LACO TECHNOLOGIES

APPLICATION NOTE

NOTE #09-24

ALTITUDE SIMULATION FOR TRANSPORTATION TESTING OF PACKAGING

SCOPE

This application note covers the use of vacuum chambers to simulate altitude for transportation testing of packaging.

BACKGROUND

Just as a high altitude mountain climber will experience lower oxygen levels due to reduced atmospheric pressure, packaging will be exposed to pressure changes associated to high altitude transportation. Simulation testing can be done to determine the effect on the packaging. Altitude simulation using a vacuum chamber is one form of test for the effects packaging may experience during transportation. Altitude simulation systems may also include vibration, heating and/or cooling controls to simulate other environmental conditions

DESCRIPTION

Products transported via aircraft can experience altitudes as high as 36,000 ft (10,973 m) and up to 12,000 ft (3,658 m) for ground transportation. When exposed to high altitude conditions, packaging may be damaged or negatively affected by pressure changes. Transportation simulation based on vacuum technology can be used to measure the performance of packaging material and construction exposed to environmental extremes associated with transport. A vacuum test method can determine the effects of transport via certain modes of transport, such as non-pressurized aircraft or trucks which travel over high mountain passes.

A simple vacuum system for transportation simulation consists of a vacuum chamber, vacuum pump, vacuum gauge, vacuum inlet and vent valve. The vacuum chamber should be sized appropriately to hold the package with a few inches extra on all sides to allow for expansion. More advanced systems can have automated controls that automatically sequence through the test cycle and can even control pressurization and depressurization rates. Installing the vacuum chamber on a vibration table is another option to enhance the testing capability of a system.

Once the packaging has been loaded into the vacuum chamber the system should be evacuated to an appropriate pressure equivalent for the altitude to be attained. Altitude and duration of the testing may be modified as appropriate for the shipping environment typical to what the package will encounter, but ASTM D 6653 recommends pressure of equivalent to 16,000 ft and duration of 60 minutes (see Pressure Conversion Table for vacuum).

PRESSURE CONVERSION TABLE

ALTITUDE (FT)	TORR (MM HG)	IN HG ABSOLUTE	PSI
0	760.0	29.92	14.70
1000	732.9	28.85	14.018
5000	632.3	24.89	12.23
8000	564.85	22.24	10.92
10000	522.84	20.58	10.11
12000	483.83	19.05	9.35
14000	446.33	17.57	8.63
16000	411.82	16.21	7.97
18000	379.57	14.94	7.34
20000	349.56	13.76	6.76
30000	225.6	8.88	4.36
40000	140.7	5.54	2.72
50000	87.3	3.44	1.69

DESCRIPTION (CONTINUED)

Following completion of the testing, the package should be inspected. Any change or deformation to the packaging should be identified and documented. Test reports should include, but not limited to a statement of the test procedure with pressure attained and test duration, packaging material and specifications and any changes to the package.

This test method can also be used to leak test product packaging under high altitude conditions. For example, a batch of sealed liquid containers are placed in a vacuum chamber under vacuum for a predetermined time. After the chamber is vented to atmosphere, the operator removes the containers and inspects them for liquid residues on the exterior. A clear acrylic vacuum chamber can be used to perform visual leak test on packaging which contain liquid while still under vacuum.

BENEFITS

The use of a vacuum chamber and systems for transportation simulation reduces high costs including replacement costs of damaged product due to package failure.

RELATED PRODUCTS

LACO Technologies designs and manufactures standard and custom vacuum chambers and turn-key systems that can be used to simulate transportation effects of packaging. Vacuum chambers applicable for this type of system include:

- Vertical Industrial (VI) Vacuum Chambers
- Vertical Clear (VC) Vacuum Chambers
- Horizontal Industrial (HI) Vacuum Chambers
- Horizontal Clear (HC) Vacuum Chambers
- Cube Industrial (CI) Vacuum Chambers
- Cube Clear (CC) Vacuum Chambers

REFERENCES

- ASTM D6653 Standard Test Methods for Determining the Effects of High Altitude on Packaging Systems by Vacuum Method