

Non Implemented Case Study– Energy Conservation Measure

Measure
Thyristor controller for resistance heating furnace
Equipment
Resistance type heating furnace
Industry / Sector
Heavy engineering
Year of Implementation
-
Cost Benefit Analysis
o Type of Measure: Long term measure
o Annual Energy Savings: 0.25 lakh kWh
o Actual cost savings: Rs.1.00 lakh
o Actual investment : Rs. 4.00 lakh
o Payback : 4 years
Implementation Highlights
<ul style="list-style-type: none"> ☞ High investment and high payback period. ☞ The product is proven and now-a-days comes along with the original equipment. ☞ Not implemented though the product has associated benefits such as avoiding use of mechanical contactors, increased life of the heating elements, precise temperature maintenance, reduction in thermal stress of the furnace due to maintenance of very narrow band width of temperature. ☞ In case of batch type of the furnaces energy savings achieved only during the soaking time only and not during heating (i.e., during raise of temperature in the furnace). ☞ The energy savings are dependent up on the duration of soaking time in every batch and number of batches.

Summary

Energy savings in a resistance heating furnace can be envisaged by incorporation of thyristorised controller to maintain very precise narrow band with of required temperature instead of very high bandwidth temperature

Background

In a heavy engineering unit, a batch type of resistance heating electric furnace is used for heat treatment (quenching) operations. The rated kW of the furnace is 200 kW.

The material is heated up to 850 °C, before quenching in an oil tank. The cycle time is about 16 hours. In 16-hour batch the soaking time is six hours. The heating elements have mechanical on & off contractors to maintain and control the temperature. The plant operates about 300 days in a year.

The temperature band width during the soaking time is 832-865 °C (i.e., $\pm 18^{\circ}\text{C}$ to $+15^{\circ}\text{C}$ of desired temperature)

The power consumption during the soaking time of the furnace is follows:

Soaking hour	kWh
First hour	148
Second hour	125
Third hour	110
Fourth hour	85
Fifth hour	70
Sixth hour	70
Total	608

The furnace was consuming 608 kWh during soaking period and operating at a very high band with of temperature. During soaking time the furnace is subject to overheating and under heating. This temperature swing is due to inherent characteristics of the mechanical contractor. (i.e., -18°C to $+15^{\circ}\text{C}$ of desired temperature).

Proposal:

During the soaking time energy consumption in the furnace can be reduced by incorporating thyristor based controllere, by which precise temperature can be maintained. (i.e., $\pm 3^{\circ}\text{C}$ of desired temperature).

To see the performance of thyrisor controller, demonstration was carried out by supplier and found that 83 kWh was saved during the trial. It was also observed that the temperature was maintained $\pm 3^{\circ}\text{C}$.

Techno-economics:

Energy savings per cycle	: 83 kWh
No of cycles per year	: 300
Annual energy savings	: 24900 kWh
Annual cost savings	: Rs. 1.00 lakh
Investment required	: Rs.4.00 lakh
Payback period	: 4 years

Principle

- ☰ Generally, the resistance heating furnaces are switched on and off using mechanical contractors. For this they normally used at a cycle times of 15 seconds are longer for reasonable service life.

Because of full power on and off and limited cycle time of contractors operation the temperature either shoots up more than the required or fall down below the range ($\pm 15^{\circ}\text{C}$ or above)
- ☰ A thyristor controller differs from the contractor type, which is very fast to respond to change of the temperature and according controls the power to the furnace. This results in maintenance of temperature in a narrow band width of $\pm 3^{\circ}\text{C}$ or below.
- ☰ A typical thyristor controller consists of a thermocouple with sensor, temperature controller and thyristor power controller. These components work together to control the temperature very precisely.
- ☰ The other benefits of the controller are extended heater life, less maintenance, improved quality of the products, reduction in thermal stresses in the furnace, etc.