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Energy Conservation In Furnaces Using Induction Furnace

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Abstract:

The application of gas-based Furnace is to melt metal i.e. iron, copper and many more, by using gas as main fuel. Recently in India steel production market grow very fast. Uses of gas as a fuel create serious environmental issues, which can be overcome by using induction furnace. There are much more benefit of application of induction furnace. Here is a gas based and induction-based furnace were compared and explained.

Keywords- gas furnaces, Induction furnace, energy conservation, electromagnetic field, eddy current, work piece, induction heating

I. INTRODUCTION.

Mostly the gas based furnace used in melting metal process which use LPG gas as main fuel due to quick and cheap availability in market. This kind of furnace can be treated as main player in market. Hence this kind of furnace are traditional and ordinary. By using induction coil, in which induction heater mainly used to supply electricity, which can produce heat, used for heating to metal. There are contact less transfer of heat between induction coil and metal. Hence heat can be controlled accurate and highly precise as per desired set temperature. Due less consumption of electricity it can be treated as eco friendly to environment as compared to ordinary method. One addition benefit of it, easy operation and less manpower required which can be beneficial for any industries. Induction furnace works on the principle of eddy current, as electromagnetic field produces the current in metal, which can be converted in to heat, can distributed in the entire metal.[1]

II INDUCTION HEATING.

The working principle of induction furnace is based on electromagnetic induction.[2]. By electromagnetic induction effect heat can be transfer to the metal object. when rate of change of flux occur through any conductor An emf induced in it. Which can be defined as $E = d\Phi/dt \dots$ [1] Where $E =$ emf (voltage) , $\Phi =$ magnetic flux in wb and $t =$ time in second . when path is short circuited through metal piece , the voltage induced in the metal piece will circulate current through metal piece called eddy current which can produce heat in the metal piece.(Figure 1). When current passing thorough metal piece with resistance R ohms, will dissipated power in the metal piece in form of heat. As R is not constant in all the metal piece, hence there are un even flow of current in metal piece. Power consumption depends on amount of heat energy

requirement to heat the metal piece. It can be depends on weight and types of metal. The power dissipated in the metal in form of heat can be calculated as $P= V*I = I^2*R$ (2)

Where P= power in KW

Mainly focus of this paper are to pre heat the metal before it can be melting, i.e. forging.

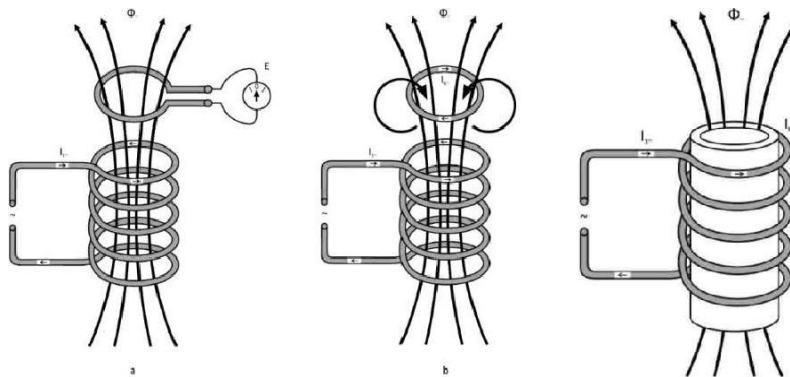


Figure 1: Faraday's Induction law [2]

III INDUCTION BASED FURNACE.

Due to high power capacity, induction furnaces are widely used in industries. [fig2]. As output product of induction furnace are more qualitative as compared to conventional Gas fired furnace. Ultimately induction furnace are the power full alternative source of Gas fired furnace.[4]



Figure:2 Induction furnace



IV ADVANTAGES OF INDUCTION FURNACE.

1. Energy efficient
2. Less maintenance and cheap parts for the same.
3. Less space requirement due to high power density.
4. Capable to attain very high temperature.
5. It is possible to apply heat for specific area as per requirement.
6. Automation also possible for the operation.
7. Fuel storage not required.
8. Application of heat can applied very accurately and precisely.
9. Heat control can be obtained very accurately.

Table: 1 Comparison between LPG furnace and Induction furnace.

| Various Parameter | LPG furnace (Gas) | Induction furnace |
|--------------------------|--|---|
| Capacity | 40 KG | 50 KW, 10 Khz |
| Heat Loss | Too much heat loss due to open heater | Less heat loss compare with LPG heater. Coil enclosed and only some area of coil are outside. This few heat loss reduce by enclosing this outside area with proper insulation. |
| Sample piece weight | 0.180 KG | 0.180 KG |
| Total energy consumption | <p>T1 = Initial temp = 390C T2 = Final temp = 7500C $\Delta T = T2 - T1 = 7110C$ M = mass = 540 KG C = 0.09 Kcal / Kg 0C Heat absorb by material = $Q = M \times C \times \Delta T$ $= 540 \times 0.09 \times 711 = 34555$ Kcal Latent heat of fusion brass = 40 Kcal/Kg Latent heat of molten Brass material = $540 \times 40 = 21600$ Kcal Total heat absorbed in Brass material = $34555 + 21600 = 56155$ Kcal Fuel = LPG CV = 10950 Kcal / Kg Total material to be heat = 540 KG 19 KG industrial LPG cylinder use for heat 540 KG = 4 Nos. Total heat input = $76 \times 10950 = 832200$ Kcal</p> | <p>T1 = Initial temp = 390C T2 = Final temp = 5500C $\Delta T = T2 - T1 = 5110C$ M = mass = 540 KG C = 0.09 Kcal / Kg 0C Heat absorb by material = $Q = M \times C \times \Delta T$ $= 540 \times 0.09 \times 511 = 24835$ Kcal Latent heat of fusion brass = 40 Kcal/Kg Latent heat of molten Brass material = $540 \times 40 = 21600$ Kcal Total heat absorbed in Brass material = $24835 + 21600 = 46435$ Kcal Calorific value = 860 Kcal/ Kwh Total material to be heat = 540 KG Total material to be heat = 540 KG Total Kwh consume for heat 540 KG material = 300 Kwh Total heat input = $860 \times 300 = 25800$ Kcal</p> |



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|--------------------------------|--|---|
| Efficiency | $\eta = \text{Total heat absorbed in Brass material (56155 Kcal) / Total heat input (832200 Kcal)}$ = 6.8 % | $\eta = \text{Total heat absorbed in Brass material (46435 Kcal) / Total heat input (258000 Kcal)}$ = 20 % |
| Energy Saving in Kcal / 540 KG | --- | 832200-258000 = 574200 Kcal |
| Total Saving in Rs / Year | --- | Rs. 219300 |
| 50 KW Induction Furnace Cost | | Rs. 856406 (Approx) |
| Simple Payback Period | | 3.90 Years (47 Months) |

Note: % saving decrease -10 % if voltage variation is $\pm 10\%$

% saving may differ in case of initial temperature variation

Above analysis carries out on the base of 24 Ton production per year. % saving increase if production increases 24 Ton per year.

By enclosing electrical heater's coil with proper insulation which is outside % saving increase.

V. CONCLUSION.

Induction furnaces are much more efficient and power saving in comparison to Gas furnaces. Which will save up to Rs. 219300 per annum. Induction Furnace offers several advantages over conventional Gas Furnaces, including higher efficiency and reliability, reduced environmental pollutions, longer lifetime), compact in size and higher efficiency as compared to Gas furnaces.



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