Factors one should consider while selecting thermal equipment.

Heat processing applications vary widely from industry to industry. Curing, drying, heat treating, sterilizing and bonding represent just a few of the many uses for ovens and furnaces. To some extent, all ovens and furnaces utilize the same basic principles of thermal transfer. Selection of heat processing equipment is dependent on the type of application. Described here are some of the factors you should consider and be aware of while selecting the equipment for your thermal application.

Heat Transfer Methods: Advantages and Disadvantages
Heat can be transferred to the work by natural convection, forced convection or by radiation.

Convection is the transfer of heat from one place to another by the movement of fluids. Convection is usually the dominant form of heat transfer in liquids and gases. Natural convection heating is gentle but slow as compared to forced convection. Both methods are flexible, easily controllable and can be directed for odd shapes.

Conduction is the most significant means of heat transfer within a solid or between solid objects in thermal contact.

Radiation does not need a medium and therefore is widely used for materials sensitive to oxidation or decomposition.

Types of Equipment
There are many issues that must be considered when selecting industrial equipment, including:

The quantity of material to be processed.
The uniformity, size and shape of the material.
The temperature tolerance that is permissible.

Temperature Uniformity
Temperature uniformity is the overall temperature variation in the oven workspace. Uniformity is generally stated as ±°F or ±°C at a given set point temperature. The obvious advantage of tight oven uniformities is that all parts within the oven will be subject to the same temperature, therefore insuring consistent product quality. However, the tighter the uniformity, the more costly the oven or furnace is to manufacture. Oven characteristics that affect uniformity are: wall losses (including through-metal); oven openings; air distribution and the volume of airflow; control accuracy and construction techniques.

Wall Losses
In order to minimize wall losses, insulation thickness should vary depending on the maximum temperature and uniformity required. Through-metal loss should be kept to an absolute minimum by special panel and unitized construction.

Oven Openings
Be sure that oven openings for fresh air and exhaust are strategically located. The location helps to provide a positive pressure differential in relation to the outside of the oven. The fresh

air opening should also be located so that the fresh air can mix thoroughly with the recirculated air.

Air Distribution

Similarly, the oven airstream should be designed so air passing through the heating elements is adequately mixed before entering the work chamber. If fresh air is insufficiently mixed with recirculated air, air layers at different temperatures, called air stratification, will affect oven uniformity. Air duct design, placement and geometry also contribute to uniformity.

Air Flow

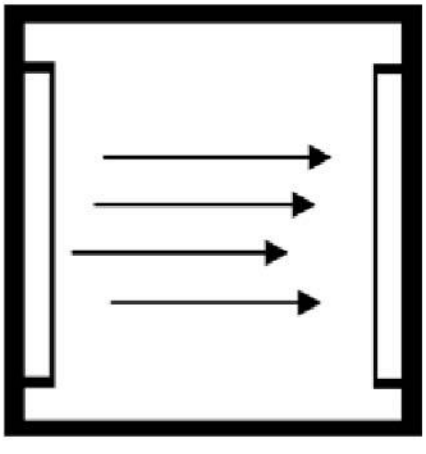
The most important factors determining temperature uniformity are the type of airflow and the volume of air being moved. Best uniformity is maintained when airflow is uniform and reaches all points in the oven. A fan and motor combination must be sized to take into account the amount of air flow through the oven in order to meet the desired uniformity. Uniform temperature at low temperatures (typically, 150°F or 66°C) is easy to maintain due to minimal wall losses. They require minimal amounts of airflow and a simple body construction. As temperatures increase, wall losses increase. Uniform condition is harder to achieve, requiring higher airflow fans and motors, enhanced insulating characteristics and more stringent airflow distribution. Uniformity is commonly tested with the use of a nine-point thermocouple survey. A thermocouple is placed in each corner of an empty oven, at least 3 inches from any surface, with one thermocouple in the centre. Temperature readings are taken for all nine thermocouples after the oven has stabilized at set point temperature. Tests like these are performed at Veliyath's testing lab to assure the uniformity of Veliyath ovens and allied equipments.

Types of Airflow

When selecting an airflow pattern, the most important consideration is the load configuration. The main goal is to minimize obstructions to the airflow for more uniform heat distribution and to maximize the product surface area with which airflow will come into contact.

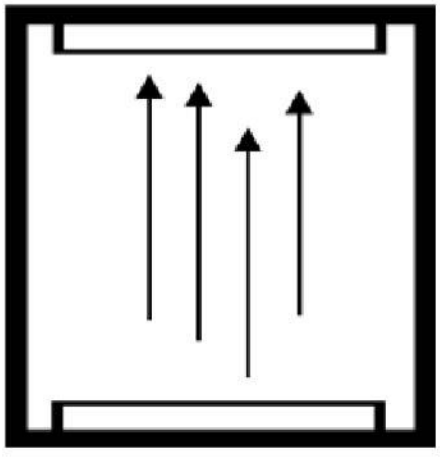
Horizontal Airflow

Supply on one side and return on the other, is most often used for a product that is tray or shelf loaded. The load is such that air can pass above and below.



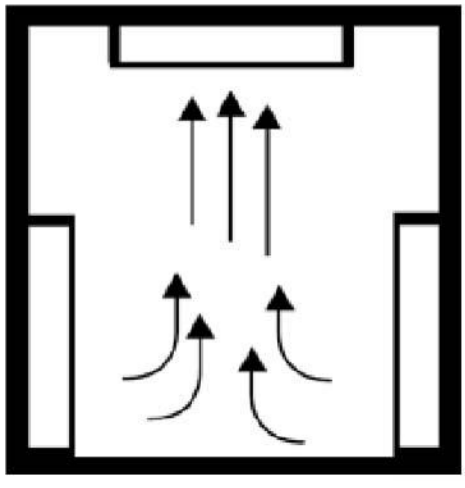
Horizontal Airflow

Vertical Airflow
Supply at top or bottom and return opposite, is for products that allow air to pass vertically through or around. Products may be shelf loaded, suspended from stationary hooks or monorails

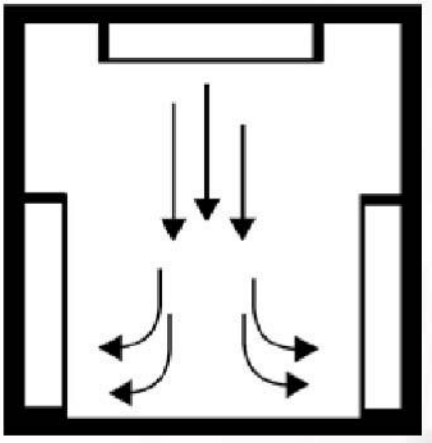


Vertical Airflow

Mixed Airflow
Supply along both lower sides and return at the top, is a combination of vertical up and horizontal airflow and is most widely adapted for all type of products and processes.



Reverse air-flow
Supply at the top and return at the bottom sides, is an airflow pattern that is basically the reverse of mixed-flow. It is often used for large loads requiring vertical airflow.



Reverse Airflow

Process Control and Monitoring
Meaningful process measurement and control is dependent upon three primary factors: Sensor Accuracy; Controller Performance; System Dynamics

Sensor Accuracy
There are many types of temperature sensors, such as, but not limited to:

- Thermistors
- Thermocouples
- Resistance temperature detectors (RTD's)
- Optical pyrometers
- Thermostatic (bimetallic) switches

Because RTD's are the most-often used, we will consider only these in this discussion. **Platinum resistance thermometers (PRTs)** offer excellent accuracy over a wide temperature range (from -200 to +850 °C). Standard Sensors are available with various accuracy specifications and numerous packaging options to suit most applications. Unlike thermocouples, it is not necessary to use special cables to connect to the sensor. The most common type (PT100) has a resistance of 100 ohms at 0 °C and 138.4 ohms at 100 °C. There are also PT1000 sensors that have a resistance of 1000 ohms at 0 °C.

Controller Performance
Modern temperature micro controllers have advanced PID algorithm with auto tuning options. The auto tune algorithm sets the PID parameters according to the rate of heat transfer. It gives very precise and accurate indication and control of the process value.

System Dynamics
The physical construction or dynamics of the controlled oven has enormous impact on the performance of the control system. A carefully-chosen highly-accurate control system cannot compensate for a poorly designed oven system. If the airflow is non-uniform, or air leaks exist in the process chamber, or the control point is improperly selected, or the heat source is incorrectly sized, the best control system in the world will not produce satisfactory results.

Oven Construction

Generally, a well constructed oven will take in to consideration the process load, temperature, accuracy and uniformity requirement. Look for these standards: a stainless steel or mild steel exterior finished in a scratch resistant paint, sufficient insulation to minimize heat loss, easily readable controls, and a door system with sufficient thermal expansion and structural integrity to avoid warping. Construction may be particularly important when a corrosive material is to be processed in the oven, or when possible contamination of the work load can occur. You will need a stainless steel interior whenever high degrees of cleanliness, clean ability and resistance to corrosion are required. This type of interior includes stainless steel material throughout the air stream portion of the oven and in the heat chamber itself. Mild steel interiors with corrosion resistant aluminium/silicone paint are acceptable for drying and for general non-corrosive heating/curing operations.

Facility Considerations

Several facility considerations are critical to the successful installation of your processing oven. Be sure the power supply is correct for the application and that it is conveniently located. The same holds true for water drains, air and water supplies (volume and pressure). Check to see if there are any facility restrictions at the location and be certain that there is proper access clearance to bring an oven into the facility.

Test and prove your process before you purchase an equipment

If at all possible, work with Veliyath test facilities to help confirm expected results. Many ovens are unique pieces of equipment for a specific job. It may not be enough that a manufacturer has built many ovens. It may be necessary to prove that a specific oven design will work before it is built. Further, Veliyath may be able to actually improve process technologies already in place. The conceptualizing and testing of new heat processing methods is a sign of innovation and capability in the industry. If possible, visit vendor facilities to determine their level of commitment in the area of innovation.