Guidance - Control of Humidity

Specifications for tribometers frequently include the requirement to control humidity within a test chamber, with specifications typically of the form:

> "The tribometer should incorporate a system of humidity control in a temperature range of 20°C to 40°C and relative humidity from 30% to 85%".

It is rarely clear whether this means:

> A: Control of relative humidity in the range 30 to 85% **within** a temperature range 20°C to 40°C.
>
> Or:
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> B: Control of relative humidity in the range 30 to 85% **and** simultaneous control of temperature within the range 20°C to 40°C.

Simply controlling the relative humidity, regardless of the ambient temperature, in other words "A", is readily achievable, at modest cost.

Controlling relative humidity at a specific temperature, in other words "B", involves a much more complicated system and control strategy. This is for the simple reason that relative humidity is of course a function of temperature.

For "B", a circulating system is required in which air is first chilled to below the dew point, to remove water content, then heated back to the required temperature, with steam injection to achieve the required temperature and humidity.

It is basically easier to raise humidity than to reduce humidity and to add heat rather than remove it, which is why the standard air conditioning cycle involves drying the air and reducing the temperature, before warming the air and adding humidity. That is how a proper combined temperature and humidity control system works.

Now, from a tribological point of view, the parameter that most affects the tribological response is the total amount of water available in the contact. The following example, calculated at a barometric pressure of 760 mm Hg, illustrates the problem with the "A" solution:

Relative Humidity	Temperature	Absolute Humidity
%	C	gm/m3
30	20	5.2
30	40	15.4
85	20	14.7
85	40	43.5

Between 20°C and 40°C, the **absolute humidity**, in other words, the total water content available within a given volume, varies by a factor of approximately 3, hence for a given value of **relative humidity**, the higher the temperature the "wetter" the tribological system.

Now, if we wished to control the parameter that affects the tribological response, in other words, **absolute humidity**, at a given value, for example 15 gm m^{-3}, then clearly the **relative humidity** must fall by a factor of approximately 3 as the temperature rises from 20°C to 40°C:

Absolute Humidity	Temperature	Relative Humidity
gm/m3	C	%
15.0	20	86.6
15.0	25	65.0
15.0	30	49.3
15.0	35	37.8
15.0	40	29.3

In practice, controlling relative humidity without at the same time controlling temperature, in other words, controlling the absolute humidity is a pretty pointless exercise.