The effects of wind are very important in selecting the right load cell capacity and determining the correct mount to use in outdoor applications. In analysis, it must be assumed that the wind can (and does) blow from any horizontal direction.

The Figure shows the effects of wind force on a vertical tank. Note that not only is there force distribution against the tank on the windward side, but also a "suction" distribution on the leeward side.

These forces tend to be additive and can tip the vessel over in the direction of the wind.

On the sides of the tank the forces are equal in magnitude but opposite in direction, resulting in no effect on the overall stability of the vessel.

Air Velocities of Wind

The maximum air velocity of wind is depending on the geographical place and height and the local situations (buildings, open field, sea, etc.). A National Meteorological Institute can provide more statistical data to determine how air velocity should be taken into account.

Calculation of Windforce

The installation is mostly affected by horizontal forces, acting in the direction of the wind. These forces can be calculated by:

\[ F = 0.63 \cdot c_d \cdot A \cdot v^2 \]

where,

- \( c_d \): Drag coefficient, for an upright circle cylinder this coefficient equals 0.8
- \( A \): Exposed cross section, equals height of the vessel \( \times \) bore of the vessel (m²)
- \( h \): Height of the vessel (m)
- \( d \): Bore of the vessel (m)
- \( v \): Air velocity of wind (m/s)
- \( F \): Force generated by the wind (N)

Hence, for upright cylindrical vessels, the following formula can be used:

\[ F = 0.5 \cdot A \cdot v^2 = 0.5 \cdot h \cdot d \cdot v^2 \]

Specifications:

- \( v = 30 \text{ m/s} \)
- \( h = 10 \text{ m} \)
- \( d = 3 \text{ m} \)

Calculation of force:

\[ F = 0.5 \cdot 10 \cdot 3 \cdot 30^2 \]

\[ F = 13500 \text{ N} \]
Wind Forces

Conclusion

• The installation should be protected against capsizing.
• Wind force should be taken into account during load cell capacity selection.
• As the wind does not always blow exactly horizontally, a vertical component could cause a measuring error, by an arbitrary zero shift. Errors bigger than 1% of the net weight can only be expected with very strong wind > 7 Beaufort.

The Effect on Load Cell Capacity and Mounts

The effect of the wind force to the load cells is different from that to the vessel. The wind force is causes a capsizing moment, which will be counteracted by the reactive moment of the load cells.

\[ F_l = \text{Force on load cell} \]
\[ F_w = \text{Force caused by wind force} \]
\[ a = \text{Distance between load cells} \]
\[ F \times b = F_w \times a \]
\[ F_w = (F \times b)/a \]

Which will cause an increase of \( F_{l1} \) and a decrease of \( F_{l2} \).

Using a calculated wind force of 13500 N and a value for \( b \) which is approximately half the height of the vessel, \( F_w \) can be calculated by:

\[ F_w = (13500 \times 5)/3 = 22500 N \]

Accuracy

The specifications illustrated on the load cell datasheet should be the basis for calculating the accuracy of a non-approved weighing system.

The accuracy of a weighing system which must be approved by the "Weights and Measures" has to meet a relevant OIML recommendation. For example, non-automatic weighing systems have to meet OIML R 76-1 edition 1992 (E).

Customer Support

VPG Transducers combines fifty years of load cell manufacturing with fifty years of application know how. For any further question, please contact our manufacturing operation or any one of our regional sales offices.