04}{\sqrt{3}} = 0.023$ m/s.

7. Method for analyzing the results

For analyzing the results the normalized errors E_n were calculated by dividing the difference between corrections by the expanded uncertainty of the comparison:

$$E_n = \frac{q(v_{lab1}) - q(v_{lab2})}{\sqrt{U(v_{lab1})^2 + U(v_{lab2})^2 + U_{stab}{}^2}},$$

where

$q(v_{lab1})$ – correction of the anemometer determined by Jormita OY

$q(v_{lab2})$ – correction of the anemometer determined by TCUT

$U(v_{lab1})$ – expanded uncertainty of the correction determined by Jormita OY

$U(v_{lab2})$ – expanded uncertainty of the correction determined by TCUT

U_{stab} – expanded uncertainty of the long-term instability of the anemometer.

The expanded uncertainties at P=95% confidence level are calculated by multiplying the corresponding standard uncertainties by the coverage factor k=2 (assuming Normal distribution).

If $-1<E_n<1$, there is no statistically significant difference between the results obtained by the two participating laboratories.

8. Results of the comparison

The comparison results for the Pitot tube are presented in the table below. The uncertainty of the possible long-term instability has not been taken into account.

Value	Jormita OY		TCUT		E_n
	Correction	Expanded uncertainty	Correction	Expanded uncertainty	
m/s	m/s	m/s	m/s	m/s	
1	-0.03	0.04	0.02	0.09	-0.51
2	-0.04	0.07	0.01	0.12	-0.36
3	-0.03	0.10	0.00	0.15	-0.17
4	-0.02	0.15	-0.04	0.18	0.09
5	0.00	0.22	-0.05	0.25	0.15
10	-0.11	0.43	-0.09	0.32	-0.04
15	-0.14	0.64	-0.12	0.46	-0.03
20	-0.15	0.86	-0.09	0.60	-0.06

The comparison results for the rotating vane anemometer are presented in the table below.

Value	Jormita OY		TCUT		E_n
	Correction	Expanded uncertainty	Correction	Expanded uncertainty	
m/s	m/s	m/s	m/s	m/s	
1	-0.03	0.04	0.06	0.09	-0.85
2	-0.03	0.07	0.07	0.12	-0.69
3	-0.03	0.10	0.08	0.15	-0.60
4	-0.02	0.15	0.05	0.18	-0.29
5	0.01	0.22	0.00	0.25	0.03
10	0.17	0.43	0.14	0.32	0.06
15	0.46	0.64	0.32	0.46	0.18
20	0.59	0.86	0.58	0.60	0.01

The comparison results for the hot wire anemometer are presented in the table below.

Value	Jormita OY		TCUT		E_n
	Correction	Expanded uncertainty	Correction	Expanded uncertainty	
m/s	m/s	m/s	m/s	m/s	
0.1	0.03	0.03	0.04	0.05	-0.17
0.2	0.02	0.03	0.03	0.05	-0.17
0.3	0.01	0.03	0.02	0.06	-0.15
0.4	0.02	0.04	0.01	0.06	0.14
0.5	0.02	0.04	0.02	0.07	0.00
0.6	0.02	0.04	0.07	0.07	-0.62
0.7	0.01	0.04	0.07	0.07	-0.74
0.8	0.00	0.04	0.07	0.08	-0.78
1	-0.01	0.04	0.07	0.09	-0.80
2	-0.04	0.07	0.10	0.12	-0.99
3	-0.03	0.10	0.13	0.15	-0.86
4	-0.07	0.15	0.11	0.18	-0.74
5	-0.11	0.22	0.03	0.25	-0.41
10	-0.15	0.43	-0.11	0.32	-0.07
15	-0.21	0.64	-0.27	0.46	0.07
20	-0.22	0.86	-0.29	0.60	0.06

9. Conclusions

For all the air velocity values $|E_n| < 1$. This indicates the general agreement between the results of Jormita OY and Testing Centre, University of Tartu. However, the biggest differences between the results are in the air velocity range (0.6…4) m/s. This can be partly explained by probably too high differential pressure values of the micromanometer used at TCUT.

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