The evaporation calculation

Increase drying procedures with number crunching.

by Jeremy Reets

A train leaves Chicago for Indianapolis (approximately 185 miles) at 9 a.m. One hour later, a train leaves Indianapolis for Chicago. They meet at noon.

Reets

If the second train had started at 9 a.m., and the first train at 10:30 a.m., they would still have met at noon.

Can you find the speed of each train? If you can, please e-mail it to me for verification.

There is enough information in the above problem to tell you the speed of the trains. You just have to know what information is important and what to do with it once you have it.

Evaporation application

When it comes to the speed of evaporation, the same is true: We have enough information, we just need to know what information is important and what to do with it.

This is very important, because when you look at what we are hired to do as water damage restoration contractors (remove excess moisture), evaporation plays a major role.

As the experts, we are expected to make educated decisions when it comes to removing excess moisture from a structure.

That means that you should be able to provide an equipment plan that is based on a credible evaporation calculation.

Don't confuse this with the dehumidifier calculators that we are currently using. That calculator does not tell you how effective you have set up your drying system for evaporation; instead, it provides a *guideline* for how many dehumidifiers you might use to control the vapor you have *due to evaporation*.

Moisture motivation

The force that motivates moisture is both defined and measured as vapor pressure.

If you have high vapor pressure in one room and lower vapor pressure in the room next to it, which way will vapor move?

It will move from higher vapor pressure to lower until there is an equalization of the pressure.

The same thing is true of evaporation.

Moisture always moves toward lower pressure, if it can. The greater the difference in the pressures indicates the speed moisture will move.

Evaporation takes place when the vapor pressure of the liquid is greater than the vapor pressure of the air.

The higher the vapor pressure in the water at the surface and the lower the vapor pressure in the air at that surface, the faster evaporation takes place.

This is nothing new. Henri Le Châtelier first put this principle into writing in 1884.

Evaporation calculation

Calculating evaporation potential (EP) is very easy. We just need to measure the vapor pressure of the liquid on or in the wet surface, and compare it to the vapor pressure of the air at the wet surface.

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What is vapor pressure?

Vapor Pressure: A measure of a substance's propensity to evaporate… It increases exponentially with an increase in temperature.

— US Environmental Protection Agency

This definition shows exactly why we would want to understand and control vapor pressure.

It is a "measure of a substance's propensity to evaporate!"

If we can understand this measurement and control the vapor pressures in our drying environments, we will be drying giants.

— J.R.

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If we were to write that out it would be: "Vapor Pressure of the Wet Surface(S) minus Vapor Pressure of the Air(A) at the Wet Surface equals Evaporation Potential(EP)."

S – A = EP

You only need three pieces of information to calculate evaporation potential:

1. Temperature of the air
2. Relative humidity of the air
3. Temperature of the wet surface

You will need to have an infrared thermometer in order to get the surface temperature.

Without surface temperature, you cannot be sure whether you are creating evaporation.

The math that you put those numbers through to get vapor pressure is pretty complicated but, fortunately, all the hard work has been done for you.

The higher the EP number, the greater the potential is for structure evaporation.

Why do we use the term "evaporation potential" and not "rate of evaporation"? There are some factors that cannot be accurately measured yet, like airflow.

Airspeed will be very different in every location of the room that you take a reading, and you will not get an accurate answer.

Creating vapor pressure differential

As you already know, vapor pressure as a measurement is another specific humidity reading.

Le Châtelier's principle

If stress is put on a system by raising the temperature then, according to Le Châtelier's principle, the rate of evaporation will exceed the rate of condensation until a new equilibrium is established.

At the new equilibrium point, a greater proportion of molecules will exist in the vapor phase.

He suggests in his principle that by adding heat to water we will create evaporation.

This is because of there being a greater differential between the vapor pressure of the water and the vapor pressure of the air directly above that water.

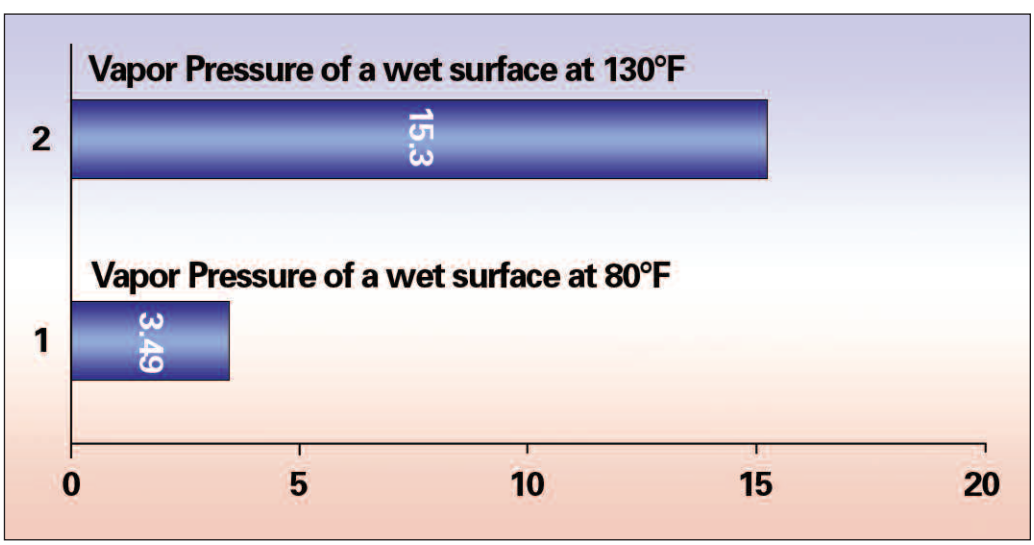
This will continue until there is an equilibrium achieved again (equal vapor pressures in both air and water).

At that point, there will be more water in the vapor phase (more water is supported as vapor at higher temperatures).

As long as we continue to supply heat and dehumidification, high speed evaporation will continue until there is no excess water.

— J.R.

Vapor pressure differential



Vapor pressure measured in kPa

As you can see, heating a wet surface from 80 degrees Fahrenheit to 130 degrees Fahrenheit increases the vapor pressure exponentially.

This is now possible to achieve without overheating the rest of the structure.

New drying technology and processes that focus heat to the wet surface make it possible to heat water to this range of temperature without ambient temperatures increasing above conventional drying temperatures.

— J.R.

Other specific humidity readings include grains per pound and dew point.

The only way to lower specific humidity is to dehumidify or remove vapor from the drying environment.

On a surface that is saturated, we read the relative humidity as 100 percent.

If you get a psychrometric chart, you will see that the only way to increase the vapor pressure of a wet surface is to heat that surface.

You can create very high vapor pressure when you *heat a wet surface*.

Heating air does nothing unless you are transferring that heat into the water. (See "Vapor pressure differential" on page 18.)

Application of evaporation calculation

On your next job, take some readings, including wet surface temperature.

Using the evaporation calculator to figure out the best way to set equipment is simple.

Once you put in your baseline readings, you can project how your efforts will affect the environment.

- To what temperature will you potentially heat the surface?
- To what can you possibly lower the specific humidity?
- What is the EP of that equipment configuration?
- How will heating the surface affect the EP?
- How will lowering the specific humidity affect the EP?

Take some time with the evaporation calculator and try many different scenarios.

You might be amazed at what this tool opens your mind to.

You will probably realize that drying knowledge has changed significantly in the last year.

There is so much new information in our industry that this is a great time to get an education update. □

Jeremy Reets operates Sharpsburg, GA-based Champion Construction Systems Inc. He is also the innovator behind the Reets Evaporation Method, the Evaporation Potential Formula, and the TES drying system distributed by Interlink Supply. Reets teaches his "Ultra High Speed Drying System" at the Reets Drying Academy and can be reached at rda@championcsi.com. For information on the TES drying system, contact Bridgepoint Systems or your local Interlink Supply distributor. You can get access to a free evaporation calculator at www.tesdryingsystem.com.