STUDY OF WASTE THERMAL ENERGY UTILIZATION OF WASTE HEAT RECOVERY SYSTEM

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ABSTRACT

Production systems represent a significant source of waste heat. The waste heat cannot be reused often. Many optimization methods can give a solution for waste heat recovery. However, the results do not depend only on the method. The low-temperature waste heat makes difficulties for its recovery within the processes. Organic Rankine Cycle units can be used for low-temperature heat transformation into electricity. Linking the Organic Rankine Cycle within the heat integrated system is not simple. This depends on the influence of a few important factors. The process parameters of the working medium, the physical and chemical characteristics of the working fluid, the continuity of heat supply, and the temperature level of waste heat are necessary conditions that must be included in optimization.

Keyword: - *Lime stone1, Cement2, Waste heat recovery system3, Power plant 4.*

1. INTRODUCTION

The main objective of this thesis is that to find out difference in fuel consumption, water consumption, and overall production cost with or without WHRS in modern cement industry and find out total saving by using WHRS. Also find out some new things which will be new things in future study.

The waste heat recovery or utilization of waste heat from various industrial processes such as cement industry, steel industry etc. are very- good things in present time.

The utilization of waste heat involves reduction of primary coast of production as well as environment friendly. Directly affect the environment and responsible of global warming, now this heat is used in WHRS for power generation and reduced the gas temperature from 300 to 100 degree Celsius.

In the last two decades, industrial waste heat has been recognized as a considerable heat resource for reaching energy and climate targets. Many studies reported about the utilization of waste heat from industrial processes and its reuse or transformation in other forms of energy. The results usually show a considerable reduction of the primary energy consumption, and have a contribution to the improvement of energy efficiency and pollution prevention targets.

Defined industrial waste heat as "heat rejected from industrial processes, in which energy (mostly heat and electricity) is used to produce high-added-value products". By that, the heat from Combined Heat and Power (CHP) plants is not considered as waste heat. The same authors denoted the different thermal carriers as the main sources of

waste heat: gaseous process streams (e.g. exhaust gas, flaring gas, low- quality steam, cooling air, etc.), liquid process streams (e.g. hot oil, cooling water, etc.) and solids (e.g. commodities and products).

1.1 Cement Manufacturing Process

The cement manufacturing process is done by various of unit operation, as shown in below the figure no.1.The starting from mining of lime stone where lime stone is received from mine's and then this lime stone is primarily crushed up to 75 mm in size and the grind it in vertical roller mill up to fine powder and this material is feed in pre heater for pyro-processing where the hot air is continuously coming from rotary kiln ,the heat is primarily generated by firing of fine coal powder in kiln with the help of a burner there are lime fine material's calcination will takes place at 800-900 degree Celsius. Then the calcined material is comes in a rotary kiln there complete calcination and melting takes place at 1450 degree Celsius temperature and the clinker nodules should be formed and at the kiln discharge the material cooling should be done in clinker cooler from 1000 degree Celsius to. 100 degree Celsius. This material is stored in yards and during finish grinding, by using of a roller press and ball mill's the mixer of (clinker + gypsum + fly ash) in the ratio of (65:5:30) ground in fine powder this is called cement. The waste heat is generated from two sources one from pre-heater and second is from clinker, which is used in WHRS for waste heat recovery up to 50-60 KW per ton of clinker.

Before the study of WHRS in cement industry we should need to have good knowledge of cement manufacturing process, which is describes here.

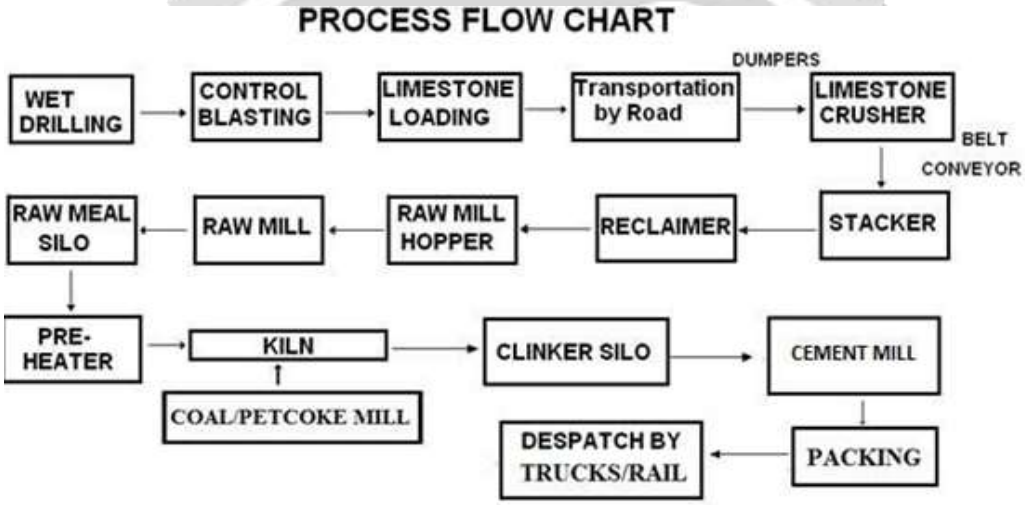

Fig-1.1: Describes the flow sheet or Operations of dry process cement plant.

1.2 Mining of lime stone (Calcium Carbonate)

The key raw material of cement manufacturing is the lime stone and this lime stone is comes from lime stone mine's there are lime stone is blasted and after tasting of lime stone the is sent to cement plant for processing.

1.3 Crushing of Limestone

The Raw limestone is fed to crusher Wobler, where +90 mm part is fed into crusher, and is crushed to -90 mm size. The -90 mm size from crusher Wobler is fed to Secondary screen where (-6mm/-10mm/ -25mm) part is rejected, while + size material is added to Crushed -90 mm Limestone.

1.4 Blending of raw meal and Storage of kiln feed

The ground raw meal is conveyed to blending-cum-storage silo(s) by mechanical conveyors. The variation in the quality of raw meal is reduced by using continuous blending silo.

1.5Preheater, Precalcinar, Kiln

In a cyclone preheater system, as shown in below figure no.(2). An efficient heat transfer takes place, when finely dispersed raw material particles when they come in contact with hot gases from kiln. The preheater is multi stage cyclone system connected with gas ducts and meal chutes. The raw meal is fed into top stage gas duct and is carried by hot gas steam into cyclone. The material gets separated from gas in cyclones and then travels downwards and through meal chute is discharged into next lower stage gas duct. In this way, material comes into contact with high temperature gases and gets preheated and partially calcined and then enters the precalcinator. In the precalcinator, further calcination takes place by firing burning zone and cement clinker is formed, then material is discharged to

the kiln. The feed travels down as the kiln rotates. The chemical reaction completes when the material reaches the kiln mid.

1.6Cooling of Clinker

The clinker is discharged from kiln at around 1000 Degree. C temp and is cooled in a high efficiency grate cooler. The cooled clinker is then transported to clinker storage silo by a set of Deep Bucket Conveyor (DBC). The clinker is discharged from kiln at around 1000 Degree. C temp and is cooled in a high efficiency grate).

1.7 Coal and pet coke crushing and grinding

The Coal or petroleum cock is highly abrasive therefore; its crushing is done usually in a roll crusher. The same system is proposed to be used. Grinding of coal is done either in air swept ball mill or in vertical roller mill. Because of saving in energy and better drying capacity VRM is proposed for use.

1.8 Cement Grinding (VRM and Ball Mill)

For OPC production, clinker with gypsum will be ground in mill. In PPC production, clinker with gypsum and fly ash will be ground in mill. In PSC production, clinker with gypsum and slag will be ground in mill. For grinding the above products, hot air is required, for which the Hot Air Generator will be installed along with coal and Petcoke mill.

1.9 Cement Storage and Packing

The ground cement is conveyed to cement silos for storage of different types of cement from where it is extracted and packed in HDPE bags by electronic rotary packing machines and dispatched to consumers by road and railway. Mechanized loading system for loading of packed bags on trucks and wagon is envisaged.

1.10 Wagon Tippler and Railway siding

Coal and pet coke will be received by road and railway. For unloading handling of coal and pet coke fully mechanized system of wagon tippler and truck tippler will be installed at the site. Also cement and clinker will be dispatched by road and railway.

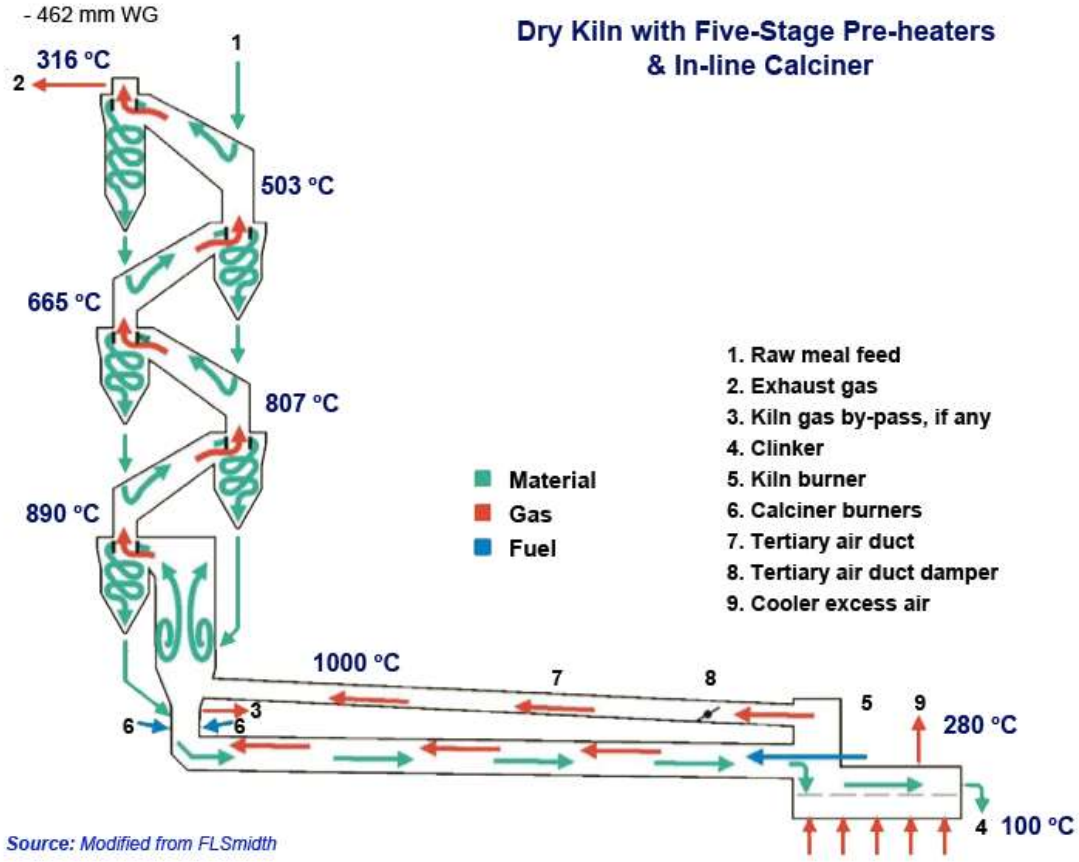

Fig-1.2 - Describes the temperature profile cement plant's pre-heater tower.

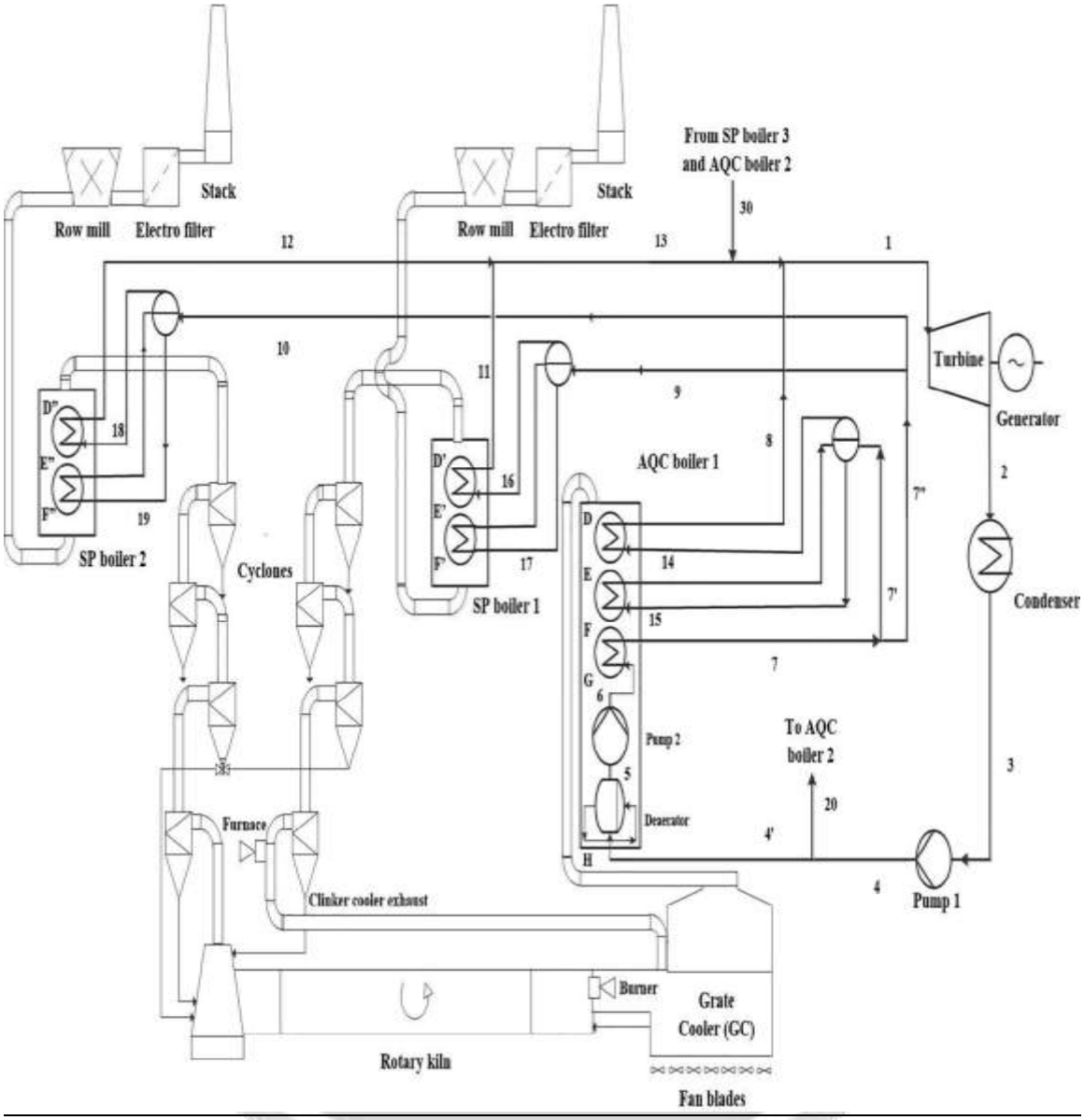

Fig:-1.3 - Describes the Processing of lime stone in a separate line pre heater cement plant with schematic view of AQC1 as well as SP1 and SP2 boilers in heat recovery from grate cooler (1) exit hot air and heat recovery from exit hot gas from cyclone in the Indian cement plant.

1.11 Objective of the Study

In previously many research and survey done on WHRS system by applying different methods Different recent cases & research:

The research article titled "Recuperator for waste heat recovery from rotary kilns.

Mathematical modeling of heat recovery from a rotary kiln.

A review of heat integration approaches for organic Rankine cycle with waste heat in production processes.

Study on Utilization of Waste Heat in Cement Plant.

Conclusion

The usable excess heat can be used at the same moment or later inside the industrial process (internally usable) or outside of the production system (externally usable). The rest of the excess heat that cannot be used internally or externally is non-usable excess heat (waste heat). Furthermore, IEA makes differences in excess heat based on its

origin. Therefore, the excess heat that originates from biomass is called green excess heat, internally used – black excess heat and externally used – white excess heat.

Reference

IEA GHG, CO2 Capture in the Cement Industry, Report 2008/3, (2008).
S. Karellas, A.-D. Leontaritis, G. Panousis, E. Bellos, E. Kakaras (2013) Energetic and Exergetic analysis of waste heat recovery systems in the cement industry, Energy 58 pp.147-156.
A.K. Chatterjee, Cement Production Technology, 66, CRC Press, 2018, doi:10.1201/9780203703335.
N.A. Madlool, R. Saidur, M.S. Hossain, N.A. Rahim, A critical review on energy use and savings in the cement industries, Renew. Sustain. Energy Rev. 15 (4) (2011) 2042–2060, doi: 10.1016/j.rser.2011.01.005.
J. Roy, M. Mishra, A. Misra, Parametric optimization and performance analysis of a waste heat recovery system using organic Rankine cycle, Energy 35 (12) (2010) 5049–5062, doi: 10.1016/j.energy.2010.08.013.
L. E. Bell, "Cooling, heating, generating power, and recovering waste heat with thermoelectric systems," Science, vol. 321, pp. 1457-1461, 2008.
Law R, Harvey A, Ready D. Opportunities for low-grade heat recovery in the UK food processing industry. Appl Therm Eng 2013; 53:188–96. https://doi.org/10. 1016/j.applthermaleng.2012.03.024.
G.jayaraman, Manual on waste heat recovery in Indian cement industry Published by Confederation of Indian Industry, CII Sohrabji Godrej Green Business Centre, Survey # 64, Kothaguda Post, R R District, Hyderabad – 500 084, India 2009 pp 12-60.
Walter H. Duda, cement data book volume-1 international process engineering in cement industry 1985 pp 18-630.