ANEMOMETERS, LOW VELOCITY:
NATURAL CONVECTION FROM HEATED SENSORS, ERRORS

Key words: Anemometers, heated sensors, errors

1. SCOPE
The scope of the method is to determine the error in velocity reading induced by natural convection from heated sensor elements of anemometers intended for recording low velocities. At low velocities natural convection from heated sensors will give rise to an error which is dependent on the direction of the flow. The error is largest for flow directions opposite to the direction of the natural convection.

2. FIELD OF APPLICATION
The method is intended to be applied to those velocity transducers that are designed to be used for recording velocities in ventilated rooms.

3. REFERENCES

4. DEFINITIONS

5. SAMPLING
The instrument used in the test should be selected in such a way that it is representative of the population to be tested.

6. METHOD OF TEST
6.1 Principle
The test is accomplished by inserting the sensor into a wind tunnel which may be tilted so that the direction of its axis is changed in a vertical plane.

6.2 Apparatus
A sketch of an apparatus is shown in Fig. 6.2. The wind tunnel is of opencircuit type.

Figure 6.2. Example of a test rig.

6.2.1 Components of test rig
The apparatus consists of the following parts and units:
- Stand
- Pivot
- Tube
- Fan with a speed control
- Flow straightener (Pressure block)
- Static pressure ports
- Screens
- Working section
- Holder for the transducer.
Flow Direction

The measurements in Fig. 6.3 are only examples of suitable dimensions. However, it is important that the diameter of the wind tunnel is sufficiently large so that blockage effects are avoided.

The inside surface of the wind tunnel shall be made aerodynamically smooth without any irregularities. The screens are installed in order to smooth out disturbances.

6.3 Preparation of test samples

In general the procedure described in Ref. 1 shall be followed.

6.4 Procedure

In the ambient outside the wind tunnel the temperature difference is recorded between the levels corresponding to the heights of the ends of the wind tunnel when orientated vertically.

- The fan is turned on and the measurement starts when the equilibrium temperature has been established.
- The transducer is placed in the air stream near the centre of the air stream. The axis of the transducer shall be aligned with the mean air flow direction and with an angular deviation not exceeding the manufacturer’s specification. The transducer shall be firmly attached to the holder so that the position of the transducer is not changed when the wind tunnel is tilted.
- The desired velocity is set by adjusting the speed of the fan and reading the pressure drop across one or more of the pressure blocks. The pressure is recorded with a differential pressure transducer and the velocity is obtained from a calibration curve which gives the pressure drop versus velocity.
- The velocity output from the instrument is recorded and plotted against actual velocity.

The measurements are carried out for three orientations of the axis (flow directions) of the wind tunnel:

- Horizontal
- Vertical flow directed downwards
- Vertical flow directed upwards

If the instrument does not show the velocity directly but has an output signal that is proportional to the electrical power supplied to the sensor (which is often the case for laboratory type instruments), this signal may also be used.

6.5 Expression of results

The velocities (or the power supply) recorded in the three directions are plotted in a graph, see Fig. 6.5a or 6.5b.

The effect of the natural convection at a given (true) velocity may be expressed as the difference between the velocity recorded in the vertical air stream directed upwards and the velocity recorded when the vertical air stream is directed downwards. Alternatively one may take the difference between the velocities recorded in the vertical air streams and the velocity recorded in the horizontal air stream.

6.6 Accuracy

The determinant for accuracy of the method is equal speed at the three orientations of the wind as given in Section 6.4. The quality of the velocity profile is not determinant if the velocity transducer is held at a fixed position when exposed to the air stream.
Figure 6.5a. Example of recorded velocity versus actual velocity for three orientations of the wind tunnel.

Figure 6.5b. Examples of power supplied to sensor versus actual velocity for three orientations of the wind tunnel.

6.7 Test report

The test report should include the following information, if relevant:

a) Name and address of the testing laboratory
b) Identification number of the test report
c) Name and address of the organisation or person who requested the test
d) Purpose of the test
e) Method of sampling and other circumstances (date and person responsible for sampling)
f) Name and address of manufacturer or supplier of the objects to be tested
g) Name or other identification marks of the object to be tested
h) Description of the object to be tested
i) Date of supply of the object to be tested
j) Date of the test
k) Test method
l) Conditioning of the test specimens, environmental data during the test (temperature, pressure, relative humidity, etc)
m) Identification of the test equipment and instruments used
n) Any deviations from the test method
o) Test results (SI units)
p) Inaccuracy or uncertainty of test results
q) Date and signature