How Can I-P Specific Enthalpy Values Be Converted to SI?

Conversion of statepoint specific enthalpy values between Inch-pound (I-P) and System International (SI) units is complicated because I-P and SI use different reference statepoints for the *dry-air* component. For SI, the reference statepoint for the *dry-air* component is 0°C and, for I-P, the reference statepoint is 0°F (–17.78°C). (The reference for the H_2O component is liquid H_2O at 0.01°C (32.018°F) for SI and I-P. *This complication is similar to the complication in converting temperature between °F and °C because the 0° (reference) temperatures are not equal.*

Because of the possible confusion in converting I-P specific enthalpy values to SI, practitioners should instead follow the practice of converting I-P barometric pressure and two other independent I-P statepoint properties to SI and then use the SI values to calculate all other SI psychrometric properties. This is the procedure least likely to result in errors. For those who still insist, two paths are available *but neither is recommended.*

One way is to only convert *differential enthalpy values* (Δh). Δh values in I-P or SI units represent the difference between beginning and ending statepoints, i.e., ($h_{\text{statepoint 1}} - h_{\text{statepoint 2}}$). In either the I-P or SI system of units, the beginning and ending specific enthalpies share a common t_{REF} (specific to I-P or SI), which cancels when the entering specific enthalpy is subtracted from the leaving specific enthalpy. Therefore, Δh values may be converted between I-P and SI using the conventional conversion constant (2.326 kJ/kg = Btu/lb).

The remainder of this section provides a method of converting individual specific enthalpy values. *I repeat—this method, although accurate, is not recommended.* Ideal gas psychrometric algorithms are used to develop and explain psychrometric specific enthalpy conversion factors. The formula below for specific enthalpy (h) includes three groupings each in brackets.

$$h = [Cpda \cdot (t - tref)] + [W \cdot Cpwv \cdot (t - tref)] + [W \cdot h\_g\_tref]$$

where

tref_IP	=	0°F (-17.78°C)
tref_SI	=	0°C (32°F)
Cpda_IP	=	0.2403 Btu/(lbda · °F) and multiplying by 4.1868 gives *Cpda_SI*
Cpda_SI	=	1.006 kJ/(kgda · °C)
Cpwv_IP	=	0.435 Btu/(lbwv · °F) and multiplying by 4.1868 gives *Cpwv_SI*
Cpwv_SI	=	1.82 kJ/(kgwv · °C)
		h_g_ref_IP is at 0°F and has a value of = 1061.06 Btu/lb_{wv}
		h_g_ref_SI is at 0°C and has a value of = 2500.77 kJ/kg_{wv}
Btu/lb	=	2.326 kJ/kg

Examination of the three groupings reveals that there is no simple conversion factor. Essentially, the conversion involves adjusting the I-P specific enthalpy value from 0°F to a 0°C (32°F) and then multiplying the adjusted value by 2.326 kJ/kg/Btu/lb.

The conversion is simplified because the adjustments to the second and third terms of the equation offset each other, i.e., the sensible enthalpy of the water vapour adjustment from 0°F to 32°F is exactly offset by the adjustment of the reference h_g_ref value from 1061 to 1075.

Therefore, the net conversion is

$$h\_SI = [h\_IP + C_{P\_DA} \cdot (0°F - 32°F)] \cdot 2.326$$

therefore,

$$h\_SI = [h\_IP - 7.687] \cdot 2.326$$

I recommend that this equation only be used when debugging software programs or comparing an SI version of a program with a previous I-P version. Anyone who chooses to convert individual specific enthalpy values will have to manipulate many numbers and eventually errors will occur. Hence, my earlier recommendation to convert the entering statepoint P_{BAR}, t_{DB}, and a humidity property to SI and then use SI psychrometric software for the remainder of the calculations. As a matter of interest, the Hyland-Wexler water and psychrometric algorithms and research all used SI units. Others then converted the Hyland-Wexler algorithms to I-P. This is one more tiny reason to calculate in SI.