KERONE

OVEN SELECTION GUIDELINES

Environment Friendly Engineering Solution Company

In Association with SVCH-Technologii, Moscow (Russia)

ISO 9001-2008 | ISO 9001-2015 | EMS 14001 | OHSAS 18001

www.kerone.com

About Kerone

KERONE now renowned name in serving specialized need of customers with best quality and economical process Heating /cooling and drying products, manufactured in high quality environment by well trained and qualified workforce(special purpose machineries) .

KERONE is pioneer in application and implementation engineering with its vast experience and team of professionals. KERONE is devoted to serve the industry to optimize their operations both economically and environmentally with its specialized heating and drying solutions.

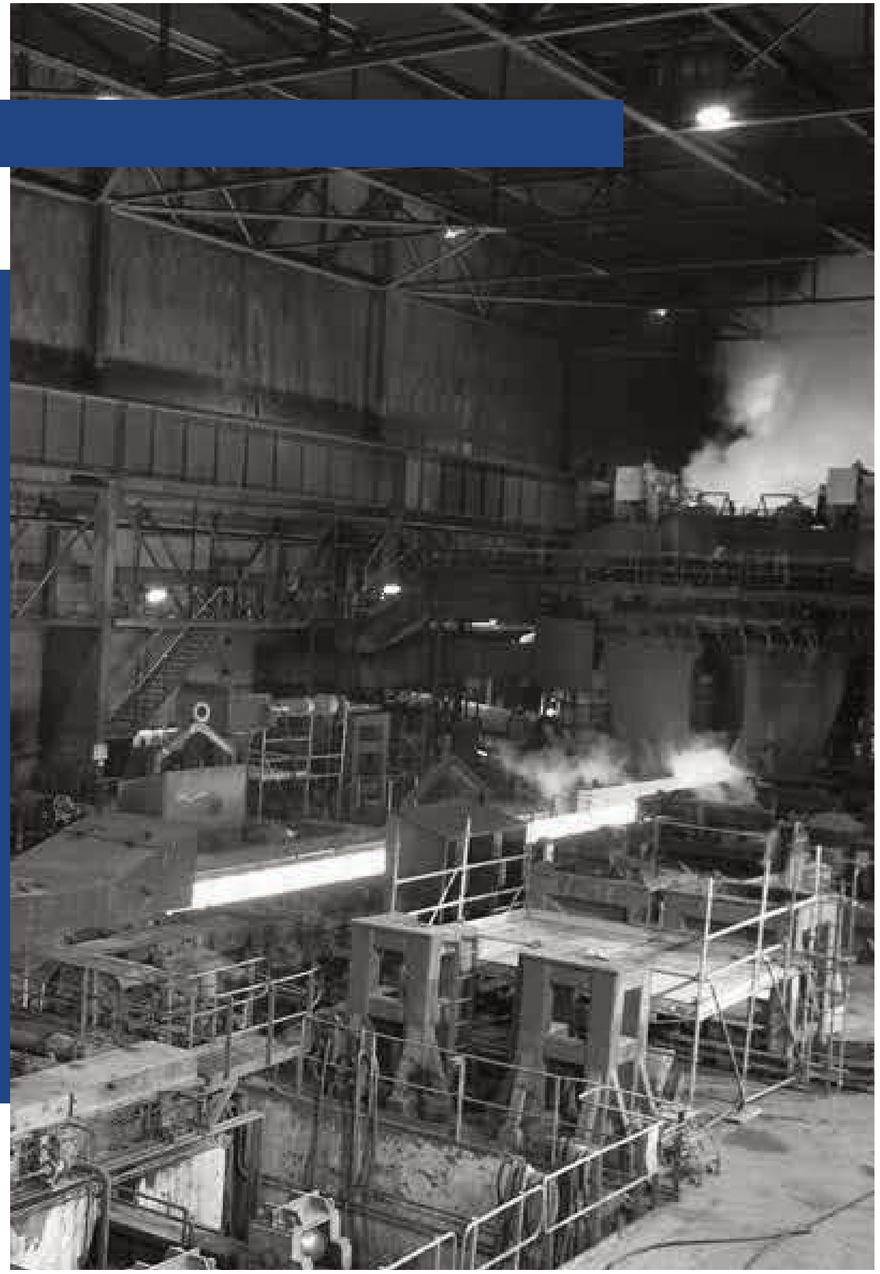
"Enhance the value of customer operation through our customer need centric engineering solution"

Mission

- To enhance the value of customer operation through our customer need centric engineering solution.
- We are committed to provide our customers, unique and best in class products in Industrial heating, drying and cooling segment, with strategic tie-up for the technical know-how with renowned leader in the industry specific segment.

Vision

- Turn into world leader in providing specialized, top-notch quality and ecological industrial heating, cooling and drying solution across the globe.
- To attain global recognition as best of quality and environment friendly engineering solution company.



40 Years
of rich **Experience**

Great after
Sale Support

Sound
Infrastructure

Team of experts
Delivering Quality

KERONE

Adherence to
Standards

Cost Effective
Solutions

Timely
Delivery

Highly
Customized Product

Purpose of this Guide

The key motivation behind this guide is to talk over general concepts and issues related to the selection of industrial equipment for heat processing.

Heat application has become necessary for all most for any type of product being manufactured and processed, this guide was created to provide a base knowledge of the intricacy of matters associated to selection of optimum equipment for any particular process. This guide is just for information please reach to Kerone's engineering team for actual product design and implementation.

Choose Carefully

Selecting heating system that best fit to your process requirement. based on type of applications such as curing, drying, heating, sterilization just few of them. Same desired outcome may require special attention, as the heat processing is varying widely from industry to industry even some occasions product under processing.

You may wonder how same thermal transfer principle differs based on the product under process or manufacture. Below we have tried to describe few general criteria that requires your attention in order to make you general classification and basic working principles.

Elementary Oven Consideration

Heating equipment are generally classified as oven and furnace, while ovens operates around 1000oF on other hand furnace operates above 1000o, is this the only difference between two categories? NO. There are lot more apart from this, just continue reading this guide you will get to know the real difference.

Heat processers are designed based on loading methodology batch type or continuous conveyor type. The source of heat can be combustion fuels such as gas, oil and etc., electric, steam or hot water depending upon desired process, material under processing, desired outcomes.

Heat Transfer Methods

Natural convention, forced convention and radiant heat transfer are few of the heat transport techniques from heating source to material under treatment. Natural convection heating usually turned out to be very speedy, but results are not uniform heating which is advantages of forced convection. Both methods are flexible, controllable and can be focused for odd shapes. Radiant heat transfer is quicker at higher temperatures and primarily cost efficient, but is not as flexible as convection and must be tailored specifically considering product requirement.

In accumulation to diverse varieties of transfer, heating equipment may be intended to contain special atmospheres such as argon or nitrogen, or may include superior manufacturing materials required for explicit needs.

Making Right choice

Issues that can encounter while selecting right type industrial equipment, includes:

- *Quality of material under processing – both before and after process*
- *The structure of material l uniformity, size and shape*
- *Feeding mechanism, manual or automated*
- *Type of firing mechanism desired*
- *Sensitivity of material towards heat*
- *Permissible tolerance level*

Batch type may turn out to be the better choice for the processes those comprise of chemical slurries, or there is huge difference in the input and output product size or output fluctuates extensively.
On other hand continuous type of suitable of processing paints, heat treatment of uniform material, food sterilisations, basically the places where the quantity is large and but processing temperature and material are mostly same.

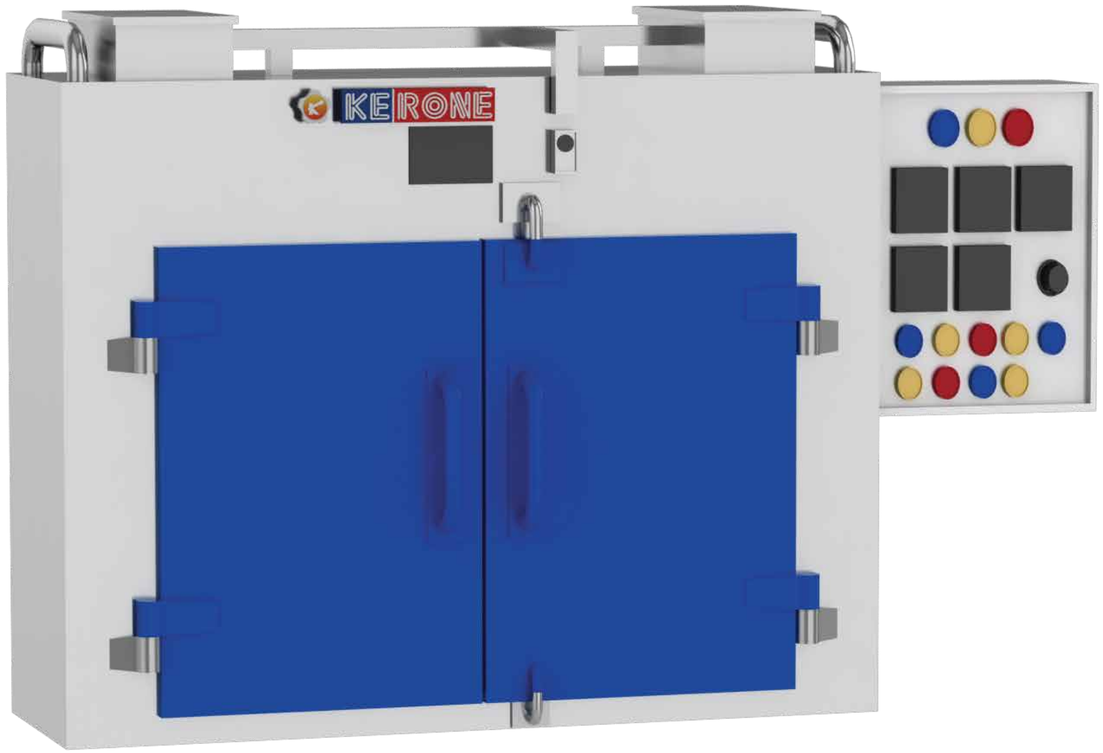
Batch-Type Ovens

This category of oven encompasses of all the oven large to small those operates in batches, which mean a predefined (limited) quality of materials are fed as input (manually or mechanically) in oven cabinet and later the door is closed and it process the material for set time period and later released.

These ovens are the largest category of ovens used to manufacture products in batches. This can be classified as cabinet-style or truck-loaded type. The characteristics of oven may change from size, feeding mechanism, construction and processing time and temperature.

At Kerone, we offer batch type ovens for both laboratory and industrial applications. Batch ovens range in capacity from 2 to 24 (only indicative) cubic feet. Typical temperature ranges are from 80°F to 850°F.

Batch type ovens can be extensively used for curing, baking, drying, finishing, annealing, sterilizing, and etc; almost the applications are limitless.



Continuous Ovens

This category of ovens includes all the type of ovens those operates in continuous manner with the help to conveyor belts for feeding material and then transporting it with in the oven and post processing taking it out of oven. No manual intervention required, sometimes have different temperature zones, no wastage of time, possible to integrate with existing process/assembly line. Conveyorized ovens are capable of handling large quantity of materials on continuous basis.

The type of conveyor designated for a continuous application depends completely on the type of products being processed and their configuration at the time of processing. Conveyorized ovens can be unitized for all type of application for those batch was selected, such as:

Curing | Baking | Cooking | Preheating | Annealing | Sterilizing | Drying

Above application are just to name few, Kerone's continuous conveyorized ovens can be used for all type of heating application. However, it becomes economical it the quality to be process are large.

Heat-Up/Soak/Cool-Down Times

Heat-up, soak, and cool-down times are key components to give importance for choosing the precise oven. Below are the few basic questions that can be asked:

1. Does the oven have adequate heating ability to convey the product to the desired temperature within the definite cycle time?

The answer to this question depends on the mass and specific heat of the product. For example, the specific heat of material is 0.126 BTU/lb x degrees Fahrenheit. For 10000 pounds of material to touch 500°F from 50°F within an hour will require:
10000 pounds x (5000F-500F) x 0.126 BTU/lb x degrees Fahrenheit ÷ 1 hour = 56,7000 Btu/H
This is the energy essential to heat the product. The heating capability of the oven should to be greater, due to heat losses via the oven walls, via exhausted air and via heating of the oven mass itself. In an oven where the exhaust rate during heat up is 60 Standard Cubic Feet Per Minute (SCFM), the heat needed to heat air will be:
60 SCFM x (5000F-500F) x 1.1 Btu/H/SCFM 0F = 29,700 Btu/H
If the wall losses for the oven are 5000 Btu/H, the heater capacity will need to be at least: 56,7000 + 29,700 + 5,000 = 60,1700Btu/H
Converting it in Kilo watts (1kw = 3412Btu/H) 60,1700Btu/H ÷ 3,412 Btu/kW-Hr = 176 kW.

2. Will the product be able to take up heat at a rate adequate to extent temperature within the definite time?

The thermal conductivity of the material, the size and shape of the product, and the velocity and direction at which the air impinges the surface of the product are decisive factors for the rate at which a product can absorb heat.

Just estimating the heat absorption rates based on charts and formulas even for common materials are not sufficient, hence at Kerone research center we conduct actual test on the materials to get to know the exact rate at which a product absorbs heat.

The absorb rate should be in range otherwise, the product may not be able to reach the desired temperature in the desired time frame, even though the heating capacity of the oven is sufficient.

3. Should the rate of increase of heat be controlled or all the product to reach the temperature in no-time?

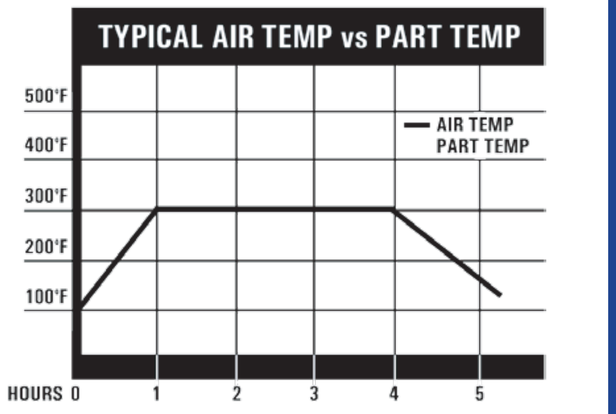
If the process does not want that the heat-up rate be controlled, a standard set point controller may be used to control oven temperature. The oven load will reach temperature as rapidly as the product volume and oven heating capabilities will allow, may not be in linearly.

If a controlled heat-up is required (e.g., heat-up at 1o F per minute), a programmable, ramping controller is needed. Such a controller allows a specific, linear heat-up rate to be programmed

Soak Times

Soak time indicates to when the item has achieved the ideal process temperature for the desired time interval. A programmable controller can be customized to stay at temperature for a predetermined time-frame, at that point chill off to finish the cycle. For many applications, the soak cycle begins once the time determined for the warm-up cycle has been finished.

To make the control more precise, it is necessary to restrict the soak time until the product temperature has reached, a Guaranteed Soak option can be utilized. In this method, the controller does not start timing the soak cycle until a thermocouple embedded on the product, or in the air stream, senses that the set point temperature has been reached.



Cool-Down Times

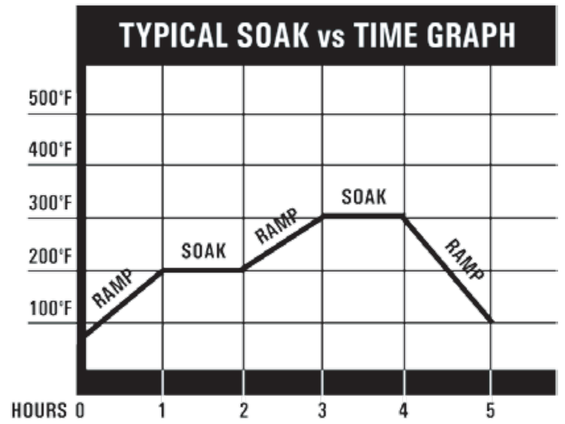
Since cooling can be thought of as expulsion of heat, product contemplations for cool-down rates are like those for heat-up rates. Ordinarily, broiler cool-down is accomplished by depleting heated air from the stove. A relating stream of cooler, surrounding air will enter the stove to supplant the warm depleted air. In the event that the cool-down rate requires no control, the main need is to estimate the fumes fan sufficiently extensive to evacuate the essential measure of heat in the required time.

Exhausting oven air can be achieved by the ways of:

1. Exhaust damper are kept open to the sufficient point, and suppling the heat from other end to maintain the temperature of oven.

2. Controlling the damper by the means of programmable controller is another option. The dampers will be controlled in order to keep cooling rate maintained.

With passive atmosphere oven, however, cooling by means of exhausting oven air is not usually a viable method, as oxygen is introduced into the oven. Air-to-air or air-to-water heat exchangers are effective in removing heat from the oven in these applications.



Air-To-Air Heat Exchangers

These use a finned plate located between the oven air and a duct through which ambient air is drawn. By this means, heat is directed over the plate and unrestricted to the ambient air. This type of exchanger is suitable for higher operating temperatures where the temperature difference between the oven air and ambient air is great enough for heat transfer to occur at a sufficient rate.

Air-To-Water Heat Exchangers

These are used at lower operating temperatures, typically 50°F above ambient. With this type of exchanger, oven air passes over a finned, water-cooled coil. The cooling rate is precisely controlled with a solenoid valve which regulates the flow of water into the coil. Remember, the coil size and flow should be designed to prevent water from boiling in the coil.

Uniform Temperature

Uniform temperature with in Oven or temperature uniformity is defined based on the usage, processing type and type of oven. Uniformity is not maintaining same temperature across oven, but the basic definition states that uniform temperature variation within the oven based in the demand of process and type of oven. Commonly expressed in ± degree C or F at from reference temperature.

Maintaining uniform temperature across oven results in smooth processing and better product quality. Oven temperature uniformity greatly affected by:

- *Oven wall losses*
- *Volume of airflow*
- *Door openings*
- *Control mechanism and accuracy*
- *Air circulation*
- *Physical construction techniques*

Wall Losses

Ovens wall as made out of metals hence the temperature losses due to walls will be if not insulated properly, hence to maintain the uniformity and minimise the losses, it is required to pull down the metal losses to absolute minimum by properly insulating the walls.

Opening and closing doors

Ensure that oven openings for fresh air and exhaust are intentionally found. The area gives a positive weight differential (in connection to the outside of the oven), so cool surrounding air brought into the oven through door seals is limited. The fresh air opening should in like manner be found so the fresh air can mix totally with the recirculated air.

Air Circulation

Also, the oven air stream ought to be planned so air going through the heating components is sufficiently blended before entering the work chamber. On the off chance that fresh air is inadequately blended with recycled air, air layers at various temperatures, called air stratification, will influence oven uniformity. Air duct design, placement and geometry also contribute to uniformity.

Air Flow

The airflow is key attribute in maintaining uniform temperature across the oven. The type of airflow (horizontal or vertical airflows), the volume of air being moved and the reach up to all points within the oven are most important determining factors in temperature uniformity.

The better the controlled air volume flows through an oven, better the uniformity can be achieved. A fan and motor combination are properly sized to make the amount of static pressure drop through the oven in order to achieve the desired uniformity. The oven walls are lesser susceptible to losses at low temperature heating, hence maintaining uniformity become easy. Uniformity becomes matters of concern as the temperature starts rising, it becomes hard to achieve the uniformity as it has higher wall losses hence need boosted insulation, requires higher airflow fans and motors and carefully designed and controlled airflow circulation.

Kerone research and development center (KRDC) we perform various type of tests to maintain uniformity that result in best quality output. Some of the type tests carried out is

Thermocouple test:

- Without input: Placing thermocouple in various corners of oven then raising the temperature from ambient to desired points and checking noting the results
- With material under processing: Material to be processed in placed under the oven the re-performing the test.

Loading and unloading Material

Material handling or material movement can be manual or automated based on type of ovens and material under processing. Inputting to and outputting material from oven is very critical as it affects the processing time, speed of material movement and also final product design. Inefficiently planned loading and unloading mechanism may turn out to be bottleneck in entire process.

Material loading are mainly of two types batch loading also known as Truck loading, the material handling in batch type of oven are usually simple, however before points that needs to be taken care are:

- Total weight of the load
- Number of units to be processing in every day
- Processing cycle time
- Number of processed outputs required per shift/day

The other type of material handling/loading mechanism is continuous flow that utilized belt type conveyors as means of moving products through an oven. Few common but important attributes of the continuous material handling are:

- How product will be fit on conveyor
- Quantity that can travel
- Weight of material
- Length of Oven
- Speed of conveyor belt
- Processing time
- Temperature within oven

Few of the conveyor belt attributes might seems to be irrelevant to material handling many are not quoting them, but I assure you they all are connected to each other.

Monorail type conveyors, Pusher type conveyors, Roller conveyors powdered, chain type conveyor, Screw conveyors are few other commonly used conveyors.

Monorail conveyors generally comprise of the chain and trolley system; they provide heavy duty application. Weight of material to carried, number of material per cabin, spacing between hook, type of hooks and fixtures, speed of conveyor motor, and processing time within the oven are some of key points to be considered of consulted with experts.

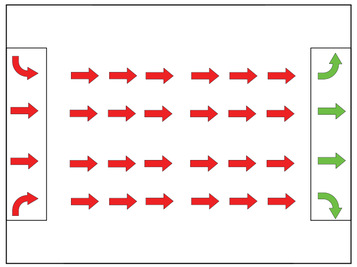
Sometimes special handling is required for the very delicate or hazardous materials, please connect with Kerone to explore all available options

Types of Airflow

As already discussed, airflow and its distribution within the oven is very critical in maintaining uniform temperature within the oven. Tests carried out in empty oven always gives brilliant results with any airflow patterns, however in fully loaded oven the story is different. Load configuration plays vital role in selection of airflow patterns, the object in deciding airflow pattern is to minimize the obstruction to flow and expose the maximum product surface area to air.
Few of the common and popular air circulation and distribution patterns are discussed, however it is advisable to connect with experts at Kerone.

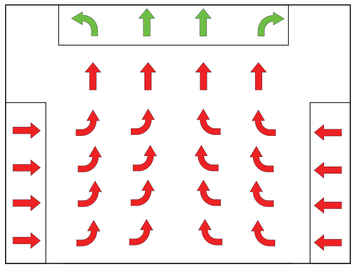
Horizontal Airflow

Hot air is supplied from one side and return to the other end in-line with surface of oven. Commonly used in batch type ovens in which the material is loaded in trays or shelf that allows the air to flow through and through from both above and below material loaded.



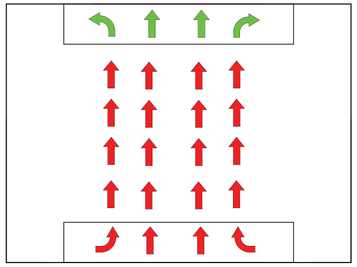
Uniflow Airflow

Hot air fed from both the side as travels along the walls and returns at the top, this is also known as hybrid airflow control which as advantages of both vertical and horizontal airflow. It is best suited when the material/product under processing is large and has complex shape.



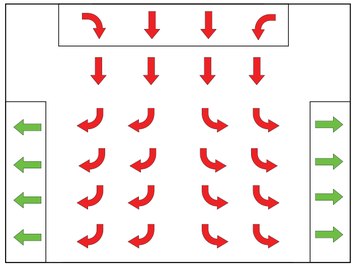
Vertical Airflow

Hot air is supplied either from top and return from bottom or other way around, effective for the materials that allows the passage of air vertically. This type of air flow is suitable for both batch and continuous ovens where material so placed or hanged such as way maximum surface area is exposed to airflow.



Reverse Airflow

This is inverse version of uniflow airflow, here in this airflow mechanism hot are is supplied from top and reruns at the bottom side of both walls or opening and closing.



Oven Loading

Oven loading are vital part of the oven in order to choose the best suited configuration. Type of loading varies based on the product/material to be loaded for processing. Few of the common loading mechanisms are:

1. Reach in front loading: Standard reach-in front loading are commonly used for the light-weight or easy to handle product.

2. Walk in front loading: Walk-in front-loading ovens are used to handle heavy or hard to handle products. Usually size of the material/products are large, suited for truck loading applications.

3. Top Loading: Top loading ovens have entry of the product/material to be processed from top opening of the ovens.

4. Drawer type loading: Few products are suitable of the drawer type of applications as it helps in minimizing heat losses by carefully designing the drawer sizes.

Oven loadings can be operated manually or powered to operate using electric or pneumatic. Powered loading doors make the process more automated and level of error are reduced. Kerone can help you with both manual and powered loading doors.

Heating Mechanism

Heater firing mechanism becomes one of the critical selection factors as this plays decisive part in energy consumption and energy utilization, which is a critical factor when processing the material and also for long run of the heater. Generally, electric fire heating systems offers best efficiency almost close to 100%, when compared with gas / fuels fired heaters, however gas fired is less expensive when compared to electric fired heaters. Direct fired gas heating is more efficient than indirect gas fired, but efficiency is only dependent on the firing but also deviates a lot based in the temperature desired and ventilation requirements. Electric heaters are generally offering better control also at low temperature and provides better temperature uniformities. Also, you can explore our new age heating techniques which uses IR, microwave and RF.

Cooling Mechanism

Exhaust fans of proper size is only sufficient for cooling at lower temperature down to 100°F. However, if your processing was at higher temperature or you require higher cooling rate or have an passive atmosphere oven, then you can explore our other cooling options such as:

1. Air- to-air
2. Air-to-water
3. Intermediate cooling chambers

Ovens in hazardous conditions

Ovens to be situated in special or hazardous conditions requires some exceptional design considerations. These ovens considerations are not only limited to within the oven chamber oven but also external atmosphere specifically for an explosion hazard from the possible ignition of dust, vapours or gas.

While designing oven that has to operate in such scenarios, requires very careful planning and similar importance to both internal and external factors, such as:

- Fans should not produce and spark on start and stop
- Properly insulated and sealed wiring and junction boxes
- Motors must be of proper rating (motors should not get over loaded or produce spark)
- Air circulation source of fresh air from and release air outside hazardous area
- Product loading and unloading should be automated to avoid any human error
- Stringent control mechanism for controlling with accuracy

Since such environmental conditions are very critical for machine and man life, hence several classifications and design guidelines are suggested by NFPA as well. You should get the environment audited first in collaboration with Kerone to enable us to design oven that is safe to operate for life time.

Electrical Power required

You should know the electrical power that would be desired to operate your oven and other machines beforehand, so you can access the gap between available to required power. You should know the voltage, number of phases available, total power consumption. While planning for desired electrical power please take all your electrical equipment in consideration and balance the loads accordingly.

Local electric frequency and load should be given importance as some part of word electrical frequency is 50Hz while for others its 60Hz. Mostly ovens are considered to work on any electrical supply, however if several supplies are present, consider the following:

a. Electrical motors are very common and important part of the oven. You should be aware of power requirement of the motors being used.
b. Three phase electrical supply is more suitable for industry scale ovens to operate as the power requirement is high and if voltage is low, then current requirement becomes high as (Power = Voltage x Current).
c. Large current will increase size of few component and will make the oven more expensive.
d. Wire should be chosen with minimum losses and higher conductivity.
e. All the connections should be properly sealed and terminated.

Please check local requirements beforehand for various ratings.

Process Control and Monitoring

Accuracy of Sensor, performance of Control systems and construction of system are key contributors in process measurement and control.

Thermistor, RTD and Thermocouple are the most popular type of temperature sensors, however they are many varieties of sensors available in the market. Choosing a temperature sensor for your application can be a critical task. Current market offers wide range of sensors that you might feel lost sometime.

Modern day controllers are having in precise temperature controller with auto tuning PIDs. Controller performance depends on the accuracy of measurement, response time controlling units and effectiveness on the final processing.

The structure or physical construction of the measured oven or furnace system has vast influence on the play-acting of the regulator system. On the off chance that the airflow supply is non-uniform, or cool air leaks exist in the process chamber, or the control point is inappropriately chosen, or the warmth source is mistakenly sized, the best control framework on the planet won't deliver agreeable outcomes. There is no hope to improve the performance shy of improving the mechanical qualities of the framework, which may not generally be conceivable.

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Processing Flammable Materials

NFPA (National Fire Protection Association) suggested various classes for the ovens based on the materials to be processed and environment condition. NFPA classifies such ovens under "Class A".

Materials which are flammable, combustible or highly reactive needs special oven construction and design standard to be followed based in guidelines of NPFA. Class A ovens are graded for extreme material handling capacity, usually specified in gallons per hour of a specified material at specific temperature.

Kerone has dedicated team of SME (subject Matter experts) those are experienced and qualified in handling critical and flammable materials. All ovens designed and built follows the NFPA rules and other regularities.

Oven Floorboards

Floorboards or the bottom surface of the oven too have vital roles to play in success of overall oven performance, other environmental and available space consideration. There are ample choices available for the selection, however will all suite your requirement? This is biggest question. Most of the ovens have a metal panel floorboard for surface mounting, other types are recessed into the factories existing floor, also the surface mounted ovens with insulated cement are available.

Truck loaded ovens mostly preferred with an isolating surface with recessed track or rails to guide the position of channels.

NFPA 86 suggested insulated floorboard for temperatures above 150oC. Floorboards corresponding to calcium silicate protecting sheet offers the essential protecting belongings while saving on installation by disregarding the necessity for pouring an isolating cement floorboard.

If you are wondering why the floorboard has become matter of concern, then contact our Kerone research and development from www.kerone.com , you will have clear picture of this importance of floorboard with live examples.

General Consideration of Oven Construction

The oven should be properly wrapped with suitable metals properly ionised (if required), painted, insulated and accurately joined. A properly constructed oven will accommodate the range of operating temperature, environment of operation and type of material operated on. Some of common consideration for the oven construction are steel exterior painted with scratch resistant paint, properly insulated wall to avoid any heat loss, easy to read and easy operate control panels, the door system with adequate thermal extension and structural integrity to run the oven for desired duration of time at required temperature.

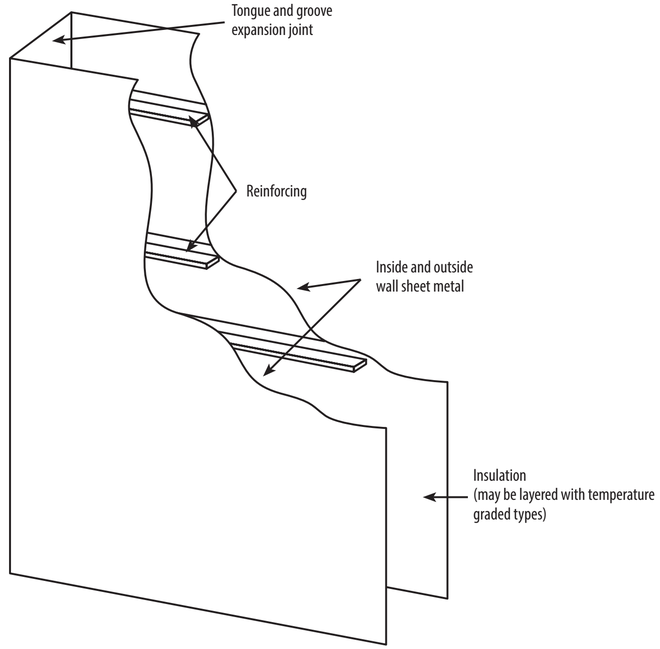
Internal oven construction becomes vital when the material to be processed are corrosive, radioactive or flammable in nature, to avoid any kind of contamination interior of oven is fabricated with the stainless steel, even some time painted with suitable chemical as well.

Several aspects (specially related to process) must to be taken into consideration for design of oven construction:

- Maximum temperature of the oven
- Size of the work chamber
- Number and type of expansion joints
- Temperature uniformity to be maintained
- Fan size depending on process
- Door size and seals
- Breaker strips to get the uniformity desired

Sealed doors are important for operation of oven key factors that affects the design/selection of type of door seal are desired atmospheric condition, size of opening, type of door and maximum temperature of operation. Oven with higher temperature uses ceramic with silicone or fiber glasses on the other hand low temperature ovens silicone seals. Vertical lift doors with pneumatic locking cylinders for bigger oven openings as they are appropriate to use and easier to seal.

Passive atmosphere ovens require distinct construction techniques for expansion since insides should be ceaselessly welded. Recirculating High Efficiency Particulate Air Filters can be shared with the best possible oven and process design to permit cutting edge control. Experience and notoriety are especially imperative on the off chance that you are keen on one of these "clean process" ovens.



Sectional view of oven wall

Other General Considerations

Apart from key oven design consideration some of the common or general facilities that is required such as: uninterrupted stable poser supply (3 phase would be preferred), proper ventilation and source of fresh air, availability of drainage facility, properly pressurised fresh water supply. These factors are not key contributor in oven design and operation with still they are necessary for successful operation of oven.

Keep it safe

Safety is greatest concern when designing and operating oven. Oven are designed to operate within specified temperature range, with specific parameter to process the particular type of material for defined time interval. Improper usage of oven may result in some serious damages such as Fire, explosion, casualty to operator injury or death; hence a proper demarcation should be written for all controls. A well-defined and easy to understand user guide may help operator to avoid any kind of fatal accidents.

See It Before we built for you (testing and proving concept):

It's always better to see the pilot version of your oven running with real material and get all the desired tests done on final output, material under processing and on oven. Visit to our research center (Kerone Research and Development Centre (KRDC).

At KRND our team will help you to stimulate the actual behaviour of oven and material. Hence, various permutation and combinations can be tried out to get the best oven.

If you have any query o you are seeking for any help, please visit www.kerone.com or write us at info@kerone.com

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