Technical Note 4

SlimLine general-purpose chamber


# Choosing a Test Chamber

***By George Coleman - Managing Director, Sharetree Limited***

***Temperature test chambers are used for many different purposes, ranging from fixed temperature testing of static products to fast thermal cycling of powered products that dissipate significant amounts of heat. An under-specified chamber will fail to perform the task correctly, while an over-specified chamber will cost more than is necessary. Each type of application requires a different chamber design if optimum performance is to be achieved and Sharetree is always pleased to advise on specific needs.***

## *1 Simple Ovens*

The simplest chambers are essentially an insulated box with a heater, and rely on convection to distribute the heat throughout the chamber. Although the temperature will not be very even over the chamber volume, this may not be important if only a single product is being tested, occupying a small part of the chamber.

The temperature is kept at the required level by using a basic on/off temperature controller. Better temperature control can be achieved by using proportional control of the heater.

## *2 Fan Circulation*

Where full use needs to be made of the chamber interior (e.g. for a batch of products) much tighter temperature distribution becomes necessary. This can only be achieved by using forced air circulation to circulate the air more quickly. Axial fans are suitable for lightly loaded chambers but higher-pressure centrifugal fans are necessary in densely loaded situations.

Faster air circulation increases the heat transfer rate between the load and the chamber air, and therefore reduces the time to reach thermal stability after loading, etc.

## *3 Hot/Cold Chambers*

Some means of cooling the chamber will be required for testing below ambient temperature. The choice is between mechanical and cryogenic cooling.

Mechanical systems use the evaporation of a refrigerant (in a cooling coil) to cool the chamber, with a compressor and heat exchanger converting the gas back to liquid in a closed cycle, to form a self contained system. A typical single-stage system will achieve temperatures down to about -40°C, while multi-stage cascade systems are available for lower temperatures.

Cryogenic systems also evaporate a liquid but the gas is then vented to atmosphere, leading to a simple but powerful system. Very low temperatures are easily achieved due to the low boiling points, at room temperature, of the liquid nitrogen (LN2) or liquid carbon dioxide (LCO2) used in these systems.

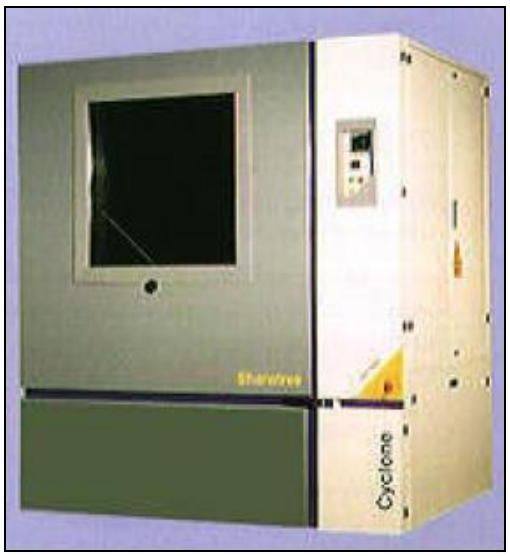
However, special delivery, storage and distribution arrangements are necessary for the cryogenic liquid and running costs can be high.

## *4 Dissipating Loads*

Electrically powered products may dissipate significant amounts of power into the chamber, and this has two main effects that need to be considered.

The product heat will raise its temperature above the surrounding air by an amount dependent on the air speed past the product. Therefore, in order for all products to be tested under the same conditions, it is important to achieve an even air flow distribution as well as an even temperature distribution in the chamber.

A more powerful cooling plant may also be required to remove the product dissipation.




*Cyclone high performance temperature-humidity chamber*

## *5 Temperature Cycling Chambers*

A temperature programmer is required for cycling applications. This allows two or more temperatures to be pre-set, together with the time at each temperature. In addition, the transition between temperatures can usually be specified (e.g. a linear or step change) and the total number of cycles required.
During cycling heat has to be put into or taken out of the load, and it is again important that the air flow is evenly distributed so that all parts of the load are subjected to similar test conditions.


*Stressmaster for fast ramp rates*

## 6 Thermal Stress Chambers

Thermal Stress chambers are a special type of thermal cycling chamber designed to subject products to mechanical stress by applying very fast temperature changes to the product. This stress causes any inherent weaknesses to fail, allowing sub-standard products to be screened out before being shipped to the end customer.

The temperature of the **product** must be changed rapidly, not just that of the surrounding air. Hence the best possible thermal coupling is needed between the product and the chamber air, which in turn implies fast air speeds (3 - 5m/ sec). A powerful circulating fan is therefore essential for a Thermal Stress chamber, and standard temperature cycling chambers are unsuitable for this purpose.

## 7 Chamber Construction

The chamber interior should be fully seam-welded and have good door seals to prevent air leakage. This helps minimise heat loss at high temperatures and ensures that moist air does not enter the chamber at low temperatures, causing frost build up. Heat losses will be further reduced if the chamber has efficient heat breaks and insulation between the inner and outer chamber.

A stainless-steel chamber interior is recommended to avoid possible corrosion problems, and is also compatible with cryogenic cooling.

## 8 System Safety

Test chambers usually need to be left unattended for long periods (e.g. overnight or at weekends) and must therefore fail safe in the event of a component failure. The chamber should be protected from control failure with an independent over-temperature trip, and should include safeguards against mains and phase failure.

Chambers with mechanical cooling plant should in addition have pressure and thermal protection fitted to the compressor system.

Cryogenic chambers must be fitted with an under-temperature trip operating a back-up valve to avoid excessively low temperatures.

## 9 Product Safety

The products under test are frequently of high value and will usually justify additional protection features. Additional high and low temperature thermostats should be specified if required; these can be set to protect the load and are inset from the chamber protection thermostat levels.

*Large walk-in chambers for Automotive testing*

## 10 Operator Safety

The most important safety features, are of course, those that protect the operator. Measures such as protection from exposed mains voltages and adequate earth bonding are mandatory under the various EC Directives and conformance is indicated by a 'CE' mark.

Measures may also be necessary to protect operators from excessively hot or cold temperatures. The latter is especially important for cryogenically cooled chambers. This can be achieved, for instance, by fitting a temperature controlled electric door lock.

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