AIR DENSITY AS APPLIED TO FUEL/AIR RATIOS

Application Note **14**

For WeatherLink as it Relates to Internal Combustion Engines

Introduction

This application note discusses air density as applied to fuel/air ratios in internal combustion engines.

Internal combustion engines operate at their peak efficiency (producing the most power or using the least fuel) when the correct ratio of oxygen and fuel are introduced into the combustion chamber. The carburetor jets (or fuel injector setting) control the ratio of how much fuel is introduced into a given airflow. Carburetors do not automatically compensate for changes in the amount of oxygen in that airflow and therefore changes in oxygen concentrations can result in inefficient operation. Changes in the oxygen content of air result from changes in the weather (barometric pressure, temperature, and humidity).

Measuring oxygen concentration in air is difficult; other measures are commonly used to estimate oxygen content. For example, determining changes in the density of the air (i.e., how much a given volume of air weighs) can produce a reasonable estimate of changes in oxygen concentration.

WeatherLink Air Density

The formula used to calculate air density in the WeatherLink® software requires measures of absolute pressure (barometric pressure uncorrected for altitude), relative humidity, and temperature. WeatherLink uses the barometer value as indicated and reports the result in lb./ft^3 or kg/m^3.

Obtaining Absolute Pressure:

- To obtain absolute pressure on a Monitor II® or Perception II®, change the weather station type to a Perception II station.
- For a Vantage Pro®, Vantage Pro2™, or Vantage VUE® system, set the elevation to zero and clear any barometer offsets. Then, perform a download to obtain the latest data.

Consult the appropriate instruction manual or the WeatherLink Help file for details.

$$\text{Air Density (in Kg/m}^3\text{)} = 1.2929 \times \frac{273.13}{(T + 273.13)} \times \frac{(AP - (SVP \times RH))}{760}$$

Where

T = Temperature in Celsius
AP = Absolute Pressure (mm of Hg)
SVP = Saturation Vapor Pressure of air over water at temp T (see Table 1)
RH = Relative Humidity (decimal)

T	SVP	T	SVP	T	SVP	T	SVP	T	SVP
0	4.58	10	9.21	20	17.55	30	31.86	40	55.40
1	4.92	11	9.85	21	18.66	31	33.74	41	58.42
2	5.29	12	10.52	22	19.84	32	35.70	42	61.58
3	5.68	13	11.24	23	21.09	33	37.78	43	64.89
4	6.10	14	11.99	24	22.40	34	39.95	44	68.35
5	6.54	15	12.79	25	23.78	35	42.23	45	71.97
6	7.01	16	13.64	26	25.24	36	44.62	46	75.75
7	7.51	17	14.54	27	26.77	37	47.13	47	79.70
8	8.04	18	15.49	28	28.38	38	49.76	48	83.83
9	8.61	19	16.49	29	30.08	39	52.51	49	88.14

Table 1: Saturation Vapor Pressure at Different Temperatures.

One must develop “rules of thumb” to use air density effectively in tuning carburetors for optimal performance. One such rule of thumb is that a five percent (5%) change in air density may require re-adjustment of the carburetor jetting. High air density readings indicate more oxygen in the air, thus more fuel is needed (richer tune), while low readings indicate less oxygen, requiring less fuel (leaner tune). Also, this formula subtracts the water vapor content of the air from the total air pressure, which may not be appropriate for other applications.

Document Part Number: 93004.314
Rev: C (July 29, 2010)
For all stations except Wizard, GroWeather, Health and Energy with WeatherLink version 5.9 and later

Davis Instruments
3465 Diablo Avenue, Hayward, CA 94545-2778 U.S.A.
510-732-9229 • Fax: 510-732-9188
E-mail: info@davisnet.com • www.davisnet.com