Influence of mounting tube diameter on anemometer output

MEASNET Anemometer Calibration Expert Group

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Introduction

In March 2017 a new edition of the IEC 61400-12-01 [1] international standard for wind energy generation systems was released. In Annex G2: Single top-mounted ane-mometer and G4: Side mounted instruments, it specifies:

“The anemometer shall be mounted on a round vertical tube of the same (± 0,1 mm) outer diameter as used during calibration (and classification), but of no larger diameter than the body of the anemometer.”

The ± 0.1 mm diameter specification requires a disproportional increase in complexity in design, procurement and stock-keeping of meteorological masts and their calibrated instrumentation.

Deutsche WindGuard Wind Tunnel Services GmbH which is a member of the MEASNET expert group for anemometer calibration has performed a parameter study in the beginning of 2018 to assess the influence of varying mounting pipe diameters upon wind tunnel calibration results for three commonly used cup anemometer types [2]; Note detailed information: [REPORT: Influence of mounting tube diameter on anemometer output.]

1 Test procedure

Each combination of anemometer model and mounting pipe diameter was tested for five consecutive calibration runs following MEASNET / IEC 61400-12-1 standard in the specified speed range of 4 m/s – 16 m/s. The installation of different mounting pipe sizes was performed in an alternating manner (e.g. 24.0, 26.9, 25.0 …).

The selected pipe diameters in this study are located in a range well below and above the 0.1mm specification in relation to the recommended mounting pipe diameter. Tests with the actual manufacturer's recommended mounting pipe diameter have also been performed.

In additional surveys an enlarged pipe size was also selected that corresponds to the outer diameter of the anemometer body.

1.1. Setup

Table 1 shows the selection of different mounting pipes manufactured for this survey in combination with the associated test specimen. The rotor plane for all tests was always located in the centre of the test section (1000 mm x1000 mm) at a height of 500 mm above the test section base plate.

Table 1 Tested anemometer types and corresponding mounting pipe diameters.
1) recommended pipe size; 2) same pipe diameter as anemometer body

Sensor	Pipe diameter / mm
WindSensor P2546A-OPR	24.0
	25.01)
	25.4
	26.0
	26.9
	46.02)
Windspeed A100L2	24.0
	25.0
	25.41)
	26.0
	26.9
	37.62)
Thies First Class Advanced 4.3351.00.000	33.0
	33.5
	33.71)
	34.0
	35.0
	50.02)

2 Results

2.1. WindSensor P2546A-OPR

The calibration results for diameters between 24.0 mm and 26.9 mm show a maximum variation ranging -0.04 % through +0.03 %. The results seem to have an arbitrary dis-tribution, which is not related to the tube diameter (Figure 1).

Only the results for an enlarged diameter of 46.0 mm, shows an influence due to the increased tube diameter. The deviation compared to the mean value of the recom-mended diameter (Ø 25.4 mm) size is about 1.1 %.

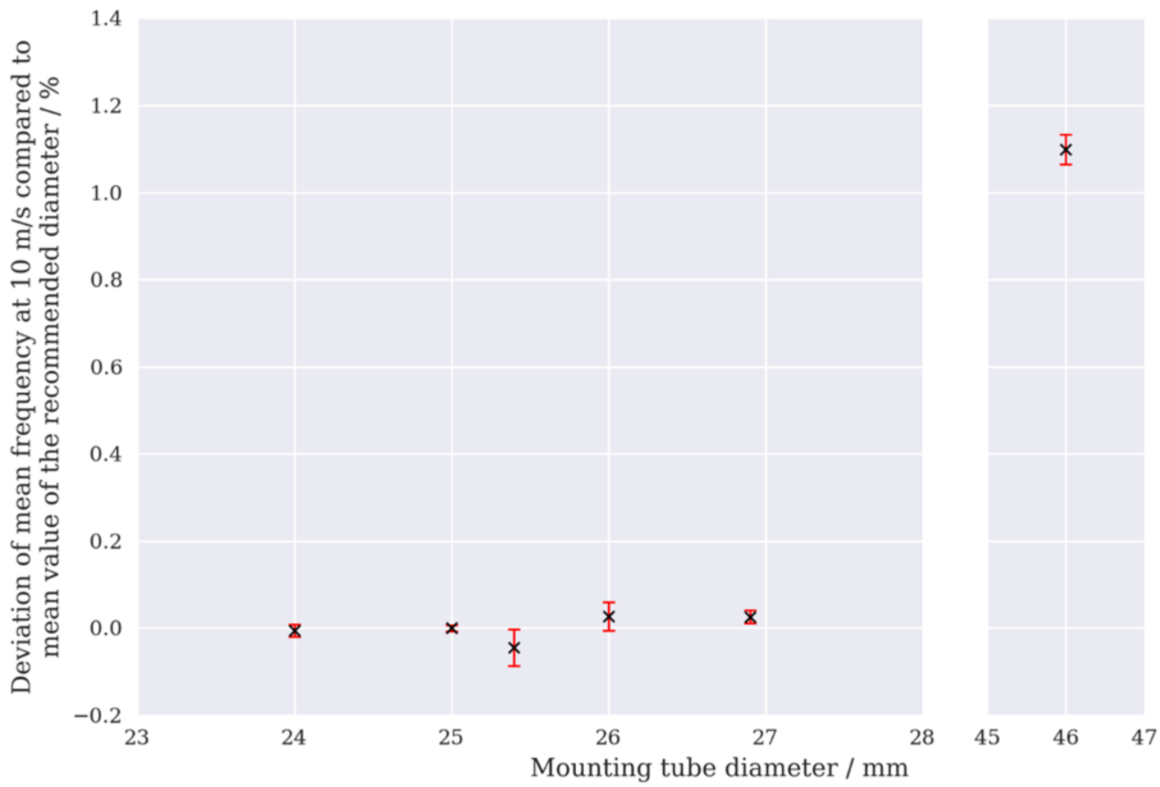

Figure 1: Deviation of the mean frequency at 10 m/s compared to the mean value at the recommended diameter for the WindSensor P2546A-OPR anemometer. The error bars indicate the standard deviation for each of the 5 measurements.

2.2. WindSpeed A100L2

The calibration results for diameters between 24.0 mm and 26.9 mm show a maximum variation of 0.22%. The results seem to have an arbitrary distribution, which is not related to the tube diameter (Figure 2).

Only the results for an enlarged diameter of 37.6 mm, shows an influence due to the increased tube diameter. The deviation compared to the mean value of the recommended diameter (Ø 25.4 mm) size is about 1.24 %.

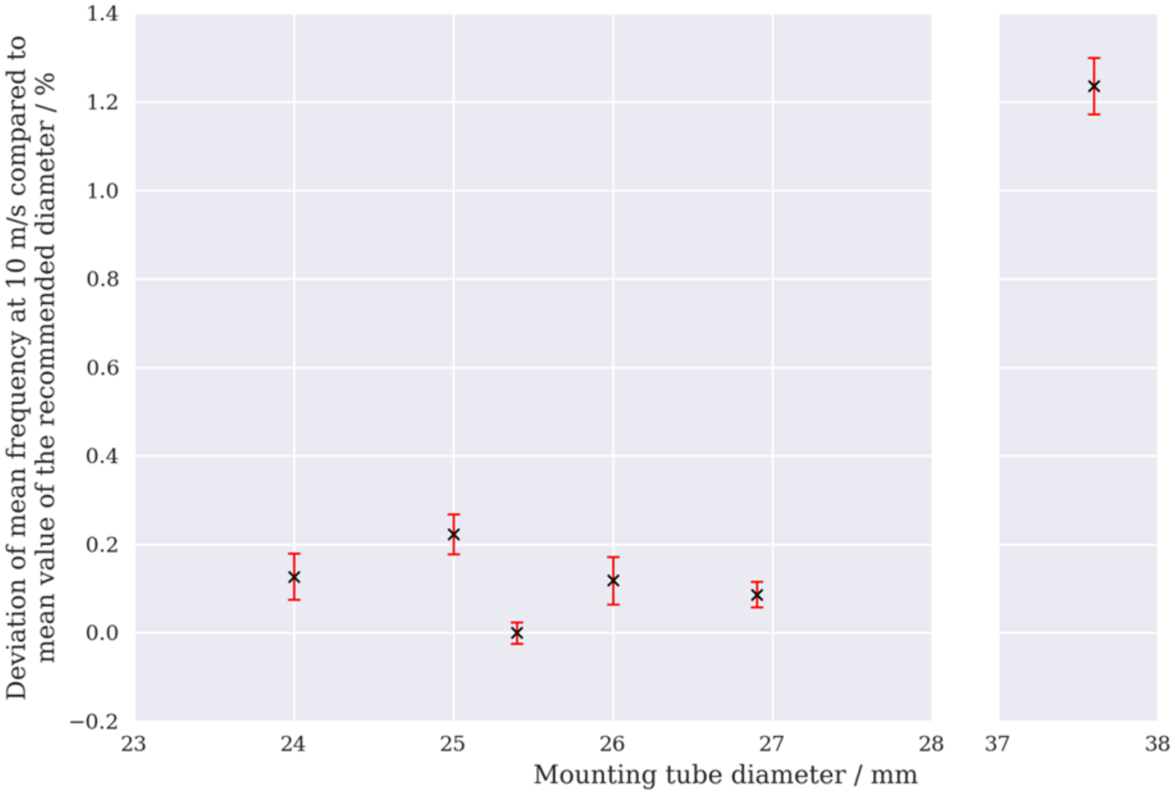

Figure 2: Deviation of the mean frequency at 10 m/s compared to the mean value of the recommended diameter size for the Windspeed A100L2 anemometer. The error bars indicate the standard deviation for each of the 5 measurements.

2.3. Thies First Class Advanced

The calibration results for diameters between 33.0 mm and 35.0 mm show a maximum variation of 0.04%. The results seem to have an arbitrary distribution, which is not related to the tube diameter (Figure 3).

Only results for an enlarged diameter of 50.0 mm show a slight influence due to the increased tube diameter. The deviation compared to the mean value of the recommended diameter (Ø 33.7 mm) size is about 0.15 %.

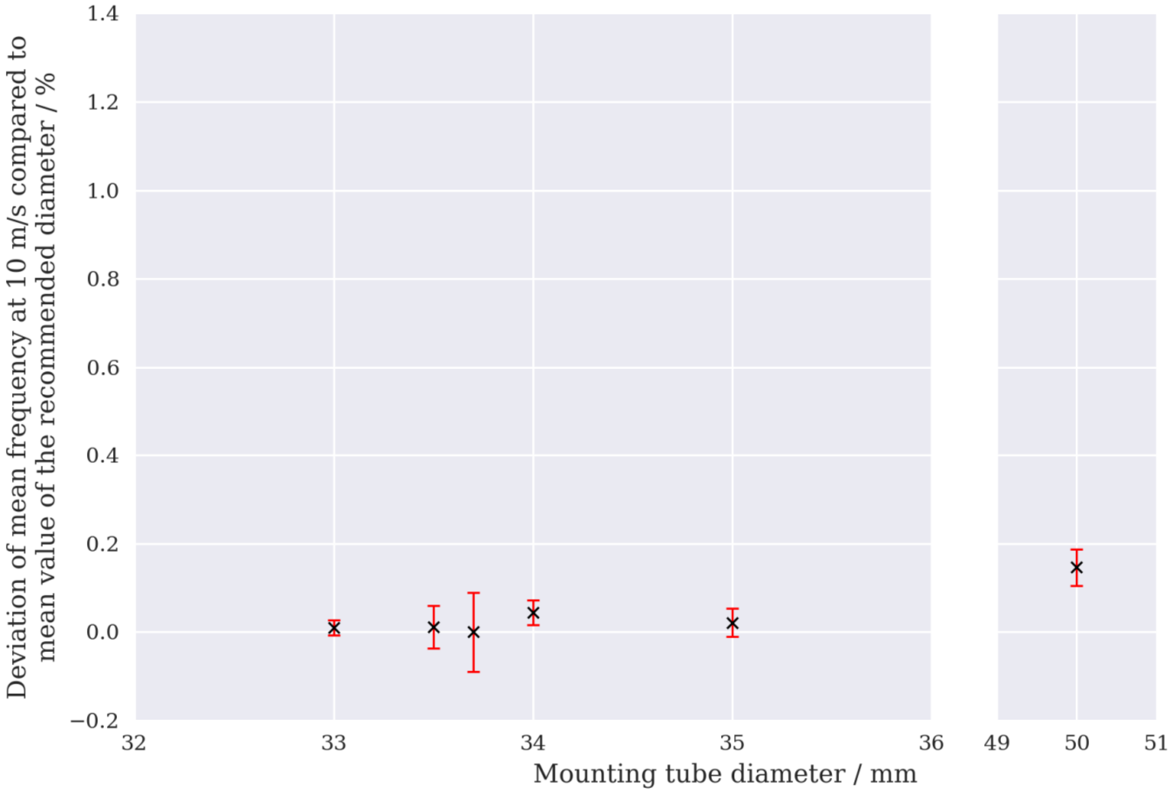

Figure 3: Deviation of the mean frequency at 10 m/s compared to the mean value of the recommended diameter size for the Thies First Class Advanced anemometer. The error bars indicate the standard deviation of the 5 measurements.

3 Concluding Statement

Based on the detailed tests performed by the MEASNET expert group member Deutsche WindGuard Wind Tunnel Services GmbH for a representative sample of widely used cup anemometer models, the MEASNET Expert Group for Anemometer Calibration states that there is no evidence that a variation of mounting pipe diameters by up to ± 1 mm will lead to a bias in wind tunnel calibration results outside the normal scatter.

Consequently, the strict requirement for a maximum permitted tolerance of ± 0.1 mm (Annex G, IEC 61400-12-1, Ed.2) for the mounting tube diameter during calibration/classification/field application does not seem to improve the uncertainty related to open field wind speed measurements.

4 References

[1] IEC 61400-12-1, Edition 2.0, WIND TURBINE GENERATOR SYSTEMS, Power performance measurements of electricity producing wind turbines, March 2017

[2] A. Roß, VT180177_01_Rev0, Influence of mounting tube diameter on anemometer output, April 2018

REPORT: Influence of mounting tube diameter on anemometer output

[3] MEASNET, ANEMOMETER CALIBRATION PROCEDURE Version 2, October 2009