A Guide to Specifying and Selecting An Industrial Oven

This Technical Bulletin provides you with an overview of how to select and specify an industrial oven to optimally meet your process application requirements. This technical bulletin provides in-depth technical information to assist you in understanding the key issues related to the oven selection process. Actual equipment specifications should be made after consultation with LEWCO sales application engineers.

If you are in a hurry, (and who isn't) simply log on to www.heat-pro.com. The on-line Oven Configurator will guide through a simple three-step process that automatically generates a comprehensive oven specification and supporting details that are unique to your unique application. The entire on-line specification process only takes a few minutes to complete. The Configurator prepares a quote request for your oven unit along with technical documentation.

User Configured Models

LEWCO, Inc. employs cutting-edge technologies to design and manufacture high quality cost effective industrial ovens. Parametric engineering, 3-Dimensional modeling, and JIT manufacturing allow LEWCO to offer custom size ovens for the price of a standard model. These technologies also allow LEWCO to offer aggressive delivery schedule while maintaining superb quality.

Process Heating Applications

Heat is used extensively in virtually all types of industry for processing. Typical applications for ovens and furnaces include bonding, curing, drying, heat-treating, and sterilizing. Although applications vary widely from industry to industry, all ovens and furnaces share the same basic thermal transfer principles. Selection of heat processing equipment depends on the process application and the specific needs of the products being manufactured.

Product photo: Continuous oven with high volume vertical down airflow.

Industrial Oven Basics

Industrial ovens are classified as heating equipment that operates from ambient temperature to I000^{o}F (538^{o}C). Industrial furnaces operate above I000^{o}F. The heat source is provided from combustion of natural gas, oil and other fuels, as well as from electricity, IR wave energy, hot water or steam.

Heat Transfer

There are three ways heat can be transferred to the work: natural convection, forced convection or by radiant heat sources. Natural convection heating can provide very rapid temperature increases, but is generally less uniform than forced convection. Both convection methods provide flexibility, ease of control and the ability to accommodate odd shaped products. Radiant heating provides heat transfer at higher temperatures at a lower initial cost. However, radiant heating is not as flexible as convection and must be tailored specifically to the product.

There are two different types of firing methods – indirect fired and direct fired. In an indirect configuration, the burner is fired through a tube or a tube type heat exchanger. Recirculation air passes over the heat exchanger, raised to the desired set point, and is delivered to the load. In direct-fired heating, a separate heat chamber heats air and recirculates it to the work chamber. The recirculated air passes through the work chamber and the temperature increases to the desired set point. This method has the disadvantage of the combustion byproducts mixing freely with the load.

Types of Industrial Ovens

Industrial ovens are designed to meet the requirements of specific types of applications. Key considerations include the quantity of material being processed, the uniformlty in size and shape of the products, the allowable temperature ranges and tolerances, and if the product or process is manufactured in a batch or on a continuous in-line basis.

Batch Ovens

Batch-type ovens are the largest category of industrial ovens used to manufacture products. Batch ovens include the bench-mounted or small cabinet-style and the truck-loaded walk-in type.

Bench-mounted or small cabinet-style ovens are used in lighter duty applications and provide an economical solution to processing a wide array of small parts. Batch ovens are used for slurries of chemicals and where the product size or output varies substantially. Cabinet units offer expanded capabilities for processing handling small or flat parts on shelves or trays through horizontal air-flows. Both types of units are commonly used for curing, drying, and sterilizing. Bench-mounted and cabinet-type ovens are most often used for laboratory applications. Typically, the units are available in electrical heat only. The units range in capacity from eight to 120 cubic feet. Temperature ranges are from 100F to 650F (38C to 343C).

Photo: LEWCO Bench Ovens.

Photo: LEWCO Cabinet Ovens.

Walk-in Ovens

Walk-In ovens are a subcategory of the batch style oven, as are bench and cabinet models. Walk-in units are among the most versatile types of industrial heat processing equipment. These units are available with either dual or horizontal airflows, and are ideally suited for processing large parts or materials on carts or racks. Walk-In ovens range in size from 3 cubic feet interior volume to 1,000 cubic feet. These ovens are used extensively for annealing processes, baking, curing, drying, finishing, and many other applications. Walk-in units are shipped factory tested and fully assembled for efficient integration into factory systems.

Photo: LEWCO Walk-in Oven.

Continuous Conveyor Ovens

As the name suggests, continuous ovens are used for heavy-duty continuous process heating applications such as curing, drying, heat treating, paint baking, pre-heating, tempering, and in applications where a large quantity of similar work-pieces are processed. Although continuous ovens are constructed similar to batch ovens, these ovens also offer product conveyance, a variety of options for air distribution to accommodate various product geometries and spatial orientations, and manual or computer-controlled loading and unloading systems for faster processing and reduced labor costs.

The type of products being processed and their configuration at the time of processing are two of the major factors in selecting the conveyor type for a continuous application.

LEWCO offers a variety of pre-engineered conveyors; including wire mesh belt, slat, and roller conveyors to meet the requirements of virtually all continuous process-heating applications. In addition, monorail conveyors are easily adaptable to a variety of work-pieces. A large number of individual work-pieces can be positioned on fixtures or rocks suspended from the monorail for efficient processing.

Conveyor Styles and Operating Characteristics

Conveyor Type	Description
Standard- flat Wire Mesh (Galvanized)	
Flat Wire Mesh (Stainless Steel)	
Slat Conveyor	
Pan Conveyor	
Roller Conveyor	

Field-Assembled Ovens

Field-assembled construction facilitates the cost effective installation of an oven too large to ship as a complete assembly. Standard design and construction techniques minimize installation time. Each oven is shipped with a fully assembled heater/burner box, insulated panels, and all controls. Available in almost any size, field-assembled industrial ovens are rated for service to 500ºF.

Heat-Up / Soak / Cool-down Cycles

Heat-up, soak, and cool-down cycle times are critical in equipment selection.

Heating Capacity – The critical question in heating capacity is whether the oven has sufficient heating capacity to bring the product to a desired temperature within a specified cycle time. Key considerations include the mass and specific heat of the product.

Time Frame – 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. The rate at which a product can absorb heat is dependent on the thermal conductivity of the material, the size and shape of the product, and the velocity and direction the convected air impinges the surface of the product. While heat absorption rates can be estimated for common materials based on charts and formulas, you should conduct actual tests if it is necessary to know the exact rate at which a product can absorb heat.

Heat-Up Rate - If the process does not require that the heat-up rate be controlled, a standard setpoint controller may be used to control oven temperature. The oven load will reach temperature as quickly as the product and oven-heating capacities will allow, but will not necessarily be linear. If a controlled heat-up is required (e.g., heat-up at 1 degree 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 refers to that time when the product has reached the desired process temperature for the desired length of time. A programmable controller can be programmed to remain at temperature for a specified period of time, then cool-down to complete the cycle. For many applications, the soak cycle begins once the time specified for the heat-up cycle has been completed. When more precise control is necessary and it is important that the soak time does not begin until the product has reached temperature, 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 airstream, senses that the setpoint temperature has been reached.

Cool-down Cycle - Since cooling can be thought of as removal of heat, product considerations for cool-down rates are similar to those for heat-up rates. Typically, oven cool-down is achieved by exhausting heated air from the oven. A corresponding flow of cooler, ambient air will enter the oven to replace the worm-exhausted air. If the cool-down rate requires no control, the only need is to size the exhaust large enough to remove the necessary amount of heat in the required time. Air-to-water heat exchangers are used at lower operating temperatures, typically 50F (28C) above ambient. With this type of exchanger, oven air passes over a finned, water-cooled coil. The cooling rate is controlled with a solenoid valve that 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.

Oven Construction

A well-constructed oven provides efficient operation for the entire temperature range of the oven with minimized heat loss to the operating environment, and ease of operation. Important characteristics to look for: durable steel exterior finished in a scratch resistant paint, adequate insulation to minimize heat loss, easily readable controls and output, and a door system that avoids warping. LEWCO ovens offer a heavy-duty structural frame, and a “Box-in-a-box construction versus panelized construction. The inner shell is completely isolated from the outer, eliminating leakage and heat transfer. This type of construction is superior to panelized construction methods.

Stainless Steel - Oven construction is especially important in applications where potential product contamination is a concern and when processing a corrosive material through an oven. In these applications, a stainless steel interior provides a high degree of cleanliness, clean-ability, and corrosion resistance. In a corrosive application, it is important to utilize stainless steel material throughout the air stream portion of the oven and in the heat chamber itself.

Aluminized steel interiors - Provides a thin layer of aluminum fused to a steel surface. This surface forms a thin oxide coating on the aluminum to protect the underlying steel from corrosion from moisture and other sources.

Mild Steel Interiors –Since the interiors are coated with corrosion resistant aluminum/silicone paint, they are adequate for drying applications above 212°F (100°C) and for general non-corrosive heating/curing operations.

SHOW: Sectional view of oven wall.

Door Seals - the type of seal is determined by maximum temperature, required atmospheric conditions within the process chamber, size of the opening, and the door style. Lower temperature ovens often use two point silicone seals. Expansion joints maintain consistent seal throughout the heat cycle. Higher temperature ovens use a combination of fiberglass or ceramic and silicone. In addition, the seals can be water-cooled. Clean process ovens use silicone HEPA seals to 500°F and ceramic gaskets up to 750°F

Types of Airflow

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

Horizontal – air flows on one side and returns on the other side. Air passes from above and below the loaded parts. This arrangement is typically used for products on trays or shelf loaded.

Vertical Down – Air flows from the top to the bottom and returns in the opposite direction. Products are typically shelf loaded or are suspended from stationary hooks, monorails or placed on conveyor belts.

Dual Vertical – Air flows from both the top and the bottom and from one side, returning on the opposite side. This pattern is ideally suited for irregularly shaped products that are truck loaded.

Temperature Uniformity - A Key to Increased Product Quality

In the simplest terms, oven temperature uniformity is the overall temperature variation in the oven workspace. Uniformity is generally stated as ±°F or ±°C at a given setpoint temperature. Tight oven uniformities insure that all parts within the oven are exposed to the same temperature for consistent product quality.

Oven characteristics that affect uniformity include wall losses (including through-metal); oven openings; air distribution and the volume of airflow, control accuracy and construction techniques.

Here's what to look for:

1. Adequate insulation thickness to minimize wall losses. Insulation thickness should vary depending on the maximum temperature and temperature uniformity required for the application.

2. Through-metal loss should be kept to an absolute minimum by special panel and unitized construction.

3. Oven openings should be strategically located for both fresh air and exhaust to provide a positive pressure differential so cooler ambient air is not introduced into the oven through door seals.

4. Fresh air openings should be located so that recirculated air is thoroughly mixed with the fresh air.

5. Air passing through the heating elements should be adequately mixed with re-circulated air before entering the work chamber to prevent air stratification and temperature variance.

6. The most important factors determining temperature uniformity is providing uniform airflow to all points in the oven. A purely horizontal or vertical airflow helps ensure uniform airflow.

A simple rule of thumb is that the greater the air volume through an oven, the better the uniformity. It's important to size the fan and motor combination to provide the amount of static pressure drop through the oven in order to meet the desired uniformity.

Uniformities at low temperatures (typically, 150°F or 66°C) are the easiest to obtain due to low wall losses. Minimal amounts of airflow and a simple body construction are all that is required. As temperatures increase, wall losses increase. However, uniformities are harder to achieve. Higher airflow fans and motors, enhanced insulating characteristics and more stringent airflow distribution are required.

Material Handling Systems

A wide variety of material handling strategies are used to move products into and out of industrial ovens. Material handling equipment ranges from simple manual systems to complex automated systems using advanced controls.

Hand-trucks – Are used with walk-in and field assembled ovens and provide a relatively simple way to move products in and out of an oven. If you are considering a truck loaded oven, determine how many products can be loaded on the truck, the total weight of the loaded truck, the number of trucks that will placed into the oven, and the total process time in the oven.

Belt-type conveyors - are commonly used to move products through an oven. Two key considerations are how the product fits on the belt and the number of parts per lineal foot of belt. Conveyor belt speed is determined by the production parts required for each hour of operation. Oven length will depend on how long the product is required to be in the oven. Other considerations include the weight of your part and the total weight of the belt moving the parts.

Other common conveyor systems - monorail conveyors, pusher conveyors, powered roller conveyors, drag chains, walking-beam conveyors, and screw conveyors. Overhead monorail conveyors provide the ability to make turns inside an oven so the conveyor can make several passes in the oven. Monorail conveyors typically consist of the chain-in-a-tube type or the chain and trolley type. The chain and trolley type provides a heavier duty conveyor. When specifying a monorail system, consider the following: weight per part; number of parts per hook; hook or fixture weight; hook spacing; conveyor speed and time needed in the oven.

Oven Loading Configurations

Oven loading configurations are an important consideration in equipment selection.

Standard reach-in front load models – are particularly well suited for lightweight or easy-to-handle parts that are loaded onto shelf.

Walk-in front load units - are used in truck-load type applications involving large, heavy or hard to handle parts. Top loading units with openings located on top of the oven are available for overhead loading requirements.

Manual or Powered Oven Doors – Ovens can be selected with manual or powered (pneumatic/electric) doors. Typically, overhead lift doors are used.

Drawer Oven Doors - can be sized close to the size of the actual part to help limit heat loss during loading operations. Typical applications include processes where parts are soaked at a specific temperature, multiple small batch processing and applications with varying start and stop times. Drawer styles include light duty cabinet units to large heavy duty units supported with a track and trolley system. Powered drawers can also be supplied with track and trolley systems.

Facility and Utility Considerations

Facility considerations such as electrical power supply, water and air sources (volume and pressure), and water drains are critical to successful industrial oven installations. Make sure that all utilities are adequate and conveniently located to the application. Review existing facility restrictions at the location. Sufficient access clearance is critical to move an oven into the facility.

Electrical Power Requirements – The first step is to determine what electrical power is available at the installation site. Since electric utilities vary widely throughout the U.S. and the world, you need to determine the voltage, phasing and the frequency at the facility (e.g., 480 volt, 3 phase, 60 hertz).

Use the following formula to convert KW to amp draw for a 3-phase system:

For a 51KW heater at 480/3/60:

51,000 W+ V3 / 480 V = 61.4 amps

Process Controls and Monitoring

Industrial ovens utilize the full range of digital and analog control systems to control and monitor all phases of oven operation and process heating.

Temperature sensors - a variety of temperature sensors are used in industrial oven applications. Some of these sensors include thermistors, thermocouples, resistance temperature detectors (RTD's), optical pyrometers, and thermostatic (bimetallic) switches.

Thermocouplers are the most popular type of temperature sensor used in industrial oven applications. Key factors affecting their performance include location and orientation, wiring (distance, connectors, gauge, tolerances and noise); thermocouple construction (exposed, enclosed, wells, sheath material, gauge, etc.); process parameters (flow rate, etc.); age (shifts due to aging). Accuracy can be improved by using thermocouples with special tolerances and tested certification.

Controller Performance

Digital controllers with built-in PID tuning parameters offer high reliability and precise indication and control. A variety of controllers are used including: programmable logic controllers (PLC), and PC-based Supervisory Computer and Data Acquisition Systems (SCADA). Operator interfaces offer graphical process representations, data collection, and process control tools. Data can be exported to spreadsheets or other analysis tools; printed in any formal; or archived on any media. Operator interfaces allow networking and process monitoring from remote supervisory computers. Personal computers often control all functions without the use of PLC's.

Floors

There are a wide variety of available floors for oven applications. Care should be taken to consider what type of floor is best for your specific application. Ovens often feature metal panel floors for surface mounting as a standard feature. Ovens can also be recessed into the existing factory floor, or surface mounted with insulating cement. In addition, other types include reinforced panel type floors, floors covered with steel plate or floors with embedded channel tracks. In dust sensitive processes, floors incorporating exposed insulating cement are not recommended.

NFPA 86, Section 2-1.5 requires insulated floors for temperatures over 300F (149C). Calcium silicate insulating board floors provide the required insulating properties while saving on installation by eliminating the need for pouring an insulating cement floor.

The type of loading and unloading equipment used can affect the type of floor for your application. In truck loaded oven applications, use an insulated floor with recessed channel tracks or rails to guide the truck into position. This ensures that the weight of the truck and load is actually supported by the factory floor. For loads that are forklift loaded, oven floors without recessed tracks, (such as a panel floor), can be used. Please note that this floor type may require reinforcing based on the load and weight configuration.

Surface mounted, metal panel or insulating cement.

Recess mounted, insulating cement and 0.25" steel plate

Recess mounted, insulating cement and 0.25" steel plate
with V groove track on plate

Recess mounted, with rails recessed in insulating cement

Insurance

Review existing insurance policies to ensure that your company has adequate insurance protection. Take care to define specific insurance requirements such as special equipment or enclosures early in the buying cycle. Many oven manufacturers provide equipment that will meet insurance requirements, and can submit the required forms and drawings to obtain approvals for you.

Safety Issues

Safety is a primary concern when considering alternative uses for a particular oven design. Improper operation may result in serious consequences such as fires, explosions, bodily injury or even death. Most industrial ovens are specified and designed for unique processes and should never be used for another process or with different operational parameters without a thorough review of all factors related to the installation and application.

Explosion Relief

NOTE: NFPA 86 requires that all fuel-fired and/or Class A process ovens are equipped to provide adequate explosion relief (1 ft^2/15 ft^3 oven volume). HEAT-PRO ovens are equipped with explosion-venting latches on the doors to meet this safety requirement. In the event that the door opening alone does not provide adequate relief area, the balance will be provided by means of an explosion-venting panel typically located in the roof of the unit. It is important to see the manufacturer's design data sheet for details on this specific application.

Special Considerations for Processes Involving Flammable Solvents

When the material to be processed in on oven contains flammable solvents, a special oven defined as 'Class A" by the National Fire Protection Association (NFPA), Bulletin 86, is required. NFPA standards are used by OSHA and insurance underwriters to meet their requirements, as well. **As defined by the NFPA:** ***A "Class A" oven must have a forced exhaust, a method to prove airflow, <u>a purge timer and an explosion</u> relief area.***

Class A ovens are rated for a maximum solvent handling capacity - generally stated in gallons per hour of a given solvent at a given operating temperature. (Gallons per hour only on continuous ovens. Gallons per batch on batch style - which is the more severe case.) **Solvent handling ratings must never be exceeded because an explosion may result.**

Atmosphere Types

A variety of atmospheres are used in specialized thermal processing applications. As an example, a process that requires a low oxygen concentration in the oven to prevent oxidation on parts would utilize an inert atmosphere. Inert gas is injected into a sealed chamber, pressurizing the oven and replacing the oxygen. Specialty gases such as argon or nitrogen are often used to limit oxygen levels to below 50 parts per million (PPM). Atmospheric ovens require sophisticated construction techniques, high integrity welds, special fabrication methods and special motor shaft seals.

Humidity

Humidity is often used to control moisture removal rates and to speed curing of certain compounds. Moisture is added in two ways: 1. Steam is directly injected into the oven, or 2. Water can be sprayed through atomizers into the oven to maintain a specified humidity level.

High humidity ovens are constructed of stainless steel interiors and have continuously back welded seams to prevent rusting and migration of moisture into the insulation. (Back welded seams refer to a technique whereby inside seams are welded on the insulation side of the wall.)

The relative humidity inside an oven is often determined by comparing "the wet bulb temperature and the dry bulb temperature." Dry bulb temperature is obtained by reading a temperature sensor placed inside the oven. Wet bulb temperature is obtained when a moisture laden sock is placed over the temperature sensor and the temperature measured. Relative humidity can be measured by two temperature readings: the higher the wet bulb temperature in relation to the dry bulb, the higher the relative humidity.

Solid state, electronic humidity transducers are used for greater accuracy. These sensors provide accurate humidity readings over a wide range of temperatures and humidity.

Show: Typical temperature/humidity chamber

Design Considerations for Ovens in Hazardous Areas

Special design features are required when the oven and/or controls are located in hazardous areas. Hazardous areas refers to areas where there is an explosion hazard from the possible ignition of dust, vapors or gas in the area external to the oven, and is not limited just to volatiles within the oven chamber. The NFPA is the main source of specialized information for the various hazardous classifications and the required design features.

Special design considerations for hazardous areas include: spark resistant fans, motors rated for hazardous areas, sealed interconnecting wiring and junction boxes, the source of make-up air from outside the hazardous area and either remote control enclosure or enclosures rated for the specific type of hazardous area.

Glossary of Terms

Back welded seams - a method of joining sheet metal panels by welding seams on the backside.

Conduction - the transfer of heat through a material by passing it from molecule to molecule.

Dry bulb - temperature of air as determined by a standard temperature sensor.

Dwell time - refers to the amount of time that the product spends in the oven. While dwell time can refer to batch-type ovens, it is most often used with regard to continuous ovens where the product is conveyed into and out of the oven within specific time Intervals.

Exhaust volume - the amount of air leaving an oven system, either passively or forced.

Forced exhaust - process air removed from an oven by an exhaust fan.

Load configuration - the way in which the parts to be processed are situated in the oven.

Lower Explosive Limit (LEL), Lower Flammable Limit (LFL) - the point at which process air containing solvents becomes explosive/flammable.

Purge timer - a settable device that times the replacement of air in an oven with fresh air or an inert gas.

Radiant heat - a mode of heat transfer in which heat is transferred in a straight line from an emitting surface, without significantly heating the Intervening space.

Setpoint temperature - an operator controlled variable. The desired temperature level of the oven selected as a numeric value on the control instrument.

Soak - the amount of time that a part or component spends at a given processing temperature.

Statatic pressure drop -the amount of difference in static air pressure between two environments.

Temperature stratification - variation in air temperature across a cross-section of air due to uneven mixing of the air.

Temperature uniformity - variation measured in active work space or in airflow entering work area generally defined as "X" spread.

Thermocouple - a temperature sensor made of two dissimilar metals welded at the measuring junction. A millivolt signal proportional to the temperature difference between hot and cold junctions is produced.

as determined by a temperature sensor with a wet wick. The relationship between wet bulb and dry bulb temperature readings is a measure of the water vapor in the air.

Three considerations are input accuracy, tuning, and output accuracy.

A. Input accuracy

The statement of controller accuracy must be carefully assessed. It may be stated as 0.2%, for example. On some controllers, this is 0.2% of the reading. On others, it is 0.2% of the selected thermocouple range. Thus, 0.2% could be either 0.2% x 1000F = 2F, ± 1 digit to allow for rounding in the controller, or 0.2% x 1746F (span of type J range) = 3.49F, ± I digit. This error must be added to the thermocouple error.

Tuning

Controller tuning can introduce error. If the PID settings are not well adjusted, the process will begin a natural deviation at some frequency. This deviation may be rapid or slow, of low magnitude or high. It may be offset *either above* or below the setpoint, or oscillate around it.

C. Output accuracy

Output accuracy is *generally less* accurate than the input. For example, a 4 to 20 ma output may have a 12-bit resolution ~4096) which means that the smallest increment of change in the output current is (20 minus 4) 4096, or 0.0039 ma per increment. This is generally adequate for most applications. If the final control device does not respond, the controller will automatically increment the output until the change is large enough to activate the final control device.

The final control *device, however, has* significant impact on the control of the process, If it is unable to control in small enough increments, the controller will be forced to under- and then over-compensate, producing choppy control performance.

The controller and the final control device must be matched. if the final control device is a valve or other type of actuator it must have the input resolution and control capability to provide minute changes as required by the control.

A precision sensor input to a high-performance, accurately-tuned controller coupled to a sloppy control device will not provide good temperature control.

used for machine logic control now offer powerful and accurate

control capabilities equivalent to the best discrete controllers. Most of the better PLCs offer 15-bit input 13

accuracy (0.05%) and floating point PID algorithms. Coupled with PC-based data collection software, sophisticated control systems can be implemented to track processes and parts (using bar codes or other
equipment) and perform logic functions based on the measured process variables.

The

System Dynamics

The physical construction or dynamics of the controlled oven or furnace system 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 supply is non-uniform, or cool 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. Nothing can be **done to improve the performance short of improving the mechanical characteristics of** the system, which may not always be possible.

On the other hand, a system with good dynamics and an inadequate control system is an excellent candidate for improved performance. The controls may be upgraded to provide a first-rate piece of equipment. LEWCO can provide properly designed equipment, and the level of control sophistication to meet your process requirements.

Testing and Proving Your Process Before an Equipment Purchase is Made

If at all possible, work with LEWCO 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, LEWCO 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.

Most of the Fortune 100 Industrial Companies have used the LEWCO Innovation Center for testing and process development before making a purchase commitment. You and any of your colleagues are welcome to utilize the same expert technical information and process solutions provided here. To get immediate engineering kelp selecting the most cost-effective heat process solution for your application, call an experienced engineer or product specialist at LEWCO, 612-781-5363, or FAX your request to 612-781-5353.

If you find this guide helpful, or if you have suggestions or questions, please contact us. If you would like a general catalog and a LEWCO capabilities brochure, call or write to us at P.O. Box 1320, Minneapolis, MN 55440-1320.

Construction

Several process -specific factors need to be taken into account in regard to oven construction. Maximum temperature of the oven and size of the work chamber will affect the construction methods used. Number and type of expansion joints used will be affected by these as well. As indicated in the discussion under uniformity~ fan size will depend on process needs and your oven may require special door seals and breaker strips to get the uniformity desired. Surface temperature specifications may require special construction techniques and load support design will depend on the type and weight of the load.

Be sure to specify vertical lift doors (with pneumatic locking cylinders) for larger oven openings. They are more convenient to use and easier to seal.

Inert atmosphere ovens require special construction techniques for expansion because interiors need to be continuously welded. Recirculating High Efficiency Particulate Air Filters (HEPA filters) can be combined with the proper oven and process design to allow state-of-the-art particle control, typically much better than Class 100 particle levels. Experience and reputation are particularly important if you are interest- **Tongue and groove expansion joint**

ed in one of these "clean process" ovens .

Class A Construction

LEWCO strongly recommends the use of an airflow switch with the forced exhaust to prove airflow. The forced exhaust is sized to keep the flammable solvent vapor concentrations below the lower explosive limit (LEL) in the oven chamber. The purge timer operates in conjunction with the forced exhaust to purge the oven of volatiles before the heaters are allowed to energize. The purge time is based upon the volume of the oven, as the oven air must be changed four times before the heater may be energized. The airflow switch is used to prove exhaust airflow. With no airflow, the heating system shuts down via the airflow switch. The explosion relief area is typically incorporated into the oven by means of an explosion relief panel or explosion relief membrane. The membrane design offers some unique advantages with easier oven loading/unloading.