VPD & INDOOR GROWING
WHITE PAPER

QUEST

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	VPD
Low Transpriation/Propagation/Early Veg	0.4-0.8
Healthy Transpriation/Late Veg/Early Flower	0.8-1.2
High Transpiration/Late Flower	1.2-1.6
Danger Zone	<0.4 / >1.6

VPD when leaves are 1C cooler than air temperature

Relative Humidity (%)

Air Temp (F/C)	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61
50/10	0.15	0.17	0.18	0.19	0.20	0.21	0.23	0.24	0.25	0.26	0.28	0.29	0.30	0.31	0.33	0.34	0.35	0.36	0.37	0.39	0.40
51.8/11	0.17	0.18	0.19	0.20	0.22	0.23	0.24	0.26	0.27	0.28	0.30	0.31	0.32	0.34	0.35	0.36	0.37	0.39	0.40	0.41	0.43
53.6/12	0.18	0.19	0.20	0.22	0.23	0.25	0.26	0.27	0.29	0.30	0.32	0.33	0.35	0.36	0.37	0.39	0.40	0.42	0.43	0.44	0.46
55.4/13	0.19	0.20	0.22	0.23	0.25	0.26	0.28	0.29	0.31	0.32	0.34	0.35	0.37	0.38	0.40	0.41	0.43	0.44	0.46	0.47	0.49
57.2/14	0.20	0.22	0.24	0.25	0.27	0.28	0.30	0.31	0.33	0.35	0.36	0.38	0.39	0.41	0.43	0.44	0.46	0.47	0.49	0.51	0.52
59/15	0.22	0.23	0.25	0.27	0.29	0.30	0.32	0.34	0.35	0.37	0.39	0.40	0.42	0.44	0.46	0.47	0.49	0.51	0.52	0.54	0.56
60.8/16	0.23	0.25	0.27	0.29	0.31	0.32	0.34	0.36	0.38	0.40	0.41	0.43	0.45	0.47	0.49	0.51	0.52	0.54	0.56	0.58	0.60
62.6/17	0.25	0.27	0.29	0.31	0.33	0.35	0.37	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64
64.4/18	0.27	0.29	0.31	0.33	0.35	0.37	0.39	0.41	0.43	0.45	0.47	0.49	0.51	0.53	0.55	0.58	0.60	0.62	0.64	0.66	0.68
66.2/19	0.28	0.31	0.33	0.35	0.37	0.39	0.42	0.44	0.46	0.48	0.50	0.53	0.55	0.57	0.59	0.61	0.64	0.66	0.68	0.70	0.72
68/20	0.30	0.33	0.35	0.37	0.40	0.42	0.44	0.47	0.49	0.51	0.54	0.56	0.58	0.61	0.63	0.65	0.68	0.70	0.72	0.75	0.77
69.8/21	0.32	0.35	0.37	0.40	0.42	0.45	0.47	0.50	0.52	0.55	0.57	0.60	0.62	0.65	0.67	0.70	0.72	0.75	0.77	0.80	0.82
71.6/22	0.35	0.37	0.40	0.42	0.45	0.48	0.50	0.53	0.56	0.58	0.61	0.64	0.66	0.69	0.72	0.74	0.77	0.79	0.82	0.85	0.87
73.4/23	0.37	0.40	0.42	0.45	0.48	0.51	0.54	0.56	0.59	0.62	0.65	0.68	0.71	0.73	0.76	0.79	0.82	0.85	0.87	0.90	0.93
75.2/24	0.39	0.42	0.45	0.48	0.51	0.54	0.57	0.60	0.63	0.66	0.69	0.72	0.75	0.78	0.81	0.84	0.87	0.90	0.93	0.96	0.99
77/25	0.42	0.45	0.48	0.51	0.54	0.58	0.61	0.64	0.67	0.70	0.73	0.77	0.80	0.83	0.86	0.89	0.92	0.96	0.99	1.02	1.05
78.8/26	0.44	0.48	0.51	0.55	0.58	0.61	0.65	0.68	0.71	0.75	0.78	0.81	0.85	0.88	0.92	0.95	0.98	1.02	1.05	1.08	1.12
80.6/27	0.47	0.51	0.54	0.58	0.62	0.65	0.69	0.72	0.76	0.79	0.83	0.87	0.90	0.94	0.97	1.01	1.04	1.08	1.11	1.15	1.19
82.4/28	0.50	0.54	0.58	0.62	0.65	0.69	0.73	0.77	0.81	0.84	0.88	0.92	0.96	0.99	1.03	1.07	1.11	1.15	1.18	1.22	1.26
84.2/29	0.54	0.58	0.62	0.66	0.70	0.74	0.78	0.82	0.86	0.90	0.94	0.98	1.02	1.06	1.10	1.14	1.18	1.22	1.26	1.30	1.34
86/30	0.57	0.61	0.65	0.70	0.74	0.78	0.82	0.87	0.91	0.95	0.99	1.04	1.08	1.12	1.16	1.21	1.25	1.29	1.33	1.37	1.42
87.8/31	0.60	0.65	0.69	0.74	0.78	0.83	0.87	0.92	0.96	1.01	1.05	1.10	1.14	1.19	1.23	1.28	1.32	1.37	1.41	1.46	1.50
89.6/32	0.64	0.69	0.74	0.78	0.83	0.88	0.93	0.97	1.02	1.07	1.12	1.16	1.21	1.26	1.31	1.35	1.40	1.45	1.50	1.54	1.59
91.4/33	0.68	0.73	0.78	0.83	0.88	0.93	0.98	1.03	1.08	1.13	1.18	1.23	1.28	1.33	1.38	1.43	1.48	1.54	1.59	1.64	1.69
93.2/34	0.72	0.77	0.83	0.88	0.93	0.99	1.04	1.09	1.15	1.20	1.25	1.31	1.36	1.41	1.47	1.52	1.57	1.63	1.68	1.73	1.78
95/35	0.76	0.82	0.88	0.93	0.99	1.05	1.10	1.16	1.21	1.27	1.33	1.38	1.44	1.50	1.55	1.61	1.66	1.72	1.78	1.83	1.89
96.8/36	0.81	0.87	0.93	0.99	1.05	1.11	1.17	1.23	1.29	1.34	1.40	1.46	1.52	1.58	1.64	1.70	1.76	1.82	1.88	1.94	2.00
98.6/37	0.86	0.92	0.98	1.05	1.11	1.17	1.23	1.30	1.36	1.42	1.49	1.55	1.61	1.67	1.74	1.80	1.86	1.92	1.99	2.05	2.11
100.4/38	0.91	0.97	1.04	1.11	1.17	1.24	1.31	1.37	1.44	1.50	1.57	1.64	1.70	1.77	1.84	1.90	1.97	2.03	2.10	2.17	2.23
102.2/39	0.96	1.03	1.10	1.17	1.24	1.31	1.38	1.45	1.52	1.59	1.66	1.73	1.80	1.87	1.94	2.01	2.08	2.15	2.22	2.29	2.36

Air Temp (F/C)	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39
50/10	0.41	0.42	0.44	0.45	0.46	0.47	0.48	0.50	0.51	0.52	0.53	0.55	0.56	0.57	0.58	0.60	0.61	0.62	0.63	0.64	0.66	0.67
51.8/11	0.44	0.45	0.47	0.48	0.49	0.51	0.52	0.53	0.55	0.56	0.57	0.58	0.60	0.61	0.62	0.64	0.65	0.66	0.68	0.69	0.70	0.72
53.6/12	0.47	0.49	0.50	0.51	0.53	0.54	0.56	0.57	0.58	0.60	0.61	0.63	0.64	0.65	0.67	0.68	0.70	0.71	0.72	0.74	0.75	0.77
55.4/13	0.50	0.52	0.53	0.55	0.56	0.58	0.59	0.61	0.62	0.64	0.65	0.67	0.68	0.70	0.71	0.73	0.74	0.76	0.77	0.79	0.80	0.82
57.2/14	0.54	0.55	0.57	0.59	0.60	0.62	0.63	0.65	0.67	0.68	0.70	0.71	0.73	0.75	0.76	0.78	0.79	0.81	0.83	0.84	0.86	0.87
59/15	0.58	0.59	0.61	0.63	0.64	0.66	0.68	0.69	0.71	0.73	0.75	0.76	0.78	0.80	0.81	0.83	0.85	0.87	0.88	0.90	0.92	0.93
60.8/16	0.61	0.63	0.65	0.67	0.69	0.71	0.72	0.74	0.76	0.78	0.80	0.81	0.83	0.85	0.87	0.89	0.91	0.92	0.94	0.96	0.98	1.00
62.6/17	0.66	0.68	0.69	0.71	0.73	0.75	0.77	0.79	0.81	0.83	0.85	0.87	0.89	0.91	0.93	0.95	0.97	0.99	1.00	1.02	1.04	1.06
64.4/18	0.70	0.72	0.74	0.76	0.78	0.80	0.82	0.84	0.86	0.88	0.91	0.93	0.95	0.97	0.99	1.01	1.03	1.05	1.07	1.09	1.11	1.13
66.2/19	0.75	0.77	0.79	0.81	0.83	0.86	0.88	0.90	0.92	0.94	0.97	0.99	1.01	1.03	1.05	1.07	1.10	1.12	1.14	1.16	1.18	1.21
68/20	0.79	0.82	0.84	0.86	0.89	0.91	0.93	0.96	0.98	1.00	1.03	1.05	1.07	1.10	1.12	1.14	1.17	1.19	1.21	1.24	1.26	1.29
69.8/21	0.85	0.87	0.90	0.92	0.95	0.97	1.00	1.02	1.05	1.07	1.09	1.12	1.14	1.17	1.19	1.22	1.24	1.27	1.29	1.32	1.34	1.37
71.6/22	0.90	0.93	0.95	0.98	1.01	1.03	1.06	1.09	1.11	1.14	1.16	1.19	1.22	1.24	1.27	1.30	1.32	1.35	1.38	1.40	1.43	1.46
73.4/23	0.96	0.99	1.01	1.04	1.07	1.10	1.13	1.15	1.18	1.21	1.24	1.27	1.30	1.32	1.35	1.38	1.41	1.44	1.46	1.49	1.52	1.55
75.2/24	1.02	1.05	1.08	1.11	1.14	1.17	1.20	1.23	1.26	1.29	1.32	1.35	1.38	1.41	1.44	1.47	1.50	1.53	1.56	1.59	1.62	1.65
77/25	1.08	1.11	1.15	1.18	1.21	1.24	1.27	1.30	1.34	1.37	1.40	1.43	1.46	1.49	1.53	1.56	1.59	1.62	1.65	1.68	1.72	1.75
78.8/26	1.15	1.18	1.22	1.25	1.28	1.32	1.35	1.39	1.42	1.45	1.49	1.52	1.55	1.59	1.62	1.65	1.69	1.72	1.76	1.79	1.82	1.86
80.6/27	1.22	1.26	1.29	1.33	1.36	1.40	1.44	1.47	1.51	1.54	1.58	1.61	1.65	1.69	1.72	1.76	1.79	1.83	1.86	1.90	1.93	1.97
82.4/28	1.30	1.33	1.37	1.41	1.45	1.49	1.52	1.56	1.60	1.64	1.68	1.71	1.75	1.79	1.83	1.86	1.90	1.94	1.98	2.02	2.05	2.09
84.2/29	1.38	1.42	1.46	1.50	1.54	1.58	1.62	1.66	1.70	1.74	1.78	1.82	1.86	1.90	1.94	1.98	2.02	2.06	2.10	2.14	2.18	2.22
86/30	1.46	1.50	1.54	1.59	1.63	1.67	1.71	1.76	1.80	1.84	1.88	1.93	1.97	2.01	2.05	2.10	2.14	2.18	2.22	2.27	2.31	2.35
87.8/31	1.55	1.59	1.64	1.68	1.73	1.77	1.82	1.86	1.91	1.95	2.00	2.04	2.09	2.13	2.18	2.22	2.27	2.31	2.36	2.40	2.45	2.49
89.6/32	1.64	1.69	1.73	1.78	1.83	1.88	1.92	1.97	2.02	2.07	2.11	2.16	2.21	2.26	2.30	2.35	2.40	2.45	2.49	2.54	2.59	2.64
91.4/33	1.74	1.79	1.84	1.89	1.94	1.99	2.04	2.09	2.14	2.19	2.24	2.29	2.34	2.39	2.44	2.49	2.54	2.59	2.64	2.69	2.74	2.79
93.2/34	1.84	1.89	1.94	2.00	2.05	2.10	2.16	2.21	2.26	2.32	2.37	2.42	2.48	2.53	2.58	2.64	2.69	2.74	2.80	2.85	2.90	2.95
95/35	1.95	2.00	2.06	2.11	2.17	2.23	2.28	2.34	2.40	2.45	2.51	2.56	2.62	2.68	2.73	2.79	2.84	2.90	2.96	3.01	3.07	3.13
96.8/36	2.06	2.12	2.18	2.24	2.29	2.35	2.41	2.47	2.53	2.59	2.65	2.71	2.77	2.83	2.89	2.95	3.01	3.07	3.13	3.19	3.25	3.30
98.6/37	2.18	2.24	2.30	2.36	2.43	2.49	2.55	2.61	2.68	2.74	2.80	2.87	2.93	2.99	3.05	3.12	3.18	3.24	3.30	3.37	3.43	3.49
100.4/38	2.30	2.37	2.43	2.50	2.56	2.63	2.70	2.76	2.83	2.90	2.96	3.03	3.09	3.16	3.23	3.29	3.36	3.43	3.49	3.56	3.62	3.69
102.2/39	2.43	2.50	2.57	2.64	2.71	2.78	2.85	2.92	2.99	3.06	3.13	3.20	3.27	3.34	3.41	3.48	3.55	3.62	3.69	3.76	3.83	3.90

WHY IS VAPOR PRESSURE DEFICIT (VPD) IMPORTANT?

VPD helps a grower identify healthy air moisture conditions over the full range of growing temperatures. Vapor pressure deficit correlates directly to plant transpiration rates. Using VPD to fine tune water flow through the plant gives the grower another "control knob" in the quest to balance the plant with its environment.

High VPD (dry conditions in the air) increases the transpiration forces placed on the plant. High VPD can cause wilting when the root water intake can't keep up with the leaf evaporation loss. Very low VPD indicates the air moisture content is high and approaching the dew point; consequently, transpiration (and nutrient transport through the plant) is inhibited.

WHAT IS VPD?

The water vapor content of air can be measured as pressure; it shows up as a part of the total air pressure. All the gases and vapors that compose air have their own pressures (they are called partial pressures). For water vapor, this would be the partial pressure of water vapor. CO2 can be measured as ppm or as a partial pressure of CO2. We usually express the level of CO2 in ppm but we could talk about it as a partial pressure if we wanted to do that.

In a warmer environment, there can be more water vapor in the air than in a colder environment. The quantity of water vapor that could exist in the air approximately doubles for every increase of 20°F. This is not a simple proportional increase as most of the doubling in each 20°F occurs in the second 10°F (this is called an exponential increase).

The saturation vapor pressure (SVP) is the maximum amount of water vapor that can exist in air at some (any specified) temperature. The difference between the pressure of water vapor actually in the air, we'll call this the actual vapor pressure (AVP), and the SVP of that same temperature air is called the vapor pressure deficit (VPD).

These 3 abbreviations are important to remember:

- SVP is saturation vapor pressure (this would be the water vapor pressure at 100%RH)
- AVP is actual water vapor pressure (this would be at the actual %RH in the air)
- VPD, vapor pressure deficit (how much the actual vapor pressure is short of the SVP)

Some growers may ask, "Why throw this odd complexity into the matter? Why not just use %RH? The reason is: %RH does NOT relate directly to the transpiration rate of plants, VPD does. The major force moving water vapor out of the leaf is the vapor pressure difference between water vapor inside the leaf and the water vapor just outside the leaf.

A quick comparison between %RH and VPD:

- Relative humidity is the straight, linear percentage that the actual vapor pressure (AVP) is to the saturation vapor pressure (SVP). Relative humidity is expressed as a percentage.

  RH is AVP divided by SVP (all at whatever the actual temperature is)

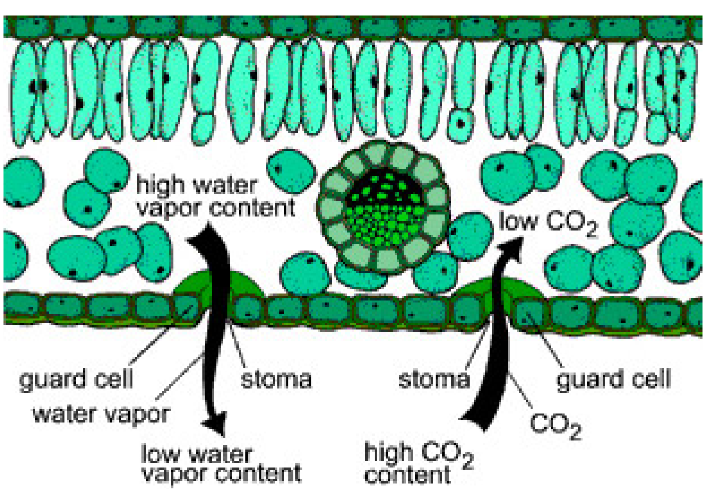
  %RH= (AIRAVP / AIRSVP) x 100 ...then tack-on a % sign.

- Vapor pressure deficit is the actual pressure difference (in units of pressure) between the AVP and the SVP. Since VPD tries to more accurately express what it is that the plant "feels", the science has been to use the leaf temperature to calculate the SVP. This is because the leaf is the location where the saturated (100%RH) inner environment of the plant meets the, usually, much drier atmosphere.

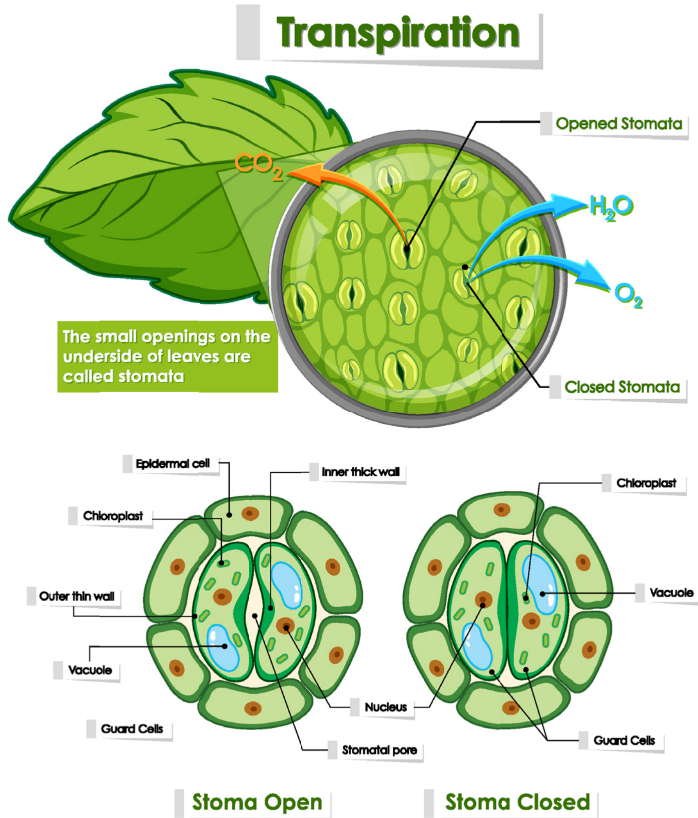
  VPD is the leaf-temperature SVP minus the product of the air-temperature SVP times the %RH

  VPD= LEAFSVP – (AIRSVP x AIR%RH)

The plant-canopy temperature is sometimes substituted for the leaf temperature when calculating the SVP. Alternatively, some growers subtract 5°F from the room temperature to account for the cooling effect of the evaporating water exiting the leaves. One issue with using leaf temperature is that various leaves are in differing amounts of light exposure ranging from full exposure to complete shade; another is that as VPD decreases (as it gets more humid), any cooling effect also decreases. So, yes, working with VPD does require you, the grower, to consider a couple more variables...as usual, with greater power comes greater responsibility.



A plant leaf cross-section.[1]



WHY VAPOR PRESSURE DEFICIT IS IMPORTANT

Plants survive and grow using sunlight, carbon dioxide, and water plus a number of inorganic elements (N, P, K, Ca, Mg, etc.).

Plant metabolism runs off of two major classes of reactions:

1. Light dependent reactions- these use water and produce oxygen as a byproduct. These reactions provide the plant with the energy it needs to grow; they are the source of the short-term energy-rich molecules, ATP (Adenosine triphosphate) and NADPH (nicotinamide adenine dinucleotide phosphate). ATP and NADPH are produced from sunlight acting on the plant's chlorophyll.
2. Light independent reactions- these take carbon dioxide from the atmosphere and convert it into carbohydrates for long-term growth and metabolism. These reactions provide the plant with the complex molecules that it needs in order to grow; light independent reactions are driven by the energy from the ATP and NADPH molecules (the molecules are then sent back for "recharging" to the light dependent system).

Most plants capture atmospheric carbon dioxide through tiny pores (stomata) in their outer skin (epidermis) on the bottom of the leaf.

With proper VPD, just the right amount of water vapor will diffuse out of the humid interior into the atmosphere through the stomata.

1 Transport Systems. BIO 181 Laboratory Distance Education. https://webprojects.oit.ncsu.edu/project/bio181de/Lab/transport/transport1.html

Because water and oxygen must diffuse out while CO_2 must diffuse in through the stomata, plants have an ongoing dilemma. Allowing maximum inflow of CO_2 for photosynthesis maximizes growth but wide-open stomata can lead to dehydration. Therefore, stomata must work to optimize plant metabolism by balancing photosynthesis and transpiration.

If too dry air induces a plant to transpire too much water, excess nutrient salts can accumulate in the leaves. This kills leaf cells and causes the leaves to display what is known as nutrient "burn".

To prevent this from happening, plants will try to limit transpiration by closing their stomata. This, of course, blocks the flow of CO_2 into the plant, reducing growth. Plants also protect themselves by rolling their leaves upward to reduce the leaf exposure area to light. Depending on the severity of conditions, this self-defense strategy may only work for a short time.

When too-moist air restricts the rate at which moisture can evaporate from the leaves, the plant cannot bring enough nutrients up from the roots. This will drastically reduce plant growth and weaken the plant, making it more susceptible to fungal attack. Sometimes the accumulating water from the roots will force its way out, showing up around the leaf margins or where the leaf attaches to the stem. This is called guttation and it is the equivalent attraction of a 75%-off sale to fungus. Fungal attack is the major reason you must avoid high moisture conditions.

Rapid air movement can partially compensate for too moist air. Leaves have a thin, boundary layer of stagnant air that resists transpiration. Air movement breaks-up that layer. Conversely, if the air is a little too dry, keeping room air circulation outside of the canopy area can help the plants cope.

VPD RANGE

Now that we've established the importance of transpiration and have some idea of how it happens, it should not be a stretch to accept that plant transpiration is driven by a vapor pressure difference of water: The partial pressure of water within the leaf vs. the partial pressure of water in the atmosphere outside the leaf.

Plant scientists and experienced growers tend to agree that the optimum vapor pressure deficit value is somewhere around 0.80 kPa (that's kilopascals, a common pressure unit for VPD). 1 kPa is very close to 4 IN WC (inches of water-column). Plants can grow somewhat acceptably in a fairly wide range of VPD, loosely ranging from 0.40 kPa to 1.25 kPa.

VPD can be calculated fairly easily, the equation is listed at the end of this article. VPDs in the following examples were calculated using the equation. Don't worry about how to get the numbers yet, just go through the examples and realize it's not hard to come up with the numbers.

VPD DURING VEGETATIVE GROWTH

Let's say a grow room's air temperature is 75°F when the lights are on. We'll use the full 5°F temperature drop for inner leaf temperature (recall- inside the leaf is the saturated location where the transpired water evaporates from, and the evaporation cools the leaf).

The SVP of 70°F (vapor pressure inside the leaf) is 2.53 kPa

In order to get a VPD around 0.80 we need the actual vapor pressure of the room environment (AVP) to be approximately 1.71 kPa. At 75°F that requires a relative humidity of 57%.

This 75/57 combination provides a VPD value very close to the 0.80 target value.

Turning to night conditions. Let's say we get the recommended 10°F drop and have a 65°F air temperature. There's not as much leaf evaporation, so not as much leaf cooling. Let's use 3°F for the leaf temperature reduction.

The SVP of 62°F is 1.92 kPa

The AVP of 65°F/52%RH is 1.11 kPa

These conditions also provide VPD just slightly greater than the 0.80 target value.

So VPD tells us we should run our 75°F room at 57%RH. When the lights go off and the room drops to 65°F, we want the humidity to be at 52%RH.

VPD DURING FLOWERING

Okay, those were the calculations with the focus on minimum plant stress. Now let's go through the same exercise for recommended flowering conditions. Here, we're going to use the reduced humidity values recommended by many growers with the aim to maximize resin production and minimize the chance of fungal infection.

Let's say, again, that the room's air temperature is 75°F when the lights are on. We'll use the full 5°F temperature drop for leaf temperature. This time we'll target 45%RH and then see what the VPD comes out to.

The SVP of 70°F is 2.53 kPa

The AVP of 75°F/45%RH is 1.35 kPa

These conditions provide a 1.18 VPD value, which is getting dry but is still within the recommended growing range.

For night conditions. Use the recommended 10°F drop for a 65°F air temperature. Let's once again use the 3°F leaf temperature reduction.

The SVP of 62°F (inside the leaf) is 1.92 kPa

The AVP of 65°F/45%RH (the grow room ambient) is 0.96 kPa These night conditions provide VPD of 0.96 which actually gets us closer to the optimum VPD, so all is good with these temperatures and 45%RH.

PRACTICAL USE OF VPD

Realize that at this level you are doing some serious high-performance fine-tuning of your gardening operation. You could be adding a few percent to the final weight of your yield, but it's going to take some work and you are going to need the proper equipment to measure and control your garden at this level.

Keeping the focus here on water vapor, you'll need a way to add moisture to your environment and a way to remove it (humidification and dehumidification). You will need to accurately measure %RH and temperature and you'll need a good oscillating fan system to jiggle the leaves.

The fan system is required because we know botrytis and other fungi are always waiting to pounce. Botrytis establishes itself best between 50 and 70°F, in still air having humidity above 55%RH. We especially want to avoid condensation; this means watch out for uncontrolled temperature drops between daytime and night.

The dehumidification system is required because (especially in the growth phase) there will be a lot of water vapor in the air during the lights on period. Much of this moisture will need to be removed as the lights go off and the temperature drops. A 75°F room at 57%RH, when cooled to 65°F goes to around 80%RH. That isn't acceptable. You will need to remove water vapor from the room at lights out.

The humidification system is required because at night's end when the lights come on and the temperature climbs back up to 75°F what was 52%RH becomes 37%RH. Again, at least for the growth phase, definitely not acceptable. You must get water vapor into the air, usually growers do this with a fogging/misting system. For a moderate sized room and fairly effective misting, we're talking about getting a couple quarts of water (rather than an ounce, or 5 gallons) up, into the air as quickly as possible.

You will also need some type of computer system capable of running a modern spreadsheet program. This is not rocket surgery, but you (or someone you know) will need to know how to use some basic features of a spreadsheet. This is useful to display the logged files from a data acquisition setup, as well as for calculating VPDs and other moisture quantities. Consider it the entry stakes to quantifying and visualizing the performance of your growing operation.

FINISHING UP

When you have the air moisture environment optimized, repeatable, and otherwise pretty much under control you can move on to adjust the other variables for best yield. Plants that aren't stressed from too high or too low air water vapor content are much better able to respond to high performance optimizing of CO2, nutrients, and lighting.

All this can seem like a lot of work, and it is sometimes, but if you truly wish to experience your plants' full genetic capability the effort is well worth it.

THE VPD EQUATION

Enter the formula on the next line into spreadsheet cell A10 (copy and paste it).

=3.386*(EXP(17.863-9621/(A7+460))-((A6/100)*-EXP(17.863-9621/(A5+460))))

You will type-in 3 values into 3 other cells:

1. Cell A5: The air temperature (A5 in the formula)
2. Cell A6: The air %RH (A6 in the formula)
3. Cell A7: The leaf temperature (A7 in the formula)

Cell A10 will then give you the total VPD for that grow room condition.

Example:

Room temperature= 80°F
Room %RH= 47%
Assumed leaf temperature= 75°F
VPD= 1.34 kPa (a little too dry for best growth)

CALCULATING INDIVIDUAL VAPOR PRESSURES

For those interested in further exploring water vapor pressure.

Enter the formula on the next line into spreadsheet cell A20 (copy and paste it).
=3.386*(A17/100)*EXP(17.863-9621/(A16+460)))

You will type-in 2 values into 2 other cells:

1. Cell A16: The air temperature (A16 in the formula)
2. Cell A17: The air %RH (A17 in the formula)

Cell A20 will then give you the water vapor pressure for that temperature and %RH combination.

Examples:

1. Room air temperature= 80°F
   Room air %RH= 47%
   Water vapor pressure= 1.67 kPa
2. Leaf temperature= 75°F
   %RH of the air inside the leaf = 100%
   Water vapor pressure= 3.00 kPa

These 2 examples show the "long way" to calculate the VPD given in the VPD equation section above this one.

Subtract the room condition from the leaf condition to come up with the room-to-leaf water vapor pressure deficit:
(3.00 – 1.67 = 1.33 kPa).