2023Q6 SONIC ANEMOMETERS

Salutations everyone! Last week we talked about wind turbine tower sections, this week we are taking it a step higher with sonic anemometers.

An anemometer is a device used to measure wind speed. There are several different types of anemometers, with the most common being cup, vane, or sonic anemometers. Pictures of a cup and vane anemometer are shown below.

Figure 1: Vane Anemometer (left) and Cup Anemometer (right)

A cup anemometer usually has several arms with cups on the end. The cups are spun by the wind and the anemometer calculates wind speed by converting the rotations of the cups over a period of time into a velocity. A vane anemometer is similar except it looks more like a fan and has a tail that points in the direction the wind is blowing. The blades of the vane anemometer spin as they are blown by the wind. These rotations over a period of time are then converted into a velocity.

Unlike cup and vane anemometers, sonic anemometers do not have any moving parts. They use sound to measure wind speed. A sonic anemometer usually has two to three transducers. A transducer is an electronic device that converts between forms of energy. These transducers act as both transmitters and receivers. Sound waves are transmitted from each transducer. The frequency of the sound waves is measured as they are received at the other transducers. A picture of a sonic anemometer is shown below.

Figure 2: Sonic Anemometer[1]

Using the time it takes for sound to travel between transducers and the distance between transducers, the sonic anemometers are able to calculate the speed of the wind passing through the transducer setup. For a two-transducer system, this is represented by the system of equations below.

$$v_{12} = v_s + v_w$$

$$v_{21} = v_s - v_w$$

Where v_{12} and v_{21} are the velocity of sound between transducers, v_s is the speed of sound, and v_w is the wind speed.

Now that we know a little more about sonic anemometers, let's dive into our questions!

Level 1: For a two-transducer sonic anemometer, calculate the wind speed if it takes 0.8 milliseconds to travel from transducer 1 to transducer 2 and 0.9 milliseconds to travel from transducer 2 to transducer 1 . The distance between transducers is 30 cm.

Level 2: Reflect on the differences between the types of anemometers. Think of some pros and cons of each type.

[1] https://www.fondriest.com/young-ultrasonic-3d-anemometers.htm