THE
ATMOSPHERIC RESERVOIR
Examining the Atmosphere and Atmospheric Resource Management

"Not Just Hot Air"

By Mark D. Schneider

Summer is right around the corner and we should prepare for the hot, humid air that accompanies it. Many people describe this air as feeling "heavy" or "weighing them down." In reality, this warm, moist air is actually lighter than the cold, dry air North Dakota experiences during much of the year. We're usually more fatigued in hotter weather and drink more water because our bodies are trying to regulate their temperatures and cool us down by perspiring.

A chemistry lesson reveals that the molecular mass of water or H_2O is 18g/mol, whereas the molecular mass of dry air is typically around 29 g/mol. According to Avogadro's law: under the same condition of temperature and pressure, equal volumes of all gases contain the same number of molecules. This means that if water molecules are added to a known volume of air, an equal amount of dry air molecules must leave in order to keep the pressure and temperature constant. When water vapor is added to dry air, the result is a decrease in the air's density.

This has implications for outdoor activities such as sports where a ball or object is kicked, batted or thrown through the air. Imagine a baseball game where it's the bottom of the ninth and all bases are loaded. A home run is needed to win the game and magically the batter has the choice of whether to hit the ball on a hot, sticky summer day or wait until Autumn when cooler, dry air is in place. It would be easier to clear a home run over the outfield wall on a hot, humid day, than on a cool, dry Autumn day. There is literally less resistance on the ball as it travels through the less dense air. Air density also decreases with altitude, so a baseball game played in Denver, Colorado on a hot, humid day would give the batter an even greater advantage.

There are other benefits to decreased air density. Everyone wants better gas mileage from their vehicles and you often hear of people complaining about poor mileage during the winter months. This has to do with fuel additives such as ethanol and methanol, but is also due to the increase in air density. As you drive, the cold, dense air creates more resistance on your vehicle and causes a decrease in gas mileage. There are additional factors, especially in older vehicles with manual carburetors, such as the air/fuel mixture that determine efficiency and gas mileage. This mixture of air and fuel changes significantly with respect to air density and this determines the overall efficiency of an engines' combustion and performance.

There are occasions where increased air density is desirable. For example, North Dakota's wind industry benefits from increased air density, which results in a substantial increase in the generation of electricity. Wind turbines produce more electricity from dry, dense air than warm, moist air with wind speeds being equal. Imagine dry, dense air making contact with the turbines on a windmill and "pushing" against them with more force. Both North Dakota and Oklahoma are known for their windy climates and are almost identical in size, but North Dakota has approximately 60% more wind energy potential due to the frequency of cold, dense air in our state.

Air density can be used to benefit us in many different ways. If you ask a scientist, they'll tell you that it's not just "hot air".

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