INDUSTRIAL OVENS, BATCH OVENS AND COMPOSITE OVENS: THEORY AND CONSIDERATIONS FOR DESIGN

INDUSTRIAL OVEN AND BATCH OVEN PROCESS APPLICATIONS

Industrial ovens are used in a wide range of applications including aging, annealing, baking, composite curing, curing, drying, finishing, heat treating, melting, powder coating ovens, preheating, research and development, sterilizing and testing. Industrial ovens are generally operate at less than 1400F and do not incorporate refractory material.

TYPES OF INDUSTRIAL OVENS

Types of industrial ovens can be simplified into two basic groups; batch ovens and conveyor ovens.

Batch industrial ovens are designed to be utilized in processes where throughput is unitized in "batches", whereas conveyor industrial ovens are generally utilized in a continuous process. Industrial batch ovens offer the flexibility of intermittent product flow, with the ability to start and stop production as required. Industrial batch ovens also offer the flexibility of processing a single large parts, or a significant number of smaller parts in a single process run. However, there is a throughput volume where the batch process becomes less economical than the conveyor process. Bench and cabinet industrial ovens are used for small batch production requirements, whereas walk-in industrial ovens are used for large batch production requirements.

Conveyor industrial ovens offer the ability to handle high production runs while minimizing product staging and handling. However, the conveyor type process has product size/shape restrictions compared to the batch oven process. Conveyor industrial ovens can be further categorized as automatic or manual. High volume throughputs are generally conveyed in an automatic fashion with an adjustable product feed rate, whereas low volume throughputs are generally conveyed in a manual fashion.

HEAT TRANSFER IN INDUSTRIAL OVENS

Heat transfer in industrial oven is primarily by forced convection.

Convection

When air is forced over a hot surface heat is transferred to the air. Air caries the heat and transfers it to the samples or material kept in the working chamber. Convection heating requires contact of the air flow with the solid part. Only the layer of the flow that is in contact with the part is actually transferring heat. These are frequently referred to as forced-air batch ovens, where the primary effectiveness of heat transfer is derived from the air volume being circulated within the batch oven. Convection industrial ovens are designed to produce an equilibrium temperature in the working chamber and maintain the set temperature.

INDUSTRIAL OVEN AND BATCH OVEN EFFICIENCY

Industrial oven efficiency can be evaluated by determining the heat loss by airflow through the exhaust system, heat carry-out by product absorption and heat carry-out by conveyor absorption. Heat loss can occur through oven roof, walls and other openings.

ENERGY SOURCES FOR INDUSTRIAL OVENS AND BATCH OVENS
Industrial ovens are unique to different application and customised to available heat source. The heat source could be Electric resistance, Steam and gas fired.

Electric resistance is widely used in small cabinet and batch ovens.
If steam line is available then steam could be used as a source of heat. Steam tubes are laid in the air chamber and air is forced over it. It transfers heat by forced convection.

AIR DISTRIBUTION IN INDUSTRIAL OVENS AND BATCH OVENS
There are two main types of airflow distribution in industrial ovens and batch ovens, vertical and horizontal. Vertical distribution is more cost effective to construct, and offers suitable heat distribution for most process. Horizontal airflow distribution offers enhanced temperature distribution, but at a significant cost especially in the larger walk-in ovens. The type of airflow distribution should be determined by the applicable process, For example: the powder coating process lends itself well to vertical airflow distribution, whereas drying operations require horizontal air flow.

TEMPERATURE CONTROLLERS FOR INDUSTRIAL OVENS

PID controller

A proportional–integral–derivative controller (PID controller) is a generic control loop feedback mechanism (controller) widely used in industrial control systems – a PID is the most commonly used feedback controller. A PID controller calculates an "error" value as the difference between a measured process variable and a desired set point. The controller attempts to minimize the error by adjusting the process control inputs. The PID controller calculation (algorithm) involves three separate constant parameters, and is accordingly sometimes called three-term control: the proportional, the integral and derivative values, denoted *P, I,* and *D.* Heuristically, these values can be interpreted in terms of time: *P* depends on the *present* error, *I* on the accumulation of *past* errors, and *D* is a prediction of *future* errors, based on current rate of change.[1] The weighted sum of these three actions is used to adjust the process via a control element such as the position of a control valve, or the power supplied to a heating element.
By tuning the three parameters in the PID controller algorithm, the controller can provide control action designed for specific process requirements. The response of the controller can be described in terms of the responsiveness of the controller to an error, the degree to which the controller overshoots the set point and the degree of system oscillation.

A temperature control system relies upon a controller to accurately control process temperature with a PID logic. For input, the controller uses a temperature sensor such as a RTD or thermocouple. It evaluates the desired control temperature set point with the actual temperature and provides an output to a heat source.

Critical items to be considered for proper controller selection include temperature range, type of input sensor (thermocouple, RTD), output required (SSR, electromechanical relay, analog output) and type and number of outputs (heat, limit, alarm).

SAFETY FEATURES
A stand by fluid thermostat is installed. To cut off heater in case of temperature overshoot

Blower systems are designed in such a way that the heat from oven does not penetrate the motor, thereby safeguarding it.