Shipping Container Fume Mitigation

Eliminating fire risk in sealed enclosures containing fuels and solvents (hydrocarbons)

Heavier-than-air gasses must be vented from floor level. It's impractical and unrealistic to attempt exhausting from the roof, or high up on walls. Even with powered systems, installations are dependent on consistent power availability. In addition, installing and maintaining a reliable and intrinsically safe powered ventilation system can be quite costly.

Until now, the only non-powered exhaust system was the rooftop spinning turbine. For fume extraction it has three significant faults: it employs rooftop exhaust only (not floor level where the gasses are), it's not reliable, it's a mechanical system which is prone to failure and turbines only exhaust while spinning, needing a minimum of 2.5 -3mph of horizontal wind to operate.

Roof Top Turbine
FIG 1.1

DRY-CON X ® **:** Exhaust Vent
FIG 1.2

Floor Level Fume Extraction
FIG 1.3

Whether power is absent or available, the DRY-CON X® system is a viable alternative. This system has no moving parts, therefore, cannot break or wear out. The ability to work 24/7 results in consistently drawing off the interior air/gasses. The DRY-CON X® one-way exhaust vent uses any external air movement, down to 1/2 mph, creating a low pressure at the port. In windless conditions, (less than 1/2 mph) thermal buoyancy triggers natural ventilation. Here, warm air ascends, exiting through upper openings while cooler air enters from below, facilitating airflow. The DRY-CON X® system stands as the sole non-mechanical vent capable of consistently preventing high pressure, ensuring uninterrupted fume drainage.

The red 20' container depicted in figure 1.3 designated for storing contaminated fuels and used oils at an industrial site, raised concerns from the local fire department regarding fume build up during weekend closures when the container was locked. To mitigate this issue, the DRY-CON X® system was implemented , incorporating (2) floor level exhausts and a high intake vent positioned at the opposite end. Since the install, there haven't been any further issues or concerns.

Figure 2.1 shows a poor example of the "cross flow ventilation" pulling air from one sidewall and out the other.

With the exhaust turbines at both ends, cross flow is not possible. Moreover, when the turbines are in motion, the lower louver would draw in air, eliminating the sole pathway for the heavy, flammable gases to exit thereby creating an unsafe container environment.

The pull-thru of the DRY-CON X ®exhaust ensures all the interior air is replaced, providing "complete air exchanges".

FIG 2.1

Heat and Moisture Management

Door Mounted Exhaust
FIG 3.1

The DRY-CON X ® system also excels at ventilating hot, humid air within an enclosure.When exhaust and intakes are mounted, they function to vent hot humid air at ceiling level, as pictured here, with the exhaust vent on a container door. On a 20' container, one exhaust and one intake is a typical installation. On a 40' container, two of each is recommended, with the exhausts at one end and the intakes at the opposite end. **Always** locate intakes high on the walls. This reduces the chance of moisture, pollen, ash, dust, or vehicle/machine exhaust or sparks getting pulled inside.

Rear Wall Intake
FIG 3.2

Fumes, Moisture and Heat Venting simultaneously

Wall mounted exhausts offer versatility. Placing an exhaust at floor level and another one above it, near the ceiling will extract both. On a dedicated fuel storage (40 ft.) container, it is recommended to place two exhaust vents low, in addition to two exhaust up high, all on an end wall if possible. The cooler the storage facility is when storing for fuels, oils, etc. the better.

Ventilating hydrocarbon fumes involves principals of fluid dynamics, specifically airflow dynamics. Imagine a pool with a drain at the bottom. When you open the drain, water flows out smoothly ,driven by gravity. Similarly, when you properly vent a space containing hydrocarbon fumes, they flow out through the exhaust vents, driven by factors like pressure differentials and buoyancy. Another example is a Jerry can: when you pour liquid from it, air enters the can from the top to replace the volume of liquid leaving from the bottom. This prevents a vacuum from forming inside the can, ensuring a steady flow of liquid out of the spout. Now, apply these concepts to ventilation by positioning the intake vent high on the wall, it allows fresh air to enter the space, replacing the volume of fumes being extracted from below. This ensures that there is no vacuum effect, promoting a continuous and efficient removal of fumes while maintaining proper air circulation.

Shipping Container Stock Vents

A shipping container is almost 100% sealed. Some have stock rectangular vents high on the sides as shown in figure 3.3 They cannot provide any ventilation due to their interior air passageway being smaller than a dime. Their only purpose is to allow pressure to equalize during transport.

FIG 3.3

Daily Air Exchanges

CFM (Cubic Feet/Minute) ratings are based on powered fans/air handling systems. With CFM specifications daily complete air exchanges are easily determined. In the absence of power, this standard is not realistic.

Daily "complete air exchanges" is the goal, determined by "cubic feet/day"CFD".

Our naturally driven exhaust systems have provided amazing results in many applications for almost two decades. Our exhaust drivers have a CFM rating per MPH(Miles/Hour) of wind, the draw rate is directly proportional to the wind speed. We used fans to test and calibrate this operational spec, but in the real-world, gusts, turbulence and thermal conditions are constantly changing. These climatic variations can be averaged over a 24 hour period to offer a probable CFD and subsequent "Air exchange rate" as per the size of an enclosure.

Low Wind Situations and No Wind Conditions

Case Study 1 : A no-wind Scenario

In a 24-hour period, a 20' container with an intake on one end and an exhaust on the other, can have 5-6 complete air exchanges in a day. The same for a 40' container, due to twice the number of vents. Add a 2-4 mph wind for half a day, and the air exchange rate will more than double.

Crossflow ventilation is still very possible. Temperature swings throughout a 24 hour period causes morning thermals, rising up the walls throughout most of the day, followed by the descending cooling air in the evening and most of the night. Having the exhaust vent on the sunny side is an advantage.

These vertical air currents range from below 1 MPH, up to 4 or 5 MPH. A 1- 2 MPH air movement is not noticeable; 3 MPH can be felt if you are looking for it. Our wall mounted exhaust vent operates in air movement as low as 1/2 MPH which is only detectable with the use of a fog machine or smoke.

This case study was conducted with unnoticeable external air movement. Even without the 2 mph winds, complete air replacement every 6 hours would be extremely advantageous, eliminating fume build up.

Its crucial to recognize that a rooftop spinning turbine as an alternative, would struggle in low wind conditions. Even high-performance turbines typically require 2 1/2 MPH of external air movement to function. Additionally, the minimum air movement required for rooftop turbines increases as they age, emphasizing the need for regular maintenance checks.

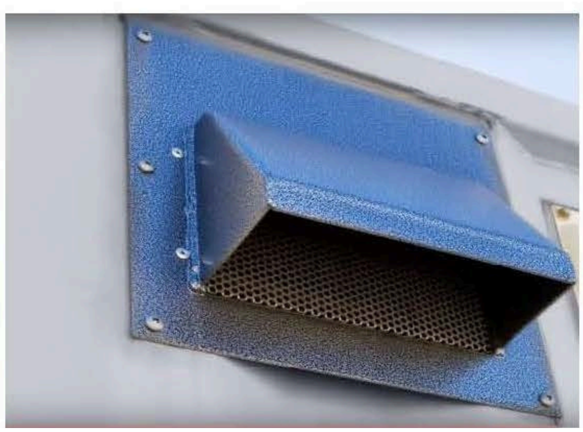
In contrast, the DRY-CON X ® system is non-mechanical , requiring no maintenance and effectively operates in all external air movement conditions. This makes it the superior choice over turbines.

Passive Vents: Intakes

Passive vents do not have airflow specifications, only screen area size, measured in square inches. They do not force ventilation, they allow it. Depending on the wind direction, they will either allow air to enter, sometimes exhaust, and often do nothing. On their own, consistent dependable air exchanges are impossible. Never expect a passive vent to act as a dedicated exhaust vent, nor an intake vent, unless there is a driving force at the opposite end. Only when there is a driving force will a passive vent function as an "Intake".

Our rain/moisture tests have shown that rain hitting louvers (figure 4.1) at certain angles ,can create mist, potentially drawing it inside the container. For that reason, we recommend hooded style intakes. (figure 4.2 & 4.3) Both our Exhaust, and Intake can be placed on any of the four walls of a shipping container. The cut-outs are not oversized, and no additional holes are required for attachment fasteners .

Louvers
FIG 4.1



Hooded Vent
FIG 4.2

DRY- CON X® Side Wall Intake
FIG 4.3

Product Applications

The Siphon is our stack mount exhaust vent. It has similar operating characteristics as the wall mount exhaust system.

Jefferson Lab: “360 Siphon” meets engineering spec of 100% elimination of stack down draft after 20 years of vent experimenting and not meeting spec.

Methane Mitigation in California: "360 Siphon" approved for methane mitigation at a Target store built on a reclaimed landfill site. 27 parking lot lamp standards complete with internal breather stacks with a Siphon on the tops. Monthly checks showed no traces of methane at ground level.

US Navy Fort Worth VA: Two high cube containers storing gen sets and machinery, with (3) “DRY-CON X® ”Exhaust and 3 Intakes on each unit. Dry and cool interiors with no fume build up.

Texas Grain Storage: Texas farmer stores 36,000 lbs. of grain in bags in 40' containers. For years he had significant loss due to moisture, loss as high as 30%. Installed the 360 Products "DRY-CON X®” system, no loss for over 2 years.

For other applications and details please see "Testimonials" on our website.

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