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To Achieve Heat Recovery from Heat Intensive Equipment Like De-Carb Annealing Furnace

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Abstract: A waste heat recovery unit (WHRU) is an energy recovery heat exchanger that recovers heat from hot streams with potential high-energy content. There are sources like heat in flue gases, heat in Vapour streams, convective and radiant heat that is lost from exterior of equipment. Heat losses from cooling water, and losses while providing chilled water, or for that matter in the disposed of chilled water, also heat stored in products that leave the process which finally losses heat in gaseous and liquid effluents leaving the process. Flue gas leaving de-carb annealing furnace to stack ranges from more than 350˚ C. At present, this gas is directly going to atmosphere and causes thermal pollution as well as loss of valuable energy. The target is to reduce thermal pollution and reuse this waste energy again in furnace.

Keywords: Waste heat recovery unit, De-carb annealing furnace, heat exchanger, Flue gas, Thermal pollution.

I. Introduction

There has been tremendous increase in the fuel prices and global warming in the past few decades, which has challenged the industries. There are also challenges in improving the efficiency of the system as well as reducing greenhouse gas emission. Due to use of waste heat recovery, there has been reduction of fuel, reduction in gas emission and increase in the efficiency of the system. Waste heat is the energy, which is generated in the industrial furnace and dumped in the environment. Heat loss is classified in the following groups; High heat loss, Medium heat loss and Low heat loss and all the losses having different temperatures. With the help of the WHR system, the efficiency of the furnace can be improved. As the exhaust gas is dumped in the environment, is wasted, and creates hazardous pollution in the air. The WHR system will recollect this exhaust gas in environment, this gas can be used in the same equipment by filtering it using properly and adjusting the system.

II. METHOLOGY

De-carb annealing furnace is divided in three zones as i) Preheat Zone, ii) Heat & Soak Zone, iii) Control Cooling Zone. Each zone has different operating burners. As preheat consist of TJ0025 burners & heat & soak & control cooling consist of TFB30 burners. Preheat is again divided in Three zones and has total nine burner each operating at 73 kw. Heat and Soak is divided in four zones and has total 18 burners operating at 87.8 kw.

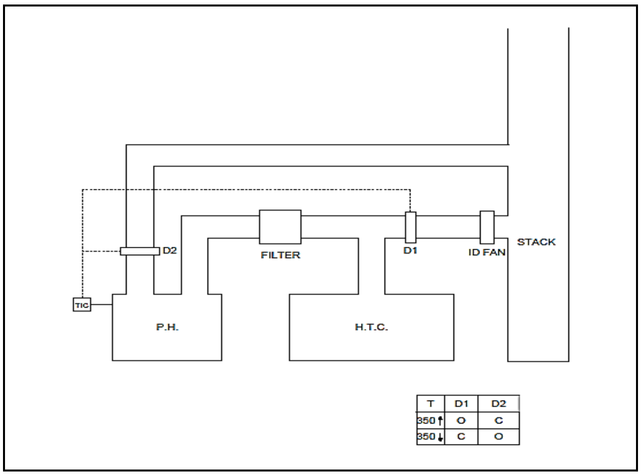

Fig 1: Schematic representation of heat recovery process

They all are operated at different temperature as Preheat at 350 ˚C, Heat & Soak at 780 ˚C and Control Cooling at 550 ˚C. Heat & Soak are provided with rich gas preheat is provided with lean gas. Rich gas has high percentage of hydrogen and lean gas has low percentage of hydrogen.

The material is first passed in to Preheat zone where wax, oil and dust removal is done & then in Heat & Soak zone the process of grain coarsening, stress relieving is done. The exhaust gas from Heat & Soak is dumped in environment and that gas is filtered and reused in Preheat Zone.

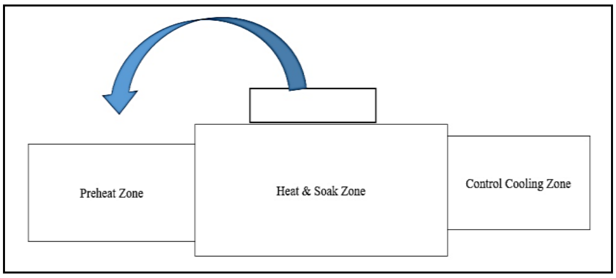

Fig 2: Block diagram of de-carb annealing furnace

III. CALCULATIONS AND RESULTS

In the system, de-carb annealing furnace, is a heat treatment method in which steel is heated above lower critical temperature 727 ˚ C in controlled atmosphere & furnace cooled. A blower provides excess air required for combustion.

Specification of de-carb annealing furnace

Capacity	36 tons per day
Furnace Loading Capacity	1500 kg per hour
LPG Flow Rate	4-5 nm^3/hr
Air Flow Rate	80-95 nm^3/hr
Theoretical Air Required	15.7721 kg of air/ kg of fuel
Furnace Exhaust Temperature	350 ˚ c
Calorific Value of LPG	49998.8 kj/kg
Specific Heat of Steel	0.50208 kj/kg°c

Actual heat applied to the system

$$Qa = \dot{m}\, Cp\, \Delta T,$$

Where,

ṁ: mass flow rate (kg/hr)

Cp: Specific heat of steel (kj/kg°C)

ΔT: Temp difference (°C)

Inputs are

ṁ = 1059.84 kg/hr

ΔT = Inputs (350 – 16) = 334 °C

C_p = 0.50208 kj/kg°C

Then Actual heat Qa = 177664.1711 kj/hr

Heat Supplied to the system:

Qs = ṁ Cv

Where

ṁ: LPG consumption (kg/hr)

Cv: calorific value of LPG (kj/kg)

Inputs are

ṁ = 20 kg/hr

Cv = 49998.8 kj/kg (propane-butane content of LPG)

Qs = 999976 kj/hr

Heat available:

Qs-Qa = 999976 – 177664.17

Qavi = 82231183 kj/hr

Stoppage of fuel consumption in Preheat Zone

Using,

= ṁ X cost of fuel

= 20 X 60

= 1200 Rs/hr

From the last record furnace was running for 3700 hr/yr

i.e. 1200 X 3700 = 44,40,000 Rs/yr

We can save 44,40,000 amount of rupees per year.

IV. CONCLUSION

Excepted conclusion after heat recovery from Furnace are:

1) The exhaust gas from Heat and Soak zone is recovered and utilize the same heat for Preheat zone.

2) 20 kg/hr LPG usage in Preheat zone is going to reduce to 10kg/hr with help of recovered exhaust gas.

REFERENCES

[1] Hassan Jaber, “Effect of exhaust gases temperature on the performance of heat recovery system”,(ES) 119(2017)775-782.

[2] Hussam Jouhara, “Waste heat recovery technologies and applications”, (ES) 6(2018)268-289.

[3] Syed Amjad Ahmad, “Waste heat recovery from flue gases using waste heat recovery boiler”, NFC-IEFR Journal of Engineering and Scientific Research (2015)135-144R.

[4] Arvind Atreya, “A novel method of waste heat recovery from high temperature furnaces”, ACEEE-Summer Study o Energy Efficiency in Industry 6(2007)10-18.

[5] Mohmoud Khaled, “A review on heat recovery from exhaust gas”, (ES) 17(2016)129-143.