The Relationship Between Air Velocity, Temperature and Pressure

KANOMAX
The Ultimate Measurements

Technical Note

Stick your hand in front of a fan or out a car window while the vehicle is in motion and you'll feel the air blowing against your hand. The air flow pushes against your skin with a tangible force that will increase as the fan spins faster or the car accelerates. The fact that the air "pushes" harder against your hand as it moves faster is an easy concept to demonstrate and to understand, however what isn't as simple to explain is that the speed of the air isn't the only factor that affects the amount of force you feel. This is partly due to the fact that your hand makes a pretty poor anemometer since it isn't sensitive enough to pick up subtle changes in airflow. Let's imagine for a minute that your hand is a sensitive anemometer though and explore these other factors with this analogy.

The faster the fan spins the greater the force applied by the airflow it generates

There are two other factors at play when you stick your hand in front of the fan or out the car window. The first is temperature. If your hand was sensitive enough you would notice a difference in the force the air flow applies to it on cold days versus warm days. This is easier to visualize with different analogy. Imagine you have a vat of honey or other thick liquid. Now picture yourself stirring the honey with a spoon. The honey is thick so you're going to meet resistance as you stir. If we start to heat the honey though you will notice it becomes easier to stir as it warms. Conversely if we start to lower the temperature of the honey as you stir you will notice the resistance increase. This is generally true of most materials, including air! While temperature changes will not affect the density of air to the same degree it affects honey it still has an impact, albeit a subtle one you probably can't detect with just your bare hand.

The second factor that will affect the force of the air is pressure. We can continue with the hand analogy for this, but let's switch fluids from air to water. Let's stick your hand under a running shower for a minute. You'll feel the water droplets gently hitting your hand and running over the surface of your skin. Now let's take your hand out of the shower and put it in front of a garden hose with a tight spray pattern. You can still feel the water droplets, but they're not so gentle any more coming out of that hose! Assuming the water in the shower and the hose was at the same exact temperature the change in the force of the water against your hand in this case is due to the change in pressure. Pressuring the water increases the amount of force it can generate even if we don't change the volume or temperature of the water used. Atmospheric pressure has a similar affect on air, but again your hand is not sensitive enough to notice this change.

Both changes in temperature and pressure relate to the density or the air and in order to get an accurate measurement of airflow it's necessary to compensate for these variables. If your anemometer or other airflow measuring instrument isn't calculating these factors then it isn't giving you an accurate airflow reading.

Part of what makes Kanomax's airflow instruments so accurate is the a second sensor that detects and compensates for changes in temperature. Most high-grade anemometers have a similar sensor, but Kanomax takes it a step further. The temperature compensation sensor on our anemometers is calibrated separately from the air velocity sensor to ensure it's accuracy. Most of our competitors don't bother to calibrate the temperature compensation sensor and as a result their units are not as accurate. This calibrated temperature compensation sensor is standard on all our thermal anemometers.

This year we're pleased to announce the addition of an on-board barometric pressure compensation sensor to the Climomaster. Prior to this it was necessary to account for barometric pressure using formulas which meant a bit of extra work and introduced a chance for human error compromising measurement results. With the addition on the on-board pressure sensor the Climomaster now has the ability to do the math for you eliminating the extra work and the chance of human error. The instrument can be setup to automatically detect barometric pressure (recommended for most locations) or you can enter the pressure yourself if desired (included for maximum accuracy in rare situations where the specific gas constant for dry air may vary slightly because of the molecular composition of air at the particular location.)

Density Correction Formula

$$V1 = P0/P1 \times Vm$$

- **V1 = Velocity corrected for density**
- **P0 = Standard Barometric Pressure 1013 hPA**
- **P1 = Actual barometric pressure as measured by the instrument**
- **Vm = Velocity as measured by the instrument**

With it's impressive 2% accuracy reading for air velocity the Climomaster was already the most accurate thermal anemometer in the world. The addition of an on on-board barometric pressure sensor has made it an even more accurate and reliable instrument. Other features that make the Climomaster the top pick for high-end applications include: 8 interchangeable probes, automatic flow rate calculation function, storage for up to 20,000 measurements and simultaneously measurements of air velocity, air temperature, relative humidity, and airflow rate. Check out our website for specifications or give us a call if you need a hand with your specific application.

Climomaster - 2% accuracy, now with automatic barometric pressure compensation

About Kanomax USA, Inc.

Kanomax has delivered the best measurement solutions in its products and services that adapt precision measurement technology for fluids and particles. Kanomax product lines include anemometers, particle counters, dust monitors, and IAQ monitors. Kanomax is contributing to technological innovation and quality improvement for the processes of quality management, environment management, and technology development in the areas of environment, health , and energy, which are essential to sustain human well-being, as well as in other industrial areas including automobile, aerospace, semiconductor, electronics manufacture, heavy industry, steel, shipbuilding, pharmaceutical, biotechnology, food-processing, medical, construction, and civil engineering.

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