TECH TIP # 43

HEATING, AIRCONDITIONING & REFRIGERATION DISTRIBUTORS INTERNATIONAL

One of a series of dealer contractor technical advisories prepared by HARDI wholesalers as a customer service.

TP Equals SP Plus VP

Almost every text, manual and catalog that relates to ducted air conditioning technology devotes some space to an explanation of how the total pressure (***TP***) in a duct system is equal to the sum of the static (**SP**) and velocity (***VP***) pressures.

Little difficulty is encountered with this simple relationship until the return or exhaust side of a system is confronted. Then, it seems, many designers become confused and frequently make mistakes,

The confusion apparently stems from the introduction of negative numbers -- do you add the ***VP*** to the ***SP*** or subtract it? -- and the addition of such terms as total suction and dynamic tube measurements to define what amounts to the same thing as the supply side static and total pressures.

Much of the confusion can be avoided by representing system pressure relationships graphically, referenced on an absolute pressure scale.* and relying solely on the terms total, static and velocity pressure.

Atmosphere Is Datum

When we take a pressure measurement in a supply duct and state that the static pressure is, say, 2.5 inches of water, what we really mean is 2.6 inches of water above atmospheric pressure. Since standard atmospheric pressure is 14.7 psi amounts to 408 inches of water, the static pressure in the supply duct of the absolute scale is 408 psi plus 2.6 or 410.6 inches of water.

On the return side, a static pressure measurement (sometimes called total suction) of 2.6 inches of water really indicates 2.6 inches of water below atmospheric pressure. Thus the static pressure in the return duct on the absolute scale would be 408.0 minus 2.6 or 405.4 inches of water.

Figures 1 and 2 graphically represent the pressure distribution in ducts with conditions above and below atmospheric pressure using the absolute scale. The horizontal line at the base represents zero pressure absolute; the dashed horizontal line above the base line represents atmospheric pressure. Let’s consider the supply side conditions in Figure 1 first.

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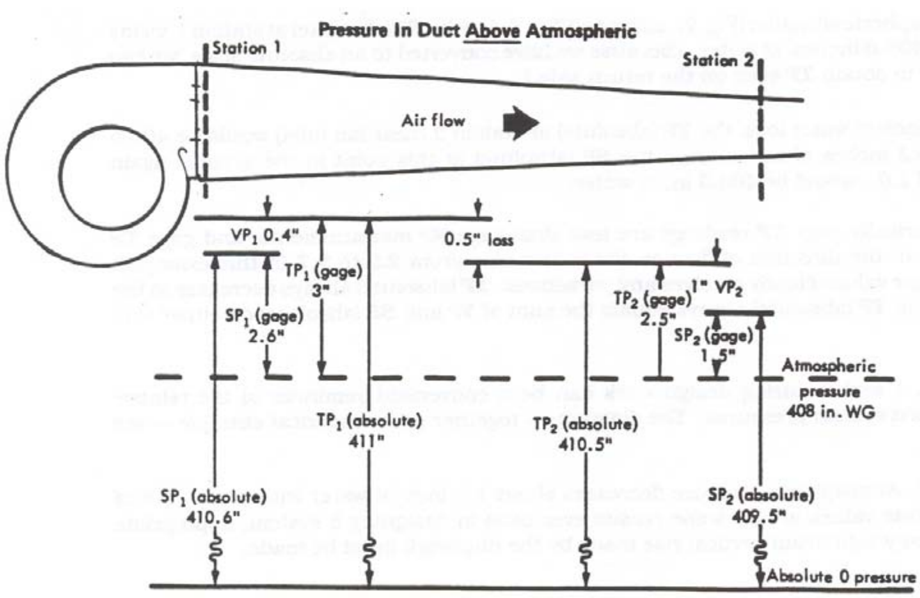
At station 1, right at fan discharge, the velocity pressure (***VP***) is assumed to be 0.4 inches of water, so to the ***SP*** (absolute) of 410.6 inches of water we add 0.4 to obtain the ***TP*** (absolute) of 411.0 inches of water. (Gauge ***TP*** as measured with a pitot tube would be 411 minus 3 inches of water.)

For a 0.5 inches of water loss in energy through the system, the ***TP*** (absolute) at station 2 would be 411.0 minus 0.5 or 410.5 inches of water. And if the ***VP*** increased to 1.0 inches of water (duct narrows) then the ***SP*** (absolute) at station 2 would be 410.5 minus 1.0 or 409.5 inches of water.

Note that only when the duct is a constant size will the pressure loss be equal to the difference in static pressure (SP_1 minus SP_2 equals 1.1 here not 0.5), but the loss is always equal to the difference in total pressure.

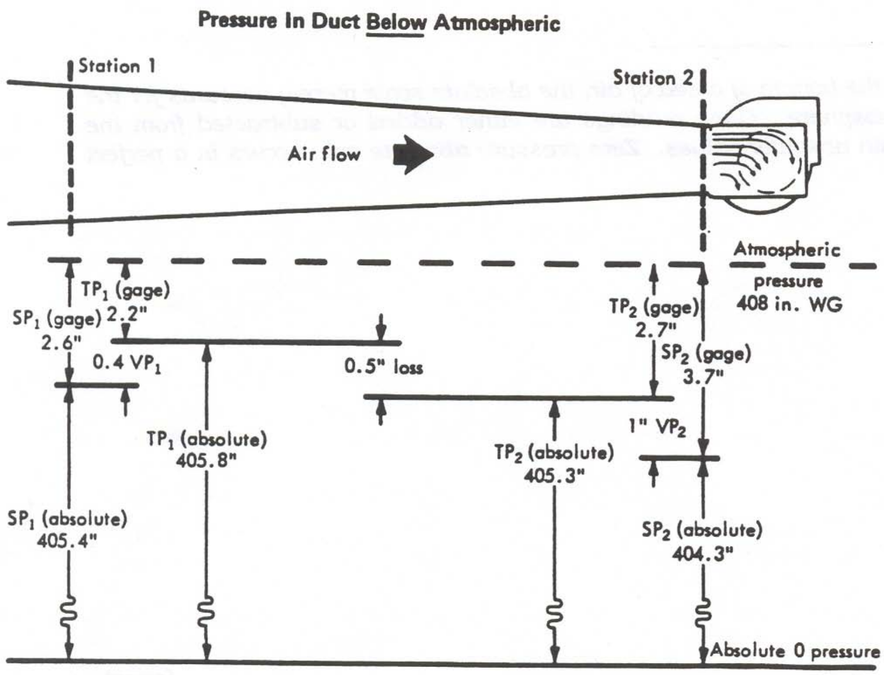


1 *SUPPLY side pressure distribution referenced to the absolute scale. Gage readings are added to atmospheric pressure to obtain absolute values.*

Principle Is No Different On Inlet Side

In the below atmospheric situation (Figure 2), adding a ***VP*** or 0.4 to the ***SP*** (absolute) at station 1 yields a ***TP*** (absolute) of 405.8 inches of water. (Because we have converted to an absolute scale, we can still add ***VP*** to ***SP*** to obtain ***TP*** even on the return side.

For a similar 0.5 inches of water loss, the ***TP*** (absolute) at station 2 (near fan inlet) would be 405.5 minus 0.5 or 405.3 inches of water. And the ***SP*** (absolute) at this point in the system, again assuming a ***VP*** of 1.0, would be 404.3 inches of water.



2 ***RETURN or exhaust side pressure distribution referenced to the absolute scale. Gage readings are subtracted from atmospheric pressure to obtain absolute values.***

Thus, while numerically gauge ***TP*** readings are less than gauge ***SP*** measurements, and gauge ***TP*** readings increase in the direction of flow on the return side (from 2.2 to 32.7 in this example), reference to absolute values clearly resolves any paradoxes. ***TP*** (absolute) always decreases in the direction of flow and ***TP*** (absolute) always equals the sum of ***VP*** and ***SP*** (absolute) on either side of the fan.

Reference to Figures 1 and 2 during design work can be a convenient remainder of the relative relationship between system pressures. The diagrams -- together with numerical example -- are self-explanatory.

A word of caution: atmospheric pressure decreases about 1.0 inches of water with every 70 feet of elevation. If absolute values are for some reason ever used in designing a system, appropriate compensation for any significant vertical rise made by the ductwork must be made.

* *Since a duct system is near the bottom of a sea of air, the absolute scale merely accounts for the pressure exerted by the atmosphere. Gauge readings are either added or subtracted from the atmospheric pressure to obtain absolute values. Zero pressure absolute only occurs in a perfect vacuum.*