Q: What effect do wind speed, variations in outside-outside temperature, barometric pressure and humidity have on Blower Door testing?

Wind

Of all the environmental effects, wind has probably the largest impact on Blower Door testing. Wind blowing on a house generates a pressure difference between inside and outside of the structure. For example, a 20 mph wind blowing against a house can create an indoor-outdoor pressure difference of as much as 50 Pascals. Wind results in variations in the house pressure readings, as well as wind induced baseline house pressures. Wind blowing against the Blower Door fan can also change the flow rate through the fan, and possibly affect the measurement accuracy of the fan flow, especially when pressurizing the house (as opposed to depressurizing). These variations in house pressure and flow readings result in variations in test results from one test to another (precision errors) and possibly a shift in the average of a set of tests (bias errors).

Tips

- If at all possible, avoid testing under high wind conditions (e.g. greater than 15 - 20 mph). Because of the effects of high winds, some airtightness test standards and programs place limits on the conditions under which tests can be performed. These limits are expressed either in terms of the baseline pressure readings, or the scatter from the best-fit line in a multi-point test. For example, the European EN 13829 test standard suggests that tests not be performed if the average baseline house pressure reading is greater than 5 Pa.

- If you have to test under windy conditions, try to set up the Blower Door on the leeward (downwind) side of the house, and also place your outside reference tube on the leeward side of the house in a sheltered location.

- If performing a manual test, use the time averaging features on the digital gauge to help dampen out wind induced pressure fluctuations.

- Always take a pre-test baseline house pressure reading, and adjust your house pressure readings by subtracting the baseline reading. The DG-700 gauge has a built-in baseline feature which makes taking and adjusting for a baseline reading very easy. If not using the DG-700's baseline feature, our TECTITE software also allows you to enter baseline readings, and it will make the necessary baseline adjustments. TECTITE allows you to enter both pre and post test baseline readings.

- If the wind speed is greater than 5 mph, do a multi-point test. If the wind speed is above 10 mph, conduct an automated multi-point test using a DG-700 and our TECTITE Software. Automated testing has numerous advantages – it allows multiple tests to be performed and then averaged to create a single result, reduces operator errors and automates baseline measurements. Automated testing makes it possible to quickly gather hundreds of times more data than is practical with a manual test. By collecting large samples of data, test repeatability can be greatly improved.

Differences Between Inside and Outside Temperatures

Indoor and outdoor temperatures affect the test results in a couple of important ways.

Stack Effect Induced Baseline Pressures

Differences between the temperature inside a house and the outdoors create small "stack effect" pressures across the pressure boundary of the house. In cold weather, the stack effect results in negative pressure at the bottom of the house (pulling outside air in) and positive pressures at the top of the house (pushing inside air out). The size of the stack effect pressure is a function of the height of the building and the inside/outside temperature difference. For example, a 15 foot tall building (floor to ceiling) with a 50 degree F difference between inside and outside temperature, would have a 5 Pascal pressure difference between the bottom and top of the building. If leaks in the building are uniformly distributed, you would measure –2.5 Pa at the bottom (house with reference to outside), and +2.5 Pa at the top. **Note:** In hot weather, stack effect pressures are reversed (negative at the top and positive at the bottom).

Because differences in air temperature create changes in house pressures, we need to measure and adjust for this baseline stack effect pressure during a Blower Door test. Failure to account for a baseline stack effect pressure of –2.5 Pa would cause an underestimation of the house leakage measurement (CFM50) by about 3%.

Differences in Air Density

The temperature of air also affects its density and its viscosity (resistance to flow). The effects of changes in viscosity are typically less important than the effects of changes in air density and are often ignored. When air heats up it expands, and when it cools it contracts. This means, for example, that when you exhaust one cubic foot of air from the house in the winter using a Blower Door fan, less than a cubic foot of outside air is drawn in (because the cold outside air is more dense and it expands once inside the house to BECOME one cubic foot at inside temperature).

Because of this and other effects, we need to make an air density adjustment. For example, if you performed a test on a house when the inside temp was 70 and the outside temp was 0, and then performed another test on the same house (in the same physical condition) when the inside temp was 70 and the outside temp was 90, you would expect to see test results differences of about 8%, if you didn't make corrections for temperature.

Tips

- Always take a pre-test baseline house pressure reading, and adjust your house pressure readings by subtracting the baseline reading. The DG-700 gauge has a built-in baseline feature which makes taking and adjusting for a baseline reading very easy. If not using the DG-700's baseline feature, our TECTITE software also allows you to enter baseline readings, and it will make the necessary baseline adjustments. TECTITE allows you to enter both pre and post test baseline readings.

- Corrections for differences in air density due to temperature are automatically made in our TECTITE software. If you are not using TECTITE, the Blower Door operation manual contains a table of Air Density Correction Factors to that can easily be applied to your measured test results. The air density corrections made in TECTITE and found in our manual are based on the Canadian CGSB Test Standard (CGSB-149.10-M86). More complex

corrections (including viscosity effects) can also be made and are, in fact, required in some blower door standards such as the EN 13829 European Test Standard, and ASTM E779-03. Our international software program, called TECTITE Express, has the capability to use the EN 13829/ASTM E779-03 correction methodology.

Barometric Pressure:

Barometric pressure (like temperature) also directly affects air density. Various Blower Door test standards deal with barometric pressure effects in different ways. The CGSB test standard uses assumptions, such as a building leakage exponent of 0.5, that make corrections for barometric pressure unnecessary (the CGSB standard corrects all test results to standard barometric pressure). Therefore, the CGSB test standard does not require a measurement of barometric pressure.

The EN 13829 standard does make a compensation for barometric pressure and therefore requires some estimate of local barometric pressure, or altitude. For example, if you performed a test on a house in Denver, and then moved that same house to sea level and performed another test, you would expect to see test results differences of about 4% due to the EN 13829 barometric pressure correction (the 4% figure is based on a house leakage exponent of 0.65 - if the house leakage exponent were 0.5 then there should be no difference in the two test results).

Tip

- Most testing programs in the North America require or allow the CGSB test standard to be used. In these programs, corrections for barometric pressure are unnecessary (TECTITE does not make barometric pressure corrections). Our international software program, called TECTITE Express, has the capability to use the EN 13829/ASTM E779-03 barometric pressure correction methodology.

Humidity:

Moisture in the air has a weak impact on density and viscosity. Humidity therefore has relatively little direct effect on the Blower Door airtightness test process and test standards do not require that humidity levels be measured. However, the house itself might physically change due to differences in humidity. For example, the size of cracks in the building envelope could conceivably shrink in the humid summer as wood and other building materials absorb moisture and expand. Likewise, cracks could get larger in winter as building materials dry out and shrink. There is really no way to correct for this effect.