

COOLING TOWER INSTITUTE

Recommended Practice For Airflow Testing of Cooling Towers



FOREWORD

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The following procedures are intended to document the conventional methods of measuring airflow. We realize that there are much more highly technical methods available. We also realize that our members have varied needs, some simple, some extremely demanding. This treatise is intended to assist the greatest number of people to be knowledgeable of several current techniques to measure the airflow from their fans. We hope it will be helpful.



Airflow Testing of Cooling Towers

There are two basic instruments for airflow testing of cooling towers: Anemometer or pitot tube. The purpose of each is to measure the velocity at a point. After a number of points are measured to obtain a representative or average velocity, the total airflow is calculated using the net discharge area of the fan. Each of these instruments is discussed below.

1. Anemometer

The anemometer is basically a calibrated propeller. As the air turns the propeller, its speed of rotation is counted mechanically or electrically.

- 1.1 The oldest design is a vane anemometer, which measures the linear feet, or meters of air moving through it and provides a mechanical readout. When combined with a unit of time (usually 30 sec. or one minute), the velocity in feet per minute can be computed. In use, the anemometer is held in the air stream on a pole at the prescribed spot. A timer calls "start", and the operator pulls a string to start the anemometer. At 30 seconds, for example, the timer calls "stop". The operator stops the reading, retrieves the anemometer, reads the thousands, hundreds and unit counts. He records the reading, resets the counter and moves to the next spot. The readings are later adjusted using a calibration curve and doubled to give a feet per minute reading. As you can see, this instrument is clumsy and takes two skilled people to make repeatable measurements. Note that if a "yaw" measurement were needed, the operator would have to read or estimate and record the yaw angle as well as the counter reading for each spot.
- 1.2 Today there are many electronic direct reading anemometers available although accuracy and moisture resistance varies with cost. A typical instrument displays velocity in Ft./Min. or M/S and temperature °F or °C. It can average many readings over typically 2 or 16 second intervals and can store readings in its memory which can later be downloaded through a standard RS232L interface into a computer.
- 1.3 An upscale version would be a propeller anemometer which has a digital readout based on an analog D.C. voltage proportional to the wind velocity. This is an unshrouded propeller with a tiny generator which can be attached to a pole with a standard 3/4" NPT (pipe) thread.
- 1.4 Propeller anemometers are available as small as 1" diameter to 8 or 9" diameter, shrouded or

unshrouded. Generally the larger the diameter the more accurate the measurement and less the sensitivity to the swirl or yaw effect.

2. Pitot Tube

The pitot tube measures velocity pressure as the difference between total and static pressure at a point. This pressure is measured with an inclined monometer or an electronic pressure transducer. Temperature must also be measured so the density at each point can be computed. Once density and velocity pressure are measured at a point, the velocity can be computed by the formula:

$$V = 1096.2 * C * (VP/D)^{1/2}$$

Where 1096.2 = Unit conversion factor
C = Pitot tube calibration coefficient
VP = Local velocity pressure (inches - H₂O)
V = Local velocity (ft/min)
D = Local Air Density (lbm/ft³)

For wet towers a special pitot tube with larger than normal holes in the nose is required. The purpose of the large holes is to prevent water droplets from clogging the tube, causing erroneous readings.

There are several types of pitot tubes available, some are very sophisticated for high velocity measurements. For our general purposes, velocity pressures will typically be less than 0.5 inches-H₂O.

For fan testing in moist air, the Prandtl type design is recommended. However, other types could also be adapted for cooling tower use.

A pitot tube developed for cooling tower use should first be calibrated against a well designed pitot tube in a dry air situation. ASME PTC 19.2 - 1987, Part 2 describes a method of calibration of a pitot tube. This will allow any correction factors necessary to account for the true performance of the modified tube to be determined.

2.1 Pressure Measurement

The velocity pressures which must be measured in a cooling tower application are typically less than 0.5 in-H₂O. Impact and static pressures are somewhat higher and can occasionally exceed 1.0 in-H₂O. Their pressures fluctuate rapidly due to the turbulence of the flow and the proximity of the measurement to the fan blades. This makes some method of dampening advisable. This can be accomplished by using a porous-plug damper in the capillary tube of the manometer or using

