

PSYCHROMETRIC CONCEPTS FOR HVAC PROJECT MANAGERS

PART – 1 EIGHT KEY PROPERTIES
LEARNING BY BUILDING YOUR OWN CHART

PART – 2 PSYCHROMETRIC PROCESSES



THE PROPERTIES WE WILL STUDY

1. DRY BULB TEMPERATURE
2. VAPOR PRESSURE
(& THE SATURATION CURVE)
3. HUMIDITY RATIO
4. RELATIVE HUMIDITY
5. SPECIFIC VOLUME
6. DEW POINT TEMPERATURE
7. WET BULB TEMPERATURE
8. SPECIFIC ENTHALPY



WHERE CAN YOU FIND MORE ABOUT THIS STUFF?

- 2013 ASHRAE HANDBOOK – Fundamentals (I-P) edition, Chapter-1

Extremely dry reading. Stay away – use it only as a reference to prove your point in case some impertinent rascal challenges your wisdom.

- Stoecker, W. F. – *Refrigeration and Air Conditioning, Chapter-16*, McGraw-Hill 1958

Don't let the date panic you. This is good stuff. This is where I first read about psychrometrics in college. His Chapter-16 is where the idea of teaching psychrometrics by building your own chart comes from.

- Gatley, D. P. – *Understanding Psychrometrics*, ASHRAE 3rd Edition

Excellent book – just a little frustrating that the author chose SI units.

- Jennings, B. H. – *Environmental Engineering*, Harper & Row Publishers

Good solid HVAC text by someone who really knew what HVAC engineers need.

- Van Wylen and Sonntag - *Fundamentals of Classical Thermodynamics*, J. Wiley and Sons, 2nd Ed., 1973

Very popular standard text from my college days. I keep this old addition as all the later additions have SI units

- Som, S.K. – *Basic Thermodynamics*, Video NPTEL, IIT Kharagpur, India

One of the best basic Thermodynamics video tutorials on the web. However, if your ear is not tuned to the “Indian English” sounds then you might have trouble understanding what is going on.

A REMINDER

OUR TEACHING PHILOSOPHY AT WTF INSTITUTE OF HIGHER LEARNING:

NO HIGHER MATH – MAYBE SOME SIMPLE ALGEBRA CAN BE SNUCK IN

FORMULAS KEPT TO A MINIMUM AND ONLY USED WHEN ABSOLUTELY NECESSARY (SO IF YOU SEE ONE – MEMORIZE IT!)

SCIENTIFIC RIGOR AND ACCURACY TOTALLY SHUNNED

THE NAME OF THE GAME IS **CONCEPTS !**

Here is my philosophy in a nutshell:

If you don't remember the formula for Relative Humidity, that is OK, you can always Google it. However, if you come to work with an incorrect understanding of what Relative Humidity is - you will cost the Company money (and Customers) in the long run.

NOTE: For those who don't know, WTF is the Wilkins Training Facility at WAC, Santa Fe Springs CA



WHO IS THIS PRESENTATION FOR?

THIS PRESENTATION IS PRIMARILY FOR PROJECT MANAGERS (ENGINEERS AND CONTRACTORS) WORKING IN THE COMMERCIAL AND INSTITUTIONAL HVAC FIELD.

WHAT IS THE GOAL?

The goal is to provide an understanding of Psychrometry that can help them in dealing with **REAL WORLD** humidification design and trouble-shooting problems. It is my belief that teaching by jumping into drawing lines on the psychrometric chart does not equip the new engineer to deal with the humidity control problems he/she will encounter during their career.

What is needed is an in-depth discussion of the **CONCEPTS** behind the properties plotted on the Chart.



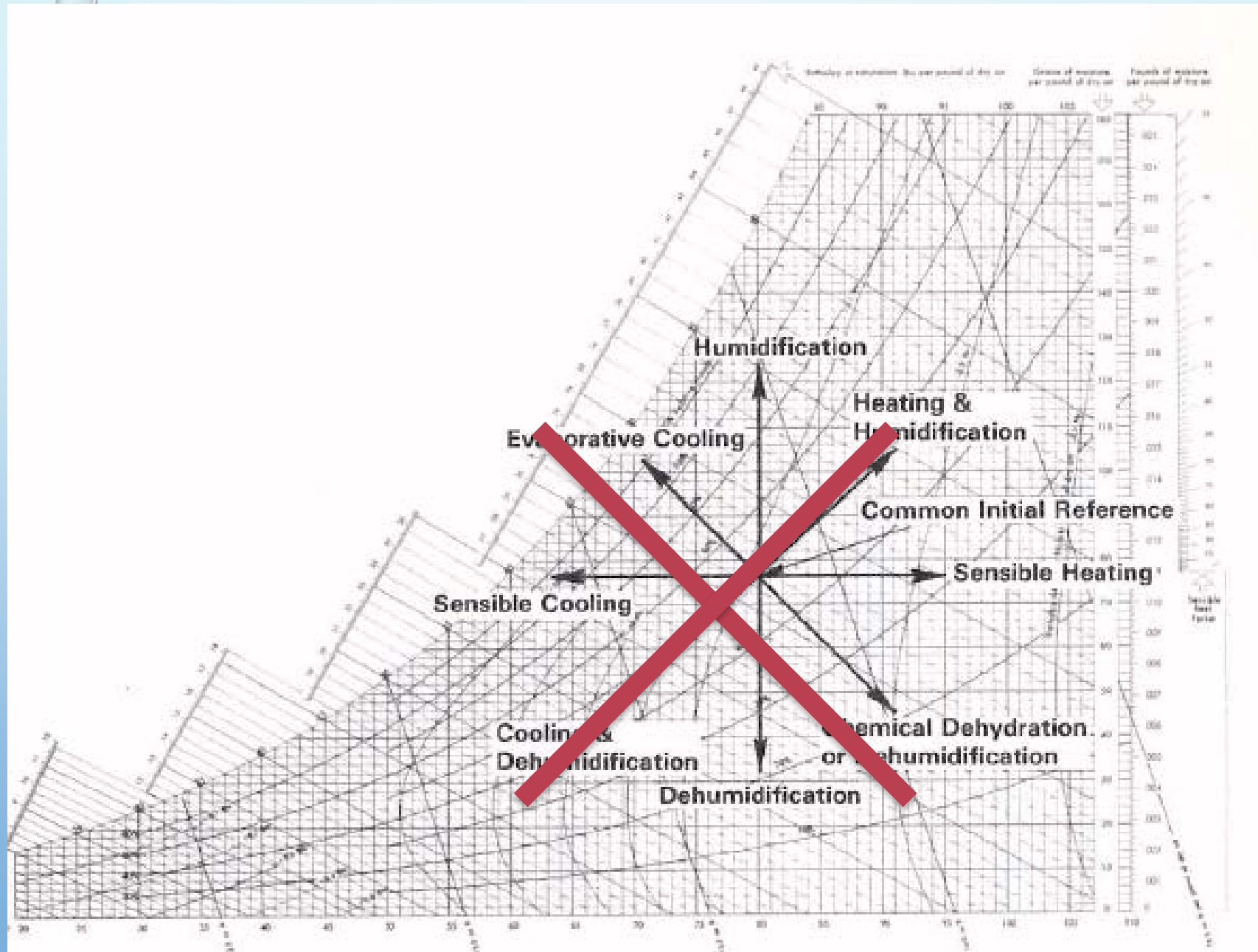
????? WHERE DO WE BEGIN ?????

Here is what W.J. Coad, a past President of ASHRAE, has to say about the study of Psychrometry:

“The Psychrometric Chart, however, *is not where one begins*; it is where one arrives after he has developed an in-depth understanding of the Thermodynamic relationships of the mixtures. Unfortunately, many texts and programs of instruction introduce the science of Psychrometrics by explaining the Psych Chart!”

W. J. Coad, Fundamentals to Frontiers, HPAC October 1985

☺ Here at WTF, we are NOT going to take the “in-depth” part seriously ... but let us just swim around in the shallows and I can guarantee you that we will find plenty of precious pearls of Psychrometric wisdom. ☺



HVAC ENGINEER



PSYCHROMETRY

SURGEON

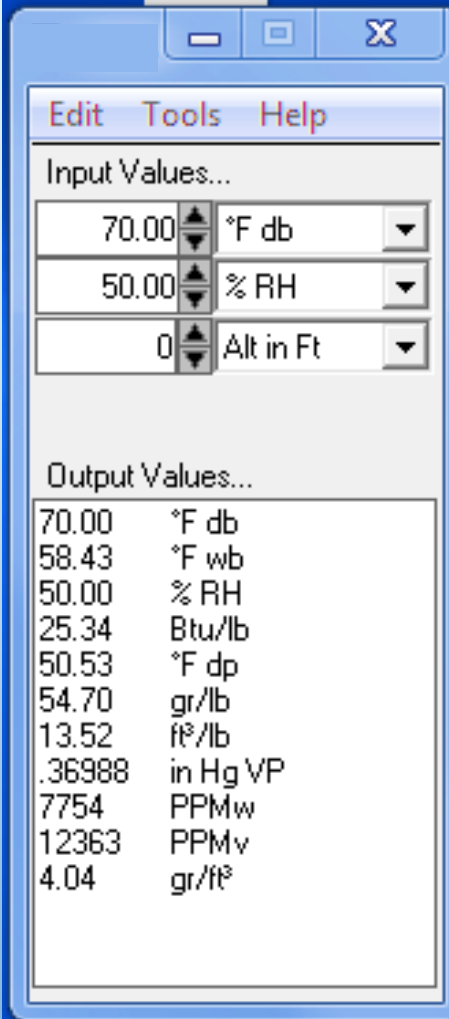


ANATOMY



THE FUTURE OF PAPER PSYCH CHART

- Very accurate values of Psychrometric properties are available through smart phone apps, computer programs and on-line calculators.
- Up until a few years ago the Psych chart could still be justified as a device that allows you to "visualize" the process. But new graphical Psychrometric software does that too - and very accurately.
- So the laminated Psych charts that we are so used to will probably vanish within a few years. And if you ever needed one, you can always quickly plot one out on a 11 x 17 (or any size) paper. There are many programs on the market that will do that.
- A good compromise is to plot the process on a paper chart but fill in the point properties using a psychrometric applet. This way you have a print to carry around in meetings and discussions.
- The example on the right shows one that has a nice feature that it will stay open on your desktop while you work in another program like PowerPoint, Word or Excel etc.
(Also free!)



The screenshot shows a software window titled "Edit Tools Help". It has two main sections: "Input Values..." and "Output Values...".

Input Values...

70.00	°F db
50.00	% RH
0	Alt in Ft

Output Values...

70.00	°F db
58.43	°F wb
50.00	% RH
25.34	Btu/lb
50.53	°F dp
54.70	gr/lb
13.52	ft³/lb
.36988	in Hg VP
7754	PPMw
12363	PPMv
4.04	gr/ft³

THE LAWS OF SCIENCE BEHIND THE CHART

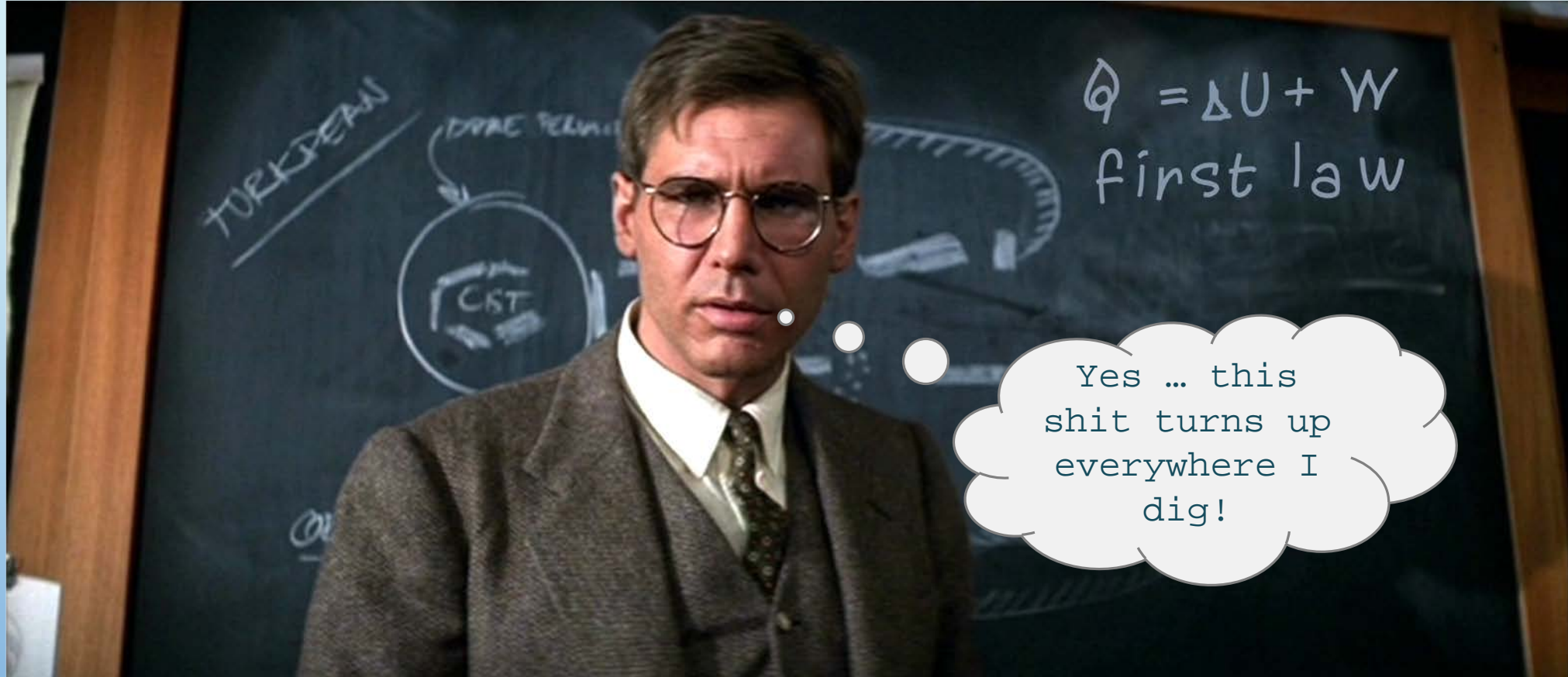
A good place to start the study of Psychrometry is to understand some of the laws of science that form the basis of this field.

Although it is almost impossible to list all the scientific laws that form the basis of Psychrometry or any other scientific discipline, you will find that (luckily) Psychrometry draws heavily on just a few well known Laws of Science. These Laws are usually taught in High School or college freshman level Physics.

What follows in the next few slides cannot be called a “refresher” attempt. It is more of “please make a note – this is why things are the way they are”.

We start with the mightiest Law of them all “The First Law”. You don’t even need to qualify it with “...of Thermodynamics”. When you say “The First Law”, the men and women of Science know what you are talking about.

THE LAWS OF SCIENCE BEHIND THE CHART



THE LAWS OF SCIENCE BEHIND THE CHART

THE FIRST LAW OF THERMODYNAMICS

Rise (+) or fall (-) in the
system's internal
molecular energy
(BTU)

$$\Delta U = Q - W$$

Work done "by" (+)
or done "on" (-) the
system
(BTU)

Heat in (+) or out (-)
of a system
(BTU)

- Energy Conservation
- Heat and Work equivalence as Energy (BTU)

Don't memorize
...
Just think it through !

THE LAWS OF SCIENCE BEHIND THE CHART

The First Law Of Thermodynamics – Continued

The First Law shows up everywhere in HVAC calculations. For example the analysis of mixing streams, cooling coils, heating coils and humidifiers etc. is generally based on a mass/energy conservation of a Control Volume using the First Law.

As an example of how THE FIRST LAW applies to calculations we use every day in HVAC, consider the following: HVAC Engineers probably use the equations below every day. These equations are a direct consequence of the First Law with certain process constraints, like constant Pressure, quasi-equilibrium and other such stuff, omitting the mention of which gives heartburn to a real Thermodynamicist – but which we will cheerfully ignore. (Except for the constant Pressure part, which comes up in later slides.) The symbols used here will be discussed and explained in later slides.

$${}_1Q_2 = m \times \Delta h$$

Always true
on the
psych. chart

$${}_1Q_2 = m \times C_p \times \Delta T$$

True only if no
phase change
occurs

INCHES OF W.G. FOR PRESSURE UNITS

WHY CHOOSE INCHES OF WATER GAGE FOR VAPOR PRESSURE?

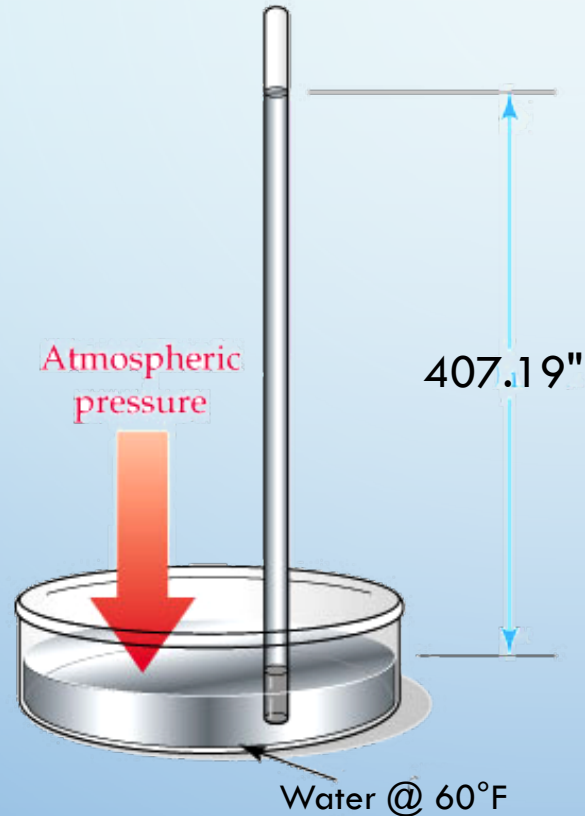
Almost any convenient (and consistent) units can be used for displaying Vapor Pressure on the Psych. Chart. And a lot of charts choose not to display Vapor Pressure at all. (We will discuss this more in a later slide when we discuss the concept of independent properties.)

I choose inches of water gage when discussing with HVAC engineers and technicians, because most of them have a very good “feel” for the magnitude of low values like a few inches of water gage. For example if I tell you that the Vapor Pressure in this room right now is 0.215 psia, chances are that it will not mean much to you. How small or large is it? On the other hand if I tell you that the Vapor pressure in this room is 6" W.G. and outside it is only 2" W.G. then you can immediately grasp the situation. As HVAC Engineers, we have all walked into plenums with a few inches of negative or positive pressure. We KNOW what that feels like. We KNOW how hard it will be to seal this room to hold its 4" W.G. differential from leaking to outside – because we have all struggled with sealing metal ductwork holding just a couple of inches of static pressure.

The above explanation also explains why I think Vapor Pressure is such a useful property to have as a visualization aid on the Psych. Chart. For e.g. if you were using the ASHRAE chart, the above inside moisture value would have come up as something like $0.0092 \text{ lb}_{\text{vapor}}/\text{lb}_{\text{dryair}}$. You may be scratching your head – is that a lot or very little?

BAROMETRIC PRESSURE

Altitude ft	Pressure psia
-1000	15.236
-500	14.966
0	14.696
500	14.430
1000	14.175
2000	13.664
3000	13.173
4000	12.682
5000	12.230



- Our chart will be based on the Standard Barometric Pressure at Sea Level, which is as follows:

14.696 psia

29.921 in. Hg @ 32°F

→ 407.19 in W.G. @ 60°F

- ± 1000 Feet from Sea Level elevation does not produce any appreciable errors for normal commercial HVAC design.
- The table on the left shows how Standard Pressure varies with Altitude.

KEY CONCEPT SLIDE - 1

Key Pressure Conversions

1 Atmosphere (atm)

14.696 psia

407.19 Inches of Water @ 60 °F

29.921 Inches of Hg @ 32 °F

760 mm Hg @ 32 °F

1 micron = 1,000 mm Hg

101.325 kPa

1 Inch of Water @ 60 °F

5.197 psf

0.03609 psi

248.84 Pa

1 psi

27.708 Inches of Water @ 60 °F

2.309 Feet of Water @ 60 °F

2.036 Inches of Hg @ 32 °F

6.895 kPa

THE LAWS OF SCIENCE BEHIND THE CHART

THE IDEAL GAS LAW - 1

An Ideal Gas (sometimes called a Perfect Gas) is simply a gas that obeys the following Ideal Gas Law at all Temperatures and Pressures.

$$P V = m R T$$

We will discuss the symbols and units in the next slide.

The working substance for this presentation is MOIST AIR – everything we discuss here will be somehow related to MOIST AIR

MOIST AIR will be considered as a mixture of **DRY AIR** and **WATER VAPOR**



IDEAL
GAS



IDEAL
GAS



IDEAL
GAS

So for the purpose of this presentation, all 3 are IDEAL gasses and the above formula can always be used.

THE LAWS OF SCIENCE BEHIND THE CHART

THE IDEAL GAS LAW - 2

An Ideal Gas (sometimes called a Perfect Gas) is simply a gas that obeys the following Ideal Gas Law at all Temperatures and Pressures.

There are a dozen different ways to write the basic IDEAL GAS Law, but for our discussion we will write it as follows:

The diagram shows the Ideal Gas Law equation $P V = m R T$ with each variable connected to a thought bubble containing its definition and units:

- P is connected to a bubble: Absolute Pressure, lb_f/ft^2
- V is connected to a bubble: Volume, ft^3
- m is connected to a bubble: Mass, lb_m
- R is connected to a bubble: Gas Constant, $\text{ft} \cdot \text{lb}_f/\text{lb}_m \cdot ^\circ\text{R}$
- T is connected to a bubble: Absolute Temperature, $^\circ\text{R}$

Units Check:
 $\text{ft} \cdot \text{lb}_f = \text{ft} \cdot \text{lb}_f$
Energy = Energy

THE LAWS OF SCIENCE BEHIND THE CHART

THE IDEAL GAS LAW - 3

- **DRY AIR** is treated as an IDEAL GAS in all our calculations
 - **DRY AIR** is a mixture of [78.1% N₂] [20.9% O₂] [Ar, Ne, CO₂, He, and others < 1%] by Volume
 - The Molecular Mass of **DRY AIR** is taken as 28.966 for our calculations
 - **R** for Dry Air is taken as $53.35 \text{ ft} \cdot \text{lb}_f / \text{lb}_m \cdot ^\circ\text{R}$
-
- **WATER VAPOR** is treated as an IDEAL GAS in all our calculations
 - The Molecular Mass of **WATER VAPOR** is taken as 18.015 for our calculations
 - **R** for Water Vapor is taken as $85.78 \text{ ft} \cdot \text{lb}_f / \text{lb}_m \cdot ^\circ\text{R}$
 - Note: Contrary to the popular believe moist air is **NOT** heavier than dry air.

THE LAWS OF SCIENCE BEHIND THE CHART

How much does the Dry Air in this room weigh ?

Given Room Volume = 40' X 20' X 8' High = 6,400 Cubic Feet

Dry Air Pressure 14.5 psia, Temp. 75°F, 50% RH

1lb, 5lb, 20lb, 50lb, 100lb, 200lb, 500lb, 1000lb

At your own leisure >>> What is the Volume of 1 lb_m of Dry Air at above conditions?

At your own leisure >>> If this room was perfectly sealed --- how much more air would be needed to pressurize it an extra 1/2" positive static?

THE LAWS OF SCIENCE BEHIND THE CHART

THE IDEAL GAS LAW - 4

For **DRY AIR**:

$$P \times V = m \times 53.35 \times T$$

For **WATER VAPOR**:

$$P \times V = m \times 85.78 \times T$$

UNITS for equations on left:

$$P \rightarrow \text{lb}_f/\text{ft}^2 \text{ Absolute} \quad [\text{psia} \times 144]$$

$$V \rightarrow \text{ft}^3$$

$$M \rightarrow \text{lb}_m$$

$$R_{\text{dry air}} \rightarrow 53.35 \text{ ft} \cdot \text{lb}_f/\text{lb}_m \cdot ^\circ\text{R}$$

$$R_{\text{water vapor}} \rightarrow 85.78 \text{ ft} \cdot \text{lb}_f/\text{lb}_m \cdot ^\circ\text{R}$$

$$T \rightarrow ^\circ\text{R} = 459.67 + ^\circ\text{F}$$

KEY CONCEPT SLIDE - 2

The Ideal gas law

For DRY AIR:

$$P_{\text{dry air}} \times V = m_{\text{dry air}} \times 53.35 \times T$$

For WATER VAPOR:

$$P_{\text{vapor}} \times V = m_{\text{vapor}} \times 85.78 \times T$$

UNITS for equations on left:

$$P \rightarrow \text{lb}_f/\text{ft}^2 \text{ Absolute } [144 \times \text{Psia}]$$

$$V \rightarrow \text{ft}^3$$

$$M \rightarrow \text{lb}_m$$

$$R_{\text{dry air}} \rightarrow 53.35 \text{ ft} \cdot \text{lb}_f/\text{lb}_m \cdot ^\circ\text{R}$$

$$R_{\text{water vapor}} \rightarrow 85.78 \text{ ft} \cdot \text{lb}_f/\text{lb}_m \cdot ^\circ\text{R}$$

$$T \rightarrow ^\circ\text{R} = 459.67 + ^\circ\text{F}$$

Remember our motto: No equations unless they are absolutely necessary? Well these are!
Memorize Them ☹

THE LAWS OF SCIENCE BEHIND THE CHART

DALTON'S LAW OF PARTIAL PRESSURES – 1

Pressure
1 psi = 2.77" H₂O

Pressure = 290" H₂O

Volume = 16 ft³

Temperature 115 °F

Nitrogen N₂

Pressure = 77" H₂O

Volume = 16 ft³

Temperature 115 °F

Oxygen O₂

Pressure = 40" H₂O

Volume = 16 ft³

Temperature 115 °F

Water Vapor

The easiest way to understand this Law is to do the following thought experiment.

- Imagine there are three containers or boxes having EQUAL VOLUMES (16 ft³) as shown above.
- We fill each one with a different gas, N₂, O₂ and Water Vapor.
- Let us pump enough N₂ in the first container to raise its pressure to 290" W.G. (10.45 psia).
- Fill O₂ container to 77" W.G. and Water Vapor container to 40" W.G. pressure.
- The temperatures in all three containers are also the same, = 115°F.
- The total of all 3 pressures is (290 + 77 + 40) = 407" W.G. And the total Volume = (3 x 16) = 48 ft³

THE LAWS OF SCIENCE BEHIND THE CHART

DALTON'S LAW OF PARTIAL PRESSURES – 1

Pressure
1 psi = 27.7" H₂O

Pressure = 290" H₂O

Volume = 16 ft³

Temperature 115 °F

Nitrogen N₂

Pressure = 77" H₂O

Volume = 16 ft³

Temperature 115 °F

Oxygen O₂

Pressure = 40" H₂O

Volume = 16 ft³

Temperature 115 °F

Water Vapor

The question now is this:

What happens if we shove all the 3 gasses in ONE of the containers?

For example, let us take the O₂ and the Water Vapor containers and force all their content into the N₂ container.

Now, if there were a method to read the pressure of individual components, N₂, O₂ and Water Vapor all stuffed in one container, what will we find?

THE LAWS OF SCIENCE BEHIND THE CHART

DALTONS LAW OF PARTIAL PRESSURES – 2

The answer to the question we asked in the last slide is a little counter-intuitive. Mr. Dalton had if figured out a couple of centuries ago. **THE PRESSURES OF THE INDIVIDUAL COMPONENTS DO NOT CHANGE – EACH BEHAVES AS IF THE OTHER 2 GASES DID NOT EXIST !**

$N_2 = 290'' \text{ H}_2\text{O}$
 $O_2 = 77'' \text{ H}_2\text{O}$
 $\text{Water Vapor} = 40'' \text{ H}_2\text{O}$

Volume = 16 ft³
Temperature 115 °F
 $N_2 + O_2 + \text{Vapor}$

$$\text{Total Pressure} = P_{N_2} + P_{O_2} + P_{\text{Water Vapor}}$$

$$\text{Total Pressure} = 290 + 77 + 40 = 407'' \text{ H}_2\text{O}$$

Dalton's Law Of Partial Pressures *states that the total pressure exerted by a mixture of non-reactive gases equals the sum of the pressures that each would exert if it were present alone.*

KEY CONCEPT SLIDE - 3

On a Psychrometric Chart, **Moist Air** is a mixture of **Dry Air** and **Water Vapor**

- Dry Air and Water Vapor exist totally independent of each other. They are not affected in any way by each other's presence. They both behave as ideal gasses.

- They occupy the same Volume:

$$V_{\text{moist air}} = V_{\text{dry air}} = V_{\text{water vapor}}$$

- They have the same DRY BULB Temperature:

$$T_{\text{moist air}} = T_{\text{dry air}} = T_{\text{water vapor}}$$

- The Total Pressure of Moist Air is always the sum of the partial pressures of the 2 components:

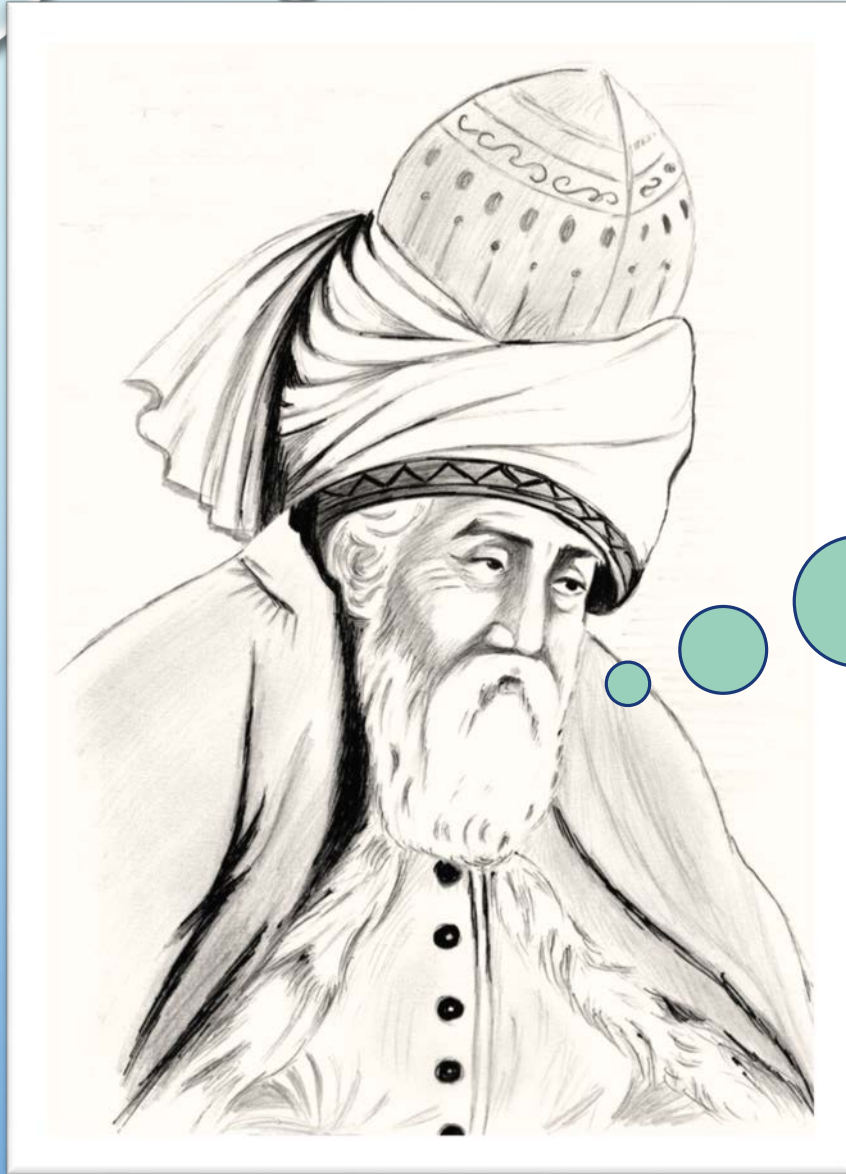
$$\begin{aligned} P_{\text{moist air}} &= P_{\text{dry air}} + P_{\text{water vapor}} = 14.696 \text{ psia (Chart Datum)} \\ &= 407.19 \text{ " W.G.} \end{aligned}$$

DRY AIR

N₂
O₂
Trace Gasses

Water Vapor
H₂O





Listen jackass ...
Stop telling me to get
to the good stuff

...

This IS the good stuff !

WHAT IS “STANDARD AIR” IN HVAC?

ASHRAE and AMCA both give the value $0.075 \text{ lb}_{\text{da}}/\text{ft}^3$ ($13.33 \text{ ft}^3/\text{lb}$) for “Standard Air”.

This density corresponds to a line through 60°F @ 100% RH and 69°F @ 0% RH on the Psych. Chart (@ sea-level Elevation).

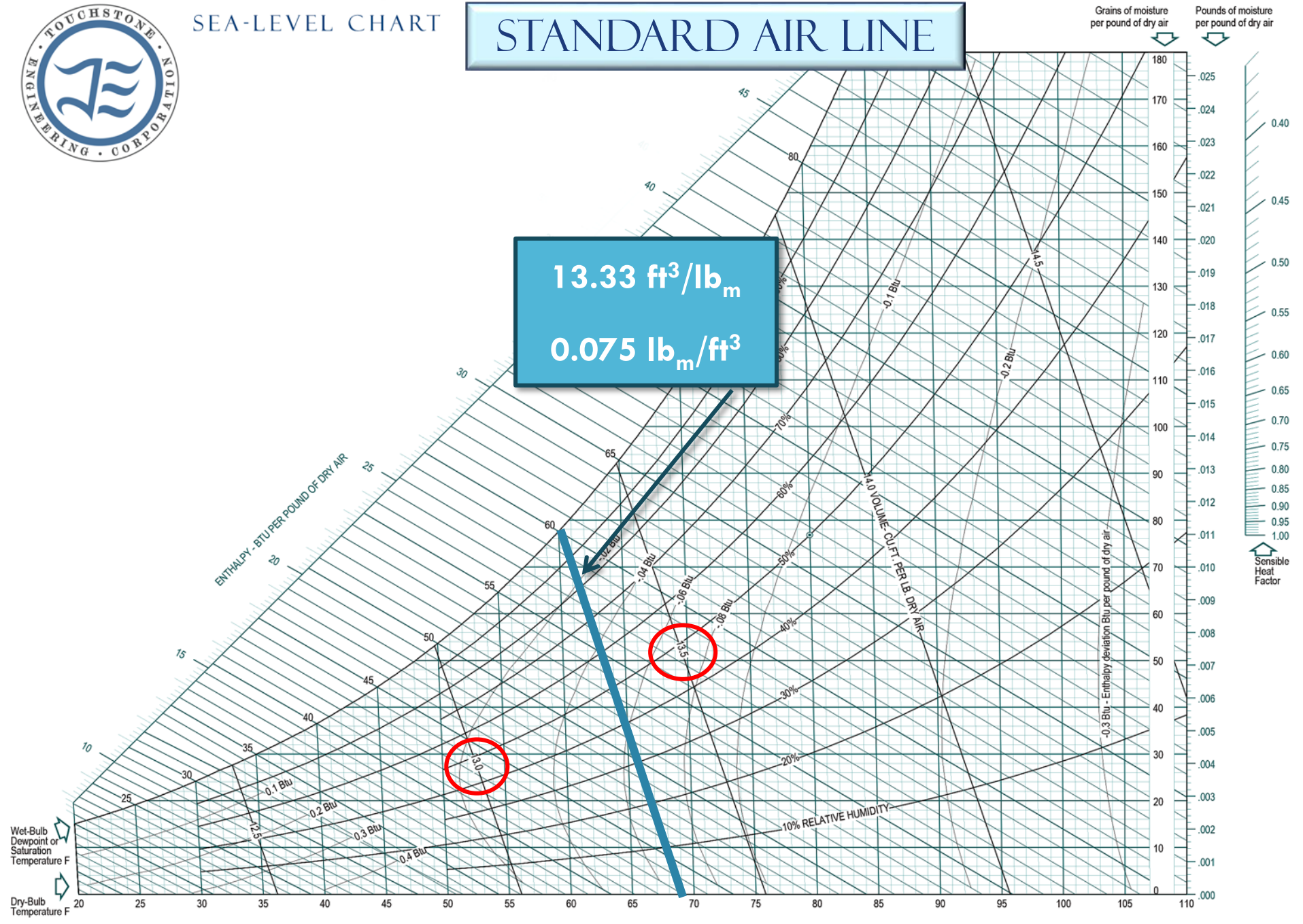
Generally speaking if you can use mass instead of volume for HVAC calculations, the results will be more accurate. This is so because the Specific Volume of air changes during cooling and heating.

However, for calculations where you have to use Volumetric flow rates, like fan selection, VAV boxes, duct sizing, and coil selection etc. the standard air density becomes the basis of catalog ratings and standard engineering formulae.



SEA-LEVEL CHART

STANDARD AIR LINE



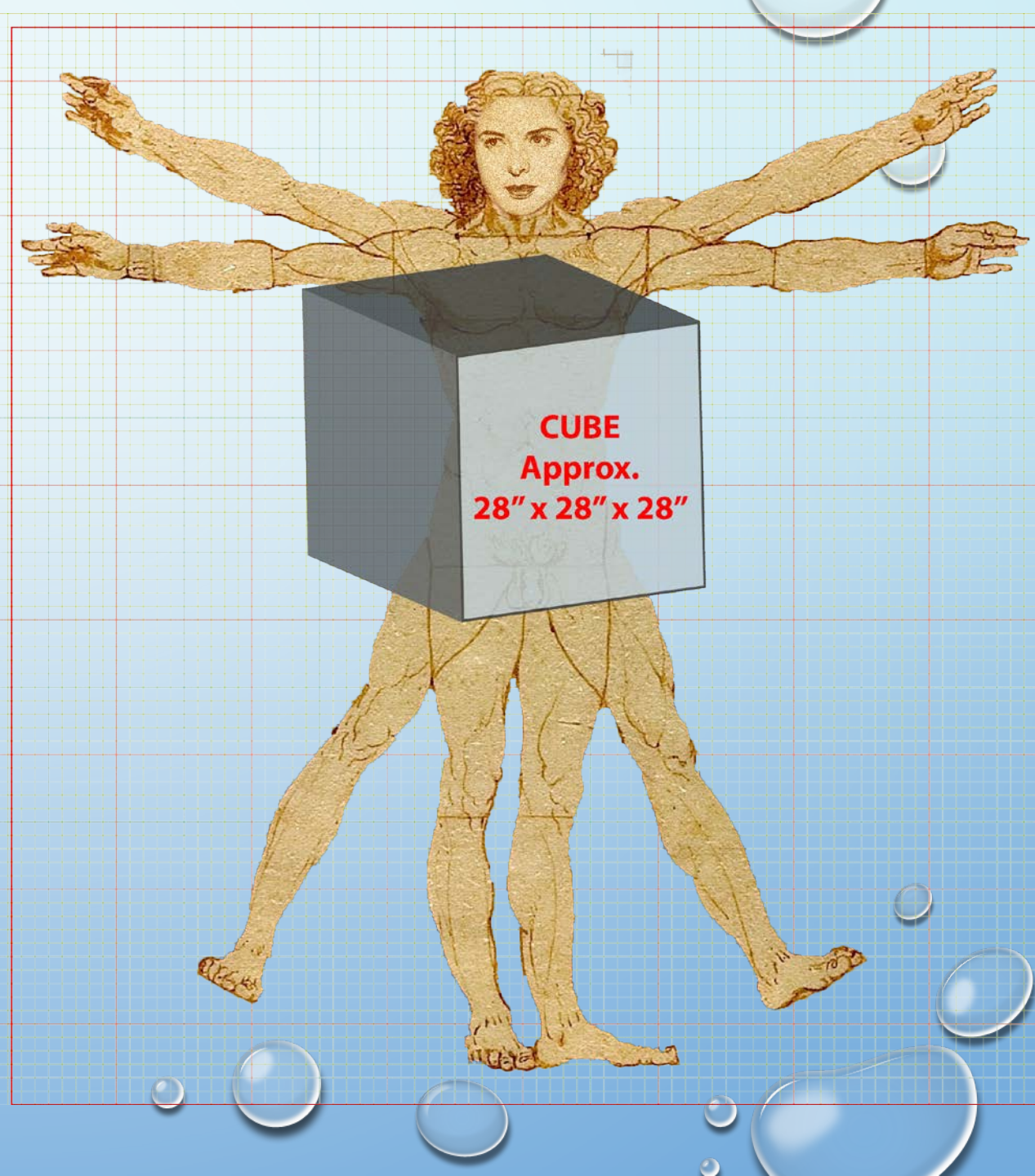
A FEW MORE PRELIMINARIES – 1

For air at Standard
Density $0.075 \text{ lb}_m/\text{ft}^3$

HOW BIG IS A CUBE
OF AIR WEIGHING
1 POUND?

13.33 ft^3

About 28.45 inches each side



A FEW MORE PRELIMINARIES – 2

Out of the 8 psychrometric chart properties that we will discuss, 3 are normalized properties which are based on **PER POUND OF DRY AIR** basis. These are:

Humidity Ratio Units $\rightarrow \text{lbm}_{\text{wat vap}} / \text{lbm}_{\text{dry air}}$ $[\text{grains}_{\text{water vapor}} / \text{lbm}_{\text{dry air}}]$

Specific Volume Units $\rightarrow \text{ft}^3 / \text{lbm}_{\text{dry air}}$

Specific Enthalpy Units $\rightarrow \text{Btu} / \text{lbm}_{\text{dry air}}$

Note the presence of **lbm_{dry air}** in the denominator of all three properties above.

Just as an example, let us say that we read the Specific Enthalpy of moist air at some temperature where the air contains 40 grains of moisture. The value read off the chart will give us the enthalpy of one pound of dry air plus the enthalpy of 40 grains of moisture associated with it (7000 + 40). NOT the enthalpy per pound (7000 grains) of moist air mixture. Now, at normal humidity levels in air conditioning, this is probably of no great consequence – but it is good to keep the concept correct.

We will discuss this further when we discuss each individual property in detail.



A FEW MORE PRELIMINARIES – 3

SYMBOLS AND UNITS OF CHART PROPERTIES (Used For This Discussion.)

Dry Bulb Temperature	T_{db}	Units → °F	[Use $T_{abs} \text{ } ^\circ\text{R} = 459.67 + \text{ } ^\circ\text{F}$ when using Gas Laws]
Wet Bulb Temperature	T_{wb}	Units → °F	
Dew-point Temperature	T_{dp}	Units → °F	

Barometric Pressure – Chart Datum = 14.696 psia (All our discussion will be based on a Sea-Level Chart.)
= 407.19 inches W.G. @ 60°F

Water Vapor Pressure P_{vapor} Units → inches W.G. @ 60°F [Use lb_f/ft^2 absolute when using Gas Laws]

Dry Air Pressure $P_{\text{dry air}}$ Units → inches W.G. @ 60°F [Use lb_f/ft^2 absolute when using Gas Laws]

Humidity Ratio W Units → $\text{grains}_{\text{vapor}}/\text{lbm}_{\text{dry air}}$ [$\text{lbm}_{\text{vapor}}/\text{lbm}_{\text{dry air}}$]

Specific Volume v Units → $\text{ft}^3/\text{lbm}_{\text{dry air}}$

Specific Enthalpy h Units → $\text{Btu}/\text{lbm}_{\text{dry air}}$

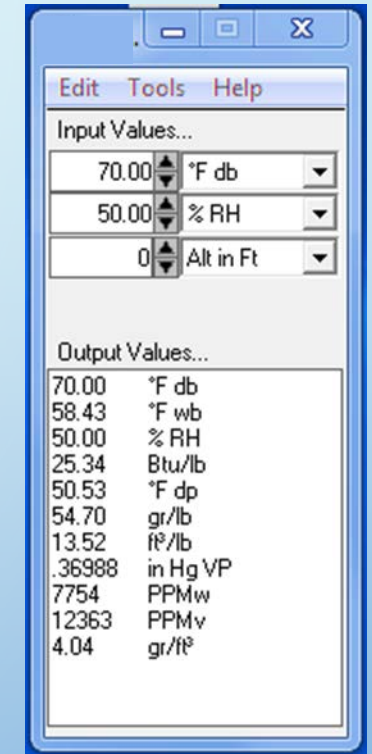
"Vapor" will always mean Water Vapor in this presentation.

A FEW MORE PRELIMINARIES – 4

- All psychrometric processes that are drawn on the Psych. Chart are **CONSTANT PRESSURE PROCESSES**. For our use the Constant Pressure will be taken as the Sea-Level atmospheric pressure, 14.696 psia. (ASHRAE publishes charts for a number of different elevations and temperature ranges.)
- The atmospheric pressure 14.696 psia converts to 407.19 inches W.G.
- As an example, a fraction of an inch W.G. pressure drop through a cooling or heating coil is not going to change the density (specific volume) of the moist air to any appreciable extent and the process can be treated as occurring at a constant pressure.
- This might be helpful for those who would like to refer back to Thermodynamics text books to verify how the various formulae we use are derived.

HOW MUCH INFORMATION IS NEEDED TO PLOT A POINT ON THE PSYCHROMETRIC CHART?

- If we consider Moist Air as a mixture of 2 ideal gasses, namely Dry Air and Water Vapor, then Thermodynamics tells us that we need 3 independent intensive properties to uniquely pin down the state of a system.
- The psychrometric chart is always constructed for a given Barometric Pressure, which in our case will be sea-level or 14.696 psia. **So now we need 2 more independent properties.**
- The 2 we select are usually the ones most easily measured. Dry Bulb Temperature is almost always the first pick. The second can be any of the remaining properties, but usually Relative Humidity, Dew Point Temperature or Wet Bulb Temperature are used.
- We will learn during our chart construction that Humidity Ratio, Dew Point Temperature, and Vapor Pressure all lie on the same (vertical) axis and are NOT independent properties. For example you can't use DP Temperature and Vapor Pressure as your 2 properties to plot on the chart. (More on this later.) Also Specific Enthalpy and Wet Bulb are never used as the 2 independent variables because of the geometry of their lines on the Psych Chart. (Very hard to plot their intersection.)



The screenshot shows a software window titled 'Edit Tools Help'. It contains two sections: 'Input Values...' and 'Output Values...'. The 'Input Values...' section has three rows: '70.00 °F db', '50.00 % RH', and '0 Alt in Ft'. The 'Output Values...' section lists various properties with their calculated values: '70.00 °F db', '58.43 °F wb', '50.00 % RH', '25.34 Btu/lb', '50.53 °F dp', '54.70 gr/lb', '13.52 ft³/lb', '.36988 in Hg VP', '7754 PPMw', '12363 PPMv', and '4.04 gr/ft³'.

Input Values...	
70.00	°F db
50.00	% RH
0	Alt in Ft

Output Values...	
70.00	°F db
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50.53	°F dp
54.70	gr/lb
13.52	ft³/lb
.36988	in Hg VP
7754	PPMw
12363	PPMv
4.04	gr/ft³

THE NATURE OF WATER VAPOR

- Moist Air is taken as a mixture of DRY AIR and superheated Water Vapor.
- Superheated Water Vapor is **INVISIBLE** (colorless and odorless). Exactly like that present in this room right now.
- If you can **see** it, like fog, rain, mist, or clouds, or steam off a boiling kettle – then that is **NOT** the substance that we are discussing here.

THE END OF FACHGESPRÄCH– 5 PART-1A

See you soon for Part-1 B

Luke!
You must Complete
the training.

