PERFORMANCE ENHANCEMENT OF LPG CYLINDER FABRICATION BY UTILIZING WASTE HEAT FROM OIL FIRED FURNACE

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ABSTRACT

In the present work waste heat recovery system is meant to integrate the heat of' waste gas within the heat treatment furnace. For this purpose a case study of typical LPG cylinder fabrication industry is considered. The waste gas from heat treatment method exits at a temperature of around 450 - 500 °C. A lot of' sensible heat is lost with these gases. This heat is used for enhancing the performance of furnace in terms of their overall efficiency. The objective of this project is to style a suitable heat recovery system for on top of cases which might efficiently remove the sensible heat and place it to use. Once analysis and calculation half we have found that by utilizing recuperative kind air pre-heater the furnace thermal efficiency is enhanced by 9.515%. Conjointly because of planned system we tend to found an annual saving of 8,700 kg of furnace oil that close to value of Rs. 4.35lakhs.

Keywords: Waste Heat, Recovery, Waste Heat Utilization, Energy Efficiency

1. INTRODUCTIO

In routine life, we tend to come across 'Metal fabrication is that the building of metal structures by cutting, bending, and collection processes. Metal fabrication may be a price another method that involves the construction machines and structures from varied raw materials. A fab shop can bid on employment, typically supported the engineering drawings, and if awarded the contract can build the product.

Important fabricated metal processes are formation, stamping, bending, forming, and machining, used to form individual items of metal; and different processes, like welding and collection, used to be part of separate components along. Establishments during this subsector might use one among these processes or a mix of those processes. a variety of quality metal components are bended, cut and assembled into large structures during this method. Custom producing is finished once the customers would like specific metal structures supported their necessities of their business.

A heat exchanger may be a heat transfer device that's used to transfer thermal energy between 2 or a lot of fluids available at different temperatures. In most heat exchangers, the fluids are separated by a heat transfer surface and ideally they are doing not combine. Heat exchangers are employed in the method, power, petroleum, transportations, air conditioning, refrigeration, cryogenic, heat recovery. Alternate fuels, et al industries.

Common samples of heat exchangers associated with our daily use are automobile radiator, condenser, evaporator, air preheated and oil coolers. Beat exchangers can be classified in many alternative ways that.

Waste heat comes each within the force of gas (for instance flue gas) and liquid. This liquid is actually known as drain water. just like the flue gas that's let out to the atmosphere, the drain water is left to flow to the river or pond when it's treated. Figure 2.1 provides an easy illustration of a method that produces waste heat once an input is given to the method. The output of the method depends on the input.

2. METHODOLOGY

2.1 Process Flow Chart

Process flow chart of typical cylinder manufacturing unit industry at M/s Sai Cylinder Pvt. Ltd. settled at Jamshedpur (JH.) is furnished as in fig.1.

Today its annual production is of 3, 00.000 LPG Cylinders, being equipped to leading oil giants like I.O.C.L, H.P.C.L., B.P.C.L. and others. The industry was established within April 2014 at Jamshedpur, District: East Singh hum. The production plant is provided with most modern technology, modern enough to satisfy stringent quality needs. M/s-Sai LPG cylinders conforms to B1S standards and has secured ISO 9001:2015 certificate.

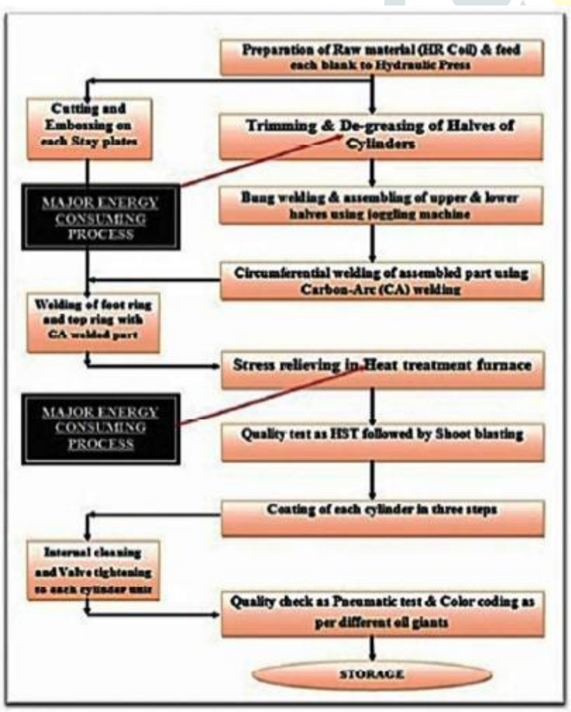


Fig.1 Process flow Chart

2.2 Existing System for Heat Treatment of Cylinders

There are many alternative heat treatment processes, some creating the steel harder and a few making it softer and easier to figure with. Differently to categories the processes is to divide them into thermal processes and thermo-chemical processes. In thermal processes, the properties of the steel are altered only by undergoing a particular temperature course. In thermo-chemical processes, chemical reactions occur throughout the temperature course.

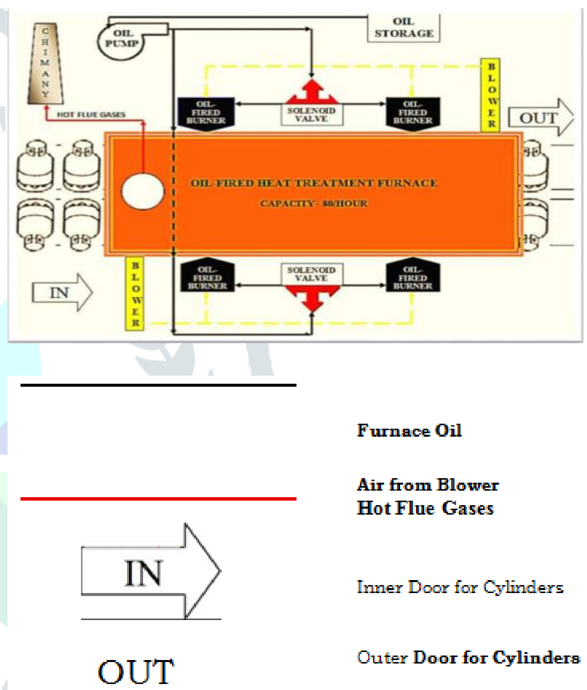


Fig.2 Present System for Heat Treatment Furnace

The processes that will be included in this thesis are categorized in figure 3 and will be explained in the sections below:

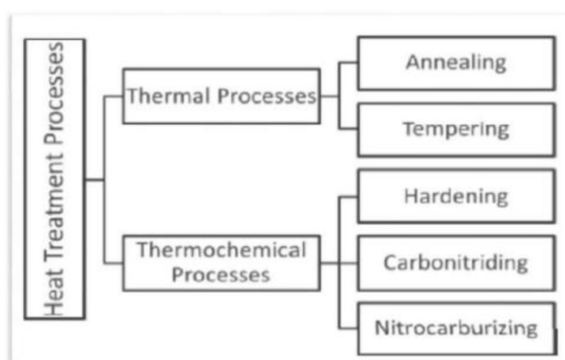


Fig.3 Categorization of Heat Treatment Processes

2.3 Proposed system for heat treated furnace

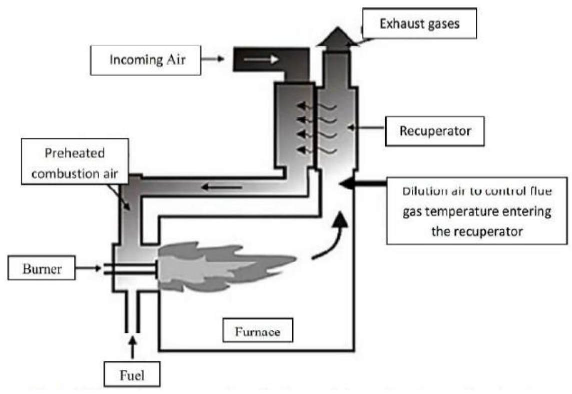


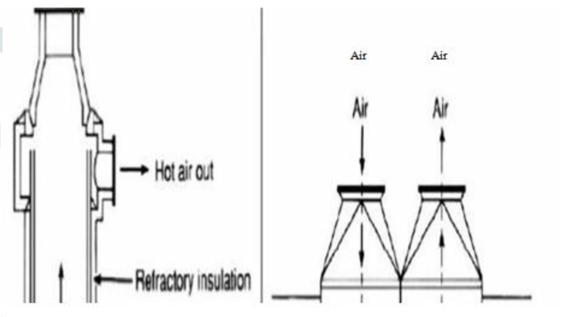
Fig.4 Typical recuperator installation used for preheating combustion air

Recuperator recover exhaust gas waste heat in medium to high temperature applications like soaking or annealing ovens, melting furnaces, afterburners, gas incinerators, radiant tube burners, and heat furnaces. Recuperator will be supported radiation, convection, or mixtures of each. Recuperators are created out of either metallic or ceramic materials.

There are 2 main styles of external recuperator:

a) Radiation recuperator b) Convection recuperator

Radiation Recuperators usually take the form of concentric cylinders, within which the combustion air passes through the annulus and therefore the exhaust gases from the furnace pass through the centre see Fig.5 (a). The easy construction implies that such Recuperators are appropriate to be used with dirty gases, have a negligible resistance to flow, and may replace the flue or chimney if area is limited. The annulus may be replaced by a ring of vertical tubes, however this style is more difficult to install and maintain. Radiation recuperator depends on radiation from high temperature exhaust gases and will not he use with exhaust gases at but concerning 800°C. Convection recuperator consists basically of bundles of drawn or solid tubes see Fig.5 (b). Internal and/or external fins may be added to help heat transfer. The combustion air usually passes through the tubes and therefore the exhaust gases outside the tubes, however there are some applications wherever this can be reversed. For example_ with dirty gases, it's easier to stay the tubes clean if the air (lows on the outside. style variations include `U' tube and double pass systems. Convection recuperator is additional appropriate for exhaust gas temperatures of but concerning 900°C. Radiation sort recuperator includes an efficiency rating (30%) and Convective sort recuperator has a lot of higher efficiency (50% to 60%). By learning higher than we tend to are proposing to install convective sort air pre-heater for oil fired heat treated furnace.



(a) (b)

[a] Doub a Shell Fiaiiaticn ReculcraporI

[b] Convection Recuoeratoc

Fig.5 Metallic Recuperators

3. RESULT ANALYSIS

Performance evaluation of proposed furnace:

After analyzing higher than information, we have found that huge quantity of heat is waste in style of flue gases. Thus we tend to are proposing recuperative kind air pre-heater in exhaust line, because of that combustion air are pre-heated. Currently we tend to evaluate the performance of furnace when installation.

A. Combustion heat of fuel

From respective equation,

We have,

$$Q_{in} = m_f\ \textbf{(kg/hr.)} * \textbf{GCV (kCal/hr.)}$$

Q_{in} = 38.316 kg/hr. * 10628 kcal/kg

Q_{in} = 4, 07,222.45 kCal/hr.

B. Quantity of heat in billet

From equation formerly,

We have,

Q_1 = m (kg/hr.) * Cp (kCal /kg / °C) * ΔT

Q_1 =1265*0.12*(700-35)

Q_1 = 1, 00,947 kCal/hr.

C. Sensible heat loss in flue gas

From above equation

%Heat loss in flue gas = $\frac{m \times c_p \times \Delta T}{GCV\ of\ fuel} \times 100$

Where,

m = weight of flue gas (air + fuel) kg / kg oil

Cp = specific heat of flue gases = 0.24 kCal / kg °C

ΔT = temperature difference between inlet and exit of chimney

Excess air = 133 % of excess air

Theoretical air required to burn 1 kg of oil	= 13.8 kg (As per refrence)
Total air supplied	= (1 + 1.33) *13.8
	= 32.154 kg / kg of oil
m = weight of flue gas (air + fuel) kg/kg oil	= (32.154 + 1.0) kg / kg of oil = 33.154 kg / kg of oil

As

% Heat loss in flue gas = $\frac{m \times c_p \times \Delta T}{GCV\ of\ fuel} \times 100$

As in existing system. Air required for combustion process was supplied at ambient temperature (i.e. 35 "C), but after installation of' recuperative type air pre-heater, the combustion air will be supplied at

Sensible heat in flue gas = Q 2 = 33.154 x 0.24 x (395 - 50)

Q_2 = 2745.151kCal/kg of FO

= 2745.151 x 38.316

Q 2 = 1, 05, 183.20 kCal / hr.

% Heat loss in flue gas = $\frac{2745.151}{10628} \times 100$

% Heat Loss in Flue Gas= 25.83 %

100 °C approximately. Due to pre-heating of combustion air up-to 100 °C, the flue gas temperature reduced to 395 °C (approximately) instead of 500 °C.

D. Heat loss from evaporation of moisture in fuel

From equation respectively

% Heat loss *from evaporation of* moisture *in* fuel $= \frac{M \times \{584 + 0.45(T_f - T_{amb})\}}{GCV\ of\ Fuel} \times 100$

Where

M = kg of moisture in 1 kg of fuel oil = 0.15 kg/kg of FO (As per reference)

E. Heat loss due to evaporation of water formed due to hydrogen in fuel

From above equation

% Heat loss from hydrogen in fuel = $\frac{9 \times H_2 \times \{584 + 0.45(T_f - T_{amb})\}}{GCV\ of\ Fuel} \times 100$

Where, H_2 = kg of H_2 in 1 kg of fuel oil = 0.1123 kg/kg of fuel oil (as per reference)

Heat due to hydrogen in fuel = 9 x H_2 x {584 + 0.45 (T_f – T_{amb})

= 9*0.1123*{584+0.45(395-35)

Q_4= 753.98 kCal /kg of FO

Q4 = 28, 889.58 kCal/hr.

Now,

% Heat loss from hydrogen in fuel = $\frac{9 \times H_2 \times \{584 + 0.45(T_f - T_{amb})\}}{GCV\ of\ Fuel} \times 100$

%Heat loss from hydrogen in fuel = $\frac{2889.58}{38.316 * 10628} * 100$

% Heat loss from hydrogen in fuel = 7.094%

T_f= Flue gas temperature, °C = 395°C (As already discussed

T_{amb}= Ambient temperature, °C = 35 °C

GCV = Gross Calorific Value of fuel, kCal /kg

Heat due to moisture in fuel = M x {1584 +0.45 (T_f-T_{amb})}

Q3= 0.15 * I584+0.45(395-35)1

Q3 = 111.9 kCallkg of FO

Q3 = 4, 287.56 kCal/hr.

Now,

$$\% \text{ Heat loss from moisture in fuel} = \frac{M \times \{584+045(T_f - T_{amb})\}}{GCV\ of\ Fuel} \times 100$$

$$\% \text{ Heat loss from moisture in fuel} = \frac{4287.56}{38.316 * 10628} X100$$

% Heat loss from moisture in fuel = 1.053 %

F. Heal loss due to openings in furnace

From previous equation

% Heat loss from opening in furnace =

$$\frac{[BBRF] * Emissivity * [FOR].* [AOO]}{\text{Oil Quantity x GCV of oil}} * 100$$

Where, BBRF is black body radiation factor

FOR is factor of radiation

AOO is area of opening

After analysis we also found that there was loss of 13.152 % from door openings, so to reduce the same we have to increase the insulation inside the furnace from 400 mm to 650 mm.

The factor of radiation through openings and the black body radiation factor can be obtained.

$$\text{And Ratio} = \frac{\textbf{Diameter or Least Width}}{\text{Thickness of Wall}} \times 100$$

Black body radiation at 700 "C = 9 kCal/ cm^2/hr

The area of the opening is 190 cm x 45 cm = 8550 cm^2

Emissivity = 0.8 (usually for furnace brick work)

Heat due from opening in furnace = (Black body radiation factor x emissivity x Factor of radiation x area of opening)

Q_5=9 * 0.8 0.8 * 8550

Qs =49, 248kCal/hr.

Now,

% Heat loss from opening in furnce

$$\frac{\text{(Black body radiation factor * emissivity * factor of rad.* area of opening)}}{\text{Quantity of oil x GCV of oil}} * 100$$

$$\% \text{ Heat loss from opening in furnce} = \frac{4924858}{38.316 * 10628} * 100$$

% Heat loss from opening in furnace = 12.01%

Factor of radiation = 0.8

Here, the opening is considered to be rectangular.

4. CONCLUSION

Reduction of energy price is that the primary advantage of heat recovery. Any heat recovered from the exhaust and return to the method reduces the energy price. Moreover, any increase in energy price can, lead to enhanced heat recovery edges. The usage of recovered waste heat reduces the quantity of heat needed by using purchased energy. Only a few different investments are free of economic risk like the utilization of oil and gas provide pipes, electrical facilities, burners and boilers usually may be reduced. If stand by facilities are needed, temporary, rather than permanent, instrumentation may be provided, preserving the price reduction.

The reduction of method heat demand will allow greater utilization of existing method or ventilating instrumentality. Wherever cycling or peaking conditions are present, heat recovery permits a flexible manner of accommodating periods of high heat demand while not providing further heating facilities.

The analysis has shown that the rise in furnace efficiency alone simply justifies the investments for furnace sizes about 1265 kg/hour. Even a lot of necessary is that the growing ought to increase product quality and production flexibility, which can be a driving force for investments in advanced control systems for furnaces of all sizes.

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