



Heat Recovery from the Boiler Start Up Vent Steam

M.A.Omprakas¹, M. Kavin², V. Pavithran², A. K. Pradheep Raj², M. Ramajayam²

¹Assistant professor, ²UG Students

Department of Mechanical Engineering, Nandha Engineering College, Erode-52,
Tamil Nadu, India

omprakas@nandhaengg.org, kavinm17@gmail.com

Abstract- This project deals Maximizing energy efficiency is an overriding priority in many sectors, no less so in the pulp and paper industry. In many cases, energy managers have exhausted conventional heat recovery measures making further efficiency gains more challenging to identify and implement within the mandated return on investment. A study was conducted and a proposed is given for using the Boiler vent steam by introduce a Pressure Reducing and DE super heating station (PRDS) in Tamil nadu newsprint and papers Limited at karur. Waste heat recovered from the exhaust steam was used to Process plant and also reduction in greenhouse gas and other emissions. So that we have designed a PRDS station to recover the Boiler vent from all the boilers running in TNPL. Due to the developing innovation we have researched new ideas and design in order to survive in this world. With an average heat recovery rate of the project delivers significant energy cost savings as well as the added benefit of an 85% reduction of heat addition into the atmosphere. In future this setup can be implemented the system as an actual functioning of the heat recovery system.

Keywords: Start-up vent, recovery boilers, PRDS station and De superheating system

Keywords—Performance ,Thermal plant, Boiler , Waste Heat recovery ,Paper Industry

I. INTRODUCTION

a) Energy Conservation:

Energy Conservation and Energy Efficiency are separate, but related concepts. Energy conservation is achieved when growth of energy consumption is reduced, measured in physical terms. Energy Conservation can, therefore, be the result of several processes or developments, such as productivity increase or technological progress. On the other hand Energy efficiency is achieved when energy intensity in a specific product, process or area of production or consumption is reduced without affecting output, consumption or comfort levels.

1.2 Definition & Objectives of Energy Management:

The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect. The objective of Energy Management is to achieve and maintain optimum energy procurement and utilisation, throughout the organization and

1. To minimise energy costs / waste without affecting production & quality
2. To minimise environmental effects.

1.3 Energy Scenario:

In the profile of energy sources in India, coal has a dominant position. Coal constitutes about (51%) of India's primary energy resources followed by Oil (36%), Natural Gas (9%), Nuclear (2%) and Hydro (2%). To address the issue concerning energy consumption, and more particularly, the need for enhancing the energy supply, India has accorded appropriate priority to both - supply side management and demand side management. On the supply side management, while it is essential for India to radically expand the capacities on all the fronts and all the segments of energy, equally important is the need for efficient consumption of energy for which a number of initiatives have been put in place.

1.3.1 Coal Sector:

Coal constitutes the most dominant constituent of the energy sector. In the year 2005-06, the coal production was over 370 million tonnes. Power Sector consumes almost 80% of coal that is produced. India has large coal reserves of the order of 200 Billion Tones, most of these are high ash content coal in the calorific value range of 3000 kilo calorie per kilogram to 4,500 kilo calorie per kilogram and ash content in the range of 30 – 45%. Using the high ash coal for the power sector is a major challenge, from the point of view of achieving high level of efficiency of consumption, and more particularly, from the point of view of environmental management due to fly ash emissions.

1.3.2 Oil Sector:

Oil constitutes over 35% of the primary energy consumption in India. It is expected that this would rise both in terms of absolute amount and proportion. The demand projection is placed at about 200 million metric tonnes by the

2.OVERVIEW OF TNPL

2.1 Tamil Nadu Newsprint and Papers Limited:

Tamil Nadu Newsprint and Papers Limited was established by the Government of Tamil Nadu to produce newsprint and writing paper using bagasse, a sugarcane residue. The Government of Tamil Nadu listed the paper mill in April 1979 as one of the most environmentally compliant paper mills in the world under the provisions of the Companies Act of 1956. The factory is situated at Kagithapuram.

2.2 History:

The Company commenced production in the year

1984 with an initial capacity of 90,000 tonnes per annum. TNPL has started the commercial production of newsprint on its new Paper Machine No. 2 from January 1996. The machine end of the 11

million metric tonnes by 2024-25. The upstream regulation is by the Director General of Hydro Carbons. They concentrate on the technical aspects and pricing is not under their domain. However, under the NELP contract, the private sector would need to have the price approved by the Government and to that extent, Director General, Hydrocarbons would have a role.

2.3 Quality Standards:

TNPL has obtained the ISO 9001 - 2000 certification

from **RWTUV** of Germany for development, manufacture and supply of Newsprint and Printing & Writing Paper. TNPL uses automated process control facilities for various process till final packing and despatch. It is implemented by The Online Integrated Information System (OIS) a mini ERP package developed by CMC Ltd for integrated flow of information from all the sections of the company covering production, materials, finance, marketing etc.

TNPL's in-house Research and Development facility is recognized by the Department of Scientific and Industrial Research (DSIR) New Delhi. The R&D department has sophisticated state-of-the art instruments and equipments. TNPL has recorded Customer Satisfaction Index (CSI) of about 7.01 to 7.50.

2.3 Environment Protection Measures:

TNPL is accredited with ISO14001:2004 certification for an effective environmental management system. By using bagasse as primary raw material, TNPL preserves over "40000 acres of forest land from depletion every year".

2.4 TNPL Plantation Programme:

As per the National Forest Policy, 1988, forest based Industries should raise the raw material needed for meeting its own requirement. In accordance with the law, TNPL has embarked upon development of plantation in the year 2004-05 and launched two plantation schemes namely Farm Forestry and Captive Plantation.

2.5 Energy Management Policy:

TNPL has installed its own power generating facility to make it 100% self sufficient through the installation of 81 MW Power Generating equipments (TG Sets) installed at the paper mill site. The surplus power generated is being exported to the State Grid. TNPL also generates green power through the 18 MW wind farm installed at Devarkulam and Perungudi of Tirunelveli district. The entire power generated at the wind farm is being exported to the State Grid. The wind farm capacity has been enhanced to 21.75 MW in March 2004 by installing 3 wind mills of 1250 kW capacity each. It has installed a Bio-methanation plant to generate methane gas from the effluent water (bagasse wash water) and use it as fuel as substitute for furnace oil in the lime kiln saving 10 KL of furnace oil every day. During the year 2004-05 TNPL generated 34.12 lakh M3 methane gas from its bio-methanation plant and used the same in lime-kiln replacing 1886 KL of furnace oil valuing Rs. 2.02 Crores. The

was supplied jointly by Voith Sulzer Paper Technology and its licensee in India, Larsen and Toubro Limited and has opened

confederation of Indian Industry has recognized the bio-methanation project implemented by TNPL as an *Innovative Project*. This project contributes to sustainable development in terms of generating in-house renewable energy and reducing green house gases.

2.6 TNPL's Products:

The paper produced by TNPL is eco- friendly as the pulp is manufactured out of renewable raw material and is subjected to Elemental Chlorine Free (ECF) bleaching. As the paper is acid free, it has a longer colour stability and enhanced permanency in terms of strength characteristics. TNPL caters to the requirements of multifunctional printing processes like sheet-fed, web offset, and digital printers. The paper reels have uniform profile with strength properties to cope even with high speed machines. TNPL manufactures Printing and Writing Papers in substances ranging from 50 GSM to 90.

GSM Newsprint is normally manufactured in 49 Gsm reels and directly sold by the company to the various newspaper establishments such as The Hindu, Malayala Manorama, Ananda Bazaar Patrika and so on. Printing & Writing paper (PWP) is manufactured in reel and sheet forms with the GSM (Grams per square meter – basis weight of the paper) varying from 50 to 80. Various sizes of reels and sheets are also cut to suit the customer requirements. Some of the major end-use segments of PWP are printing applications, note books, computer, stationery, office stationery, etc.

- i. TNPL Ultra White Maplitho
- ii. Radiant Printing
- iii. Hardbound Notebook
- iv. Symbolic of TNPL's commitment to the environment, the "World Wide Fund for nature (WWF)" has entered into a pact with TNPL to use the "Panda" logo in TNPL's branded products.

2.7 Awards & Accolades:

2.7.1 Environmental Strategy of the Year Award:

TNPL won the Environmental Strategy award for the year 2011 at the PPI Annual Awards ceremony at Brussels.

2.7.2 Green Business Leadership Award:

In recognition of its environmental conservation initiatives, the Tamil Nadu Newsprint and Papers Limited has been awarded the *Green Business Leadership Award* in the Pulp and Paper Sector for the year 2009-2010.

The TNPL Managing Director, T.K. Ramachandran, received the award from the *Union Minister for New and Renewable Energy*, Farooq Abdullah, in the presence of TERI Chairman and eminent environmentalist R.K. Pachauri in New Delhi recently. The TNPL was adjudged the best performer at the national level in the Pulp and Paper category in EVI Green Business Survey conducted by The Financial Express and Emergent Ventures India, an integrated climate change

company with the Indian School of Business, Hyderabad as the knowledge partner.

2.7.3 *The Energy & Resources Institute(TERI)Corporate*

Award:

TNPL has been awarded second prize in the prestigious "TERI Corporate Environmental Award 2008" at 7th TERI Corporate Awards Ceremony : 31 May 2008, New Delhi in recognition of its various initiatives taken in Corporate Environment Management.

2.7.4 *Excellence in Corporate Governance:*

The Institute of Company Secretaries of India (ICSI), New Delhi has conferred on TNPL, the "ICSI National Award of Excellence in Corporate Governance" for the year 2004 in the Public Sector category. This is the first time such a prestigious award in Corporate Governance has been given to a State Public Sector Undertaking. So far, in the last two years, only major Central Public Sector Undertakings, viz. ONGC and IBP got the award.

2.7.5 *Best Paper Mill 2001-02 & 2007-08:*

TNPL has been given the prestigious award Paper Mill of the year 2001-2002 & 2007-08 [23] for TNPL's overall performance, approaches for meeting social obligations, ensuring global competitiveness, sustainable development & technology options by the Indian Paper Manufacturers' Association, New Delhi.

2.7.6 *Certificate of Excellence:*

TNPL bagged, the Certificate of Excellence in Productivity, Quality, Innovation and Management from the "Institute of Economic Studies", New Delhi.

III. LITRATURE REVIEW

We are aware that the population of the world is increasing dramatically, and the demand for energy is greater than ever before. Fossil fuels are the main source of our energy, and are not renewable resources meaning that once used they cannot be replaced or recreated. They also pose environmental problems during their extraction, transportation and utilisation. However all the forecasts suggest that more fuels will be burned in the future and 85% of it will be fossil fuel, and almost every step of the process of supplying energy damages the environment? All these factors have forced us to go for extensive designing and manufacturing of highly efficient energy conversion devices which produces minimum damage to environment. Mixed gas-steam cycle based power plants have been chosen for this purpose as they are efficient systems and continuous extensive researches are in progress in the direction of increasing its efficiency. It is significant to have a systematic review of literature from the point of view to find the useful information for engineering design, performance prediction, application and scope of the future research work in the field of mixed gas-steam cycle. This very chapter is an attempt in this direction. 2.1 Various Configurations of Gas Turbine based Thermal Power Plants A large number of configurations of gas turbine based thermal power plants are possible. A vast quantity of literature is available on this topic however; here it is restricted mainly to those power plants which are associated with recovery and utilisation of waste

heat as a modus operandi to enhance the power plant performance. [2008] Mosafa A.H. et al. [28] have demonstrated that in recent decade, more attention has been paid to reheat gas turbine cycles because of their high exhaust gas temperature. Using heat energy of exhaust gases in a steam generating system is one scheme that has been suggested. In this research, heat recovery steam generator (HRSG) is analysed as an appliance for transferring heat between exhaust gases and water and design parameters were optimized. The results show that decreasing pinch point temperature difference makes both energetic and exergetic efficiency increase. They also show that with larger process steam pressure, exergetic efficiency increase significantly but energetic efficiency decreases. These efficiencies are less affected by variation of final temperature difference. However decreasing the final temperature difference makes the mass flow rate of steam increase. Thus for optimum design of HRSG in a combined system such as cogeneration gas turbine cycle with reheat, a proper value of the mentioned parameters must be chosen depending on the demand for power or heat in different situation. [2007] Layi Fagbenle R. et al. [18] have carried out thermodynamic analysis considering both the first and the second laws of thermodynamics on a 53 MW (net) biogas-fired integrated gasification steam injected gas turbine (BIG/STIG) plant. The energy utilization diagrams (EUDs) for the plant and for the reaction subsystems have also been considered, revealing both problems and potentials for improvement. The analysis indicates a thermal efficiency of about 41% (power based) and 45% (power and recovered heat based) but that the exergy loss in the combustion chamber was largest at about 79% of the total system exergy loss. [2007] Roumeliotis I. and Mathioudakis K. [37] have presented experimental work concerning the effect of water injection on a compressor stage. The effect on compressor stage performance and stability is examined for water injection up to 2%. The behaviour of the airflow in the blade rows is examined through aerodynamic measurements. The results indicate that although the water injection appears to not have any significant effect on the flow pattern and to stage pressure rise and stall margin, there is a measurable effect on compression efficiency, which seems to result mainly from losses of a mechanical nature and water acceleration. The efficiency degradation is found proportional to the water ratio entering the engine. [2005] Poullikkas [36] has presented in this work an overview of current and future sustainable gas turbine technologies. In particular, various gas turbine technologies are described and compared. Emphasis has been given to the various advance cycles involving heat recovery from the gas turbine exhaust, such as, the gas to gas recuperation cycle, the combined cycle, the chemical recuperation cycle, the Cheng cycle, the humid air turbine cycle, etc. The thermodynamic characteristics of various cycles are considered in order to establish their relative importance to future power generation markets. The combined cycle technology is now well established and offers superior to any of the competing gas turbine based systems, which are likely to be available in the medium term for large-scale power generation applications. In small-scale generation, less than 50 MW, it is more cost effective to install and a less complex power plant due to the adverse effect of the economics of scale. Combined cycle plants in this power output range normally have higher specific investment costs and lower electrical efficiencies but also offer robust and reliable performance. Mixed air steam turbines (MAST) technologies are among the possible ways to improve the performance of gas turbine based power plants at feasible costs (e.g. peak load gas

turbine plants). [2004] Lingen Chen et al. [20] have done a performance analysis and optimization of an open-cycle regenerator gas-turbine power plant. The analytical formulae about the relation between power output and cycle overall pressure-ratio are derived taking into account the eight pressure-drop losses in the intake, compression, regeneration, combustion, expansion and discharge processes, flow process in the piping, the heat transfer loss to the ambient environment, the irreversible compression and expansion losses in the compressor and the turbine, and the irreversible combustion loss in the combustion chamber. The power output is optimized by adjusting the mass-flow rate and the distribution of pressure losses along the flow path. Also, it is shown that the power output is a maximum with respect to the fuel-flow rate or any of the overall pressure-drops and the maximized power output has an additional maximum with respect to the overall pressure-ratio. The numerical example shows the effects of design parameters on the power output and heat-conversion efficiency. [2004] Mustapha Chaker et al. [30] have emphasized that the inlet fogging of gas turbine engines for power augmentation has seen increasing application over the past decade yet not a single technical paper treating the physics and engineering of the fogging process, droplet size measurement, droplet kinetics, or the duct behavior of droplets, from a gas turbine perspective, is available. This paper along with Parts I and II provides the results of extensive experimental and theoretical studies conducted over several years coupled with practical aspects learned in the implementation of nearly 500 inlet fogging systems on gas turbines ranging in power from 5 to 250 MW. In Part III of this paper, the complex behavior of fog droplets in the inlet duct is addressed and experimental results from several wind tunnel studies are shown. [2004] Bhargava R. et al. [3] have presented a comprehensive and simple in application design methodology to obtain a gas turbine working on recuperated, intercooled, and reheat cycle utilizing existing gas turbines.

Applications of the proposed design steps have been implemented on the three existing gas turbines with wide ranging design complexities. The results of evaluated aerothermodynamic performance for these existing gas turbines with the proposed modifications are presented and compared in this paper. Sample calculations of the analysis procedures discussed, including stage-by-stage analysis of the compressor and turbine sections of the modified gas turbines have been also included. All the three modified gas turbines are found to have higher performance, with cycle efficiency increase of 9% to 26%, in comparison to their original values. [2004] Torbidoni L. and Massardo A.F. [44] have presented with the objective of performing reliable innovative gas turbine cycle calculations, a new procedure aimed at evaluating blade cooling performance. This complete analytical (convective and film) blade cooling modeling provides the coolant mass flow and pressure loss estimation, and is a useful tool in the field of innovative gas turbine cycle analysis, mainly when alternative fluids are considered. In this case, in fact, the conventional semi-empirical data based on the use of air as traditional coolant and working media are no longer suitable. So the analytical approach represents a way of properly investigating alternative cooling methods and fluids. In the presented analysis the effects of internal blade geometry on cooling performance are summarized by the Z parameter which also highly affects the coolant flow pressure losses. Since existing

technology represents a natural starting point for the assessment of Z , the model is able to automatically estimate a proper value relying only on available semi-empirical data which were established for air-cooled gas turbine blades. When alternative fluids are considered, the same estimated value of Z is still maintained for the calculation, with the result of investigating the performance of existing blade technology for novel operational conditions. This represents an example of how the analytical approach, supported by conventional air-cooled blade semi-empirical data appears as an innovative tool in the analysis of novel gas turbine cycles. [2003] Victor de Biasi [46] has proposed a project estimated at \$11,500,000 that would cut NO_x emission over 50 percent, increase generating capacity by 50MW and improve heat rate by almost 15 percent at ambient temperature from 250 F to over 900 F. Humid air injection is patented and proven technology licensed by Hill Energy Systems. Basically introduces an external supply of preheated, humidified and pressurized air into a gas turbine downstream of the compressor and upstream of the combustor. This supplementary injection serves to cool peak flame temperatures in the combustor (which reduces thermal NO_x) and increase mass flow to the gas turbine expander (augments power output and reduces heat rate). It is of greater importance as a low-cost and superior alternative technology to water or steam injection for NO_x control with significant power augmentation heat rate reduction as coincidental benefits. [1998] Horlock J. H. [14] has proposed the flow through a gas turbine in a variety of forms. The STIG plant involves the generation of steam by the gas turbine exhaust in a heat recovery steam generator (HRSG), and its injection into

or downstream of the combustion chamber. This increases the mass flow through the turbine and the power output from the plant, with a small increase in efficiency. In the Evaporative gas turbine (or EGT) cycle, water is injected in the compressor discharge in a regenerative gas turbine cycle (a so-called CBTX plant-compressor[C], burner[B], turbine[T], heatexchanger [X]); the air is evaporatively cooled before it enters the heat exchanger. While the addition of water increases the turbine mass flow and power output, there is also apparent benefit in reducing the temperature drop in the exhaust stack. In one variation of the basic EGT [1998] Dechamps P. J. [8] has looked at some of the heat recovery possibilities with the newly available gas turbine engines, characterized by a high exhaust temperature, a high specific work, and the integration of some gas turbine cooling with the boiler in this paper. The schemes range from classical dual pressure systems, to triple pressure systems with reheat in supercritical steam conditions. For each system, an optimum set of variables (steam pressures, etc.) is proposed. The effect of some changes on the steam cycle parameters, like increasing the steam temperatures above 570°C are also considered. Emphasis is also put on the influence of some special features or arrangements of the heat recovery steam generators, not only from a thermodynamic point of view.

differences and pressure drops in heat/mass transfer equipment). The efficiency penalties associated with each process are evaluated by a second-law analysis, which also includes the cycles considered in Part A. For any given TIT in the range considered (1250 to 1500°C), the more reversible air/ water mixing mechanism realized in the saturator allows HAT cycles to achieve efficiencies about 2 percentage points higher than those of RWI cycles: At the TIT of 1500°C made possible by intercooling, state-of-the-

art aero-engines embodying the above-mentioned cycle modifications can reach net electrical efficiencies of about 57 and 55 percent, respectively. This compares to efficiencies slightly below 56 percent achievable by combined cycles based upon large-scale heavy-duty machines.

3.1. The information to be collected during the detailed audit includes:

1. Energy consumption by type of energy, by department, by major items of process equipment, by end-use
2. Material balance data (raw materials, intermediate and final products, recycled materials, use of scrap or waste products, production of by-products for re-use in other industries, etc.)

3.2 Energy Audit Instruments:

3.2 Identification of Energy Conservation Opportunities:

- i. Fuel substitution: Identifying the appropriate fuel for efficient energy conversion
- ii. Energy generation: Identifying Efficiency opportunities in energy conversion equipment/utility such as captive power generation, steam generation in boilers, thermic fluid heating, optimal loading of DG sets, minimum excess air combustion with boilers/thermic fluid heating, optimising existing efficiencies, efficient energy conversion equipment, biomass gasifiers, Cogeneration, high efficiency DG sets, etc.
- iii. Energy distribution: Identifying Efficiency opportunities network such as transformers, cables, switchgears and power factor improvement in electrical systems and chilled water, cooling water, hot water, compressed air, Etc.
- iv. **Energy usage by processes:** This is where the major opportunity for improvement and many of them are hidden. Process analysis is useful tool for process integration measures.

3.3. Technical and Economic feasibility:

The technical feasibility should address the following issues

1. Technology availability, space, skilled manpower, reliability, service etc
2. The impact of energy efficiency measure on safety, quality, production or process.
3. The maintenance requirements and spares availability
4. The Economic viability often becomes the parameter for the management key acceptance.

The

economic analysis can be conducted by using a variety of methods. Example: Pay back method, Internal Rate of Return method, Net Present Value method etc. For low investment short duration measures, which have attractive economic viability, simplest of the methods, payback is usually sufficient.

3. Energy cost and tariff data

4. Process and material flow diagrams

5. Generation and distribution of site services (eg.compressed air, steam).

6. Sources of energy supply (e.g. electricity from the grid or self-generation)

7. Potential for fuel substitution, process modifications, and the use of co-generation systems (combined heat and power generation).

8. Energy Management procedures and energy awareness training programs within the establishment.

Existing baseline information and reports are useful to get consumption pattern, production cost and productivity levels

The requirement for an energy audit such as identification and quantification of energy necessitates measurements; these measurements require the use of instruments. These

instruments must be portable, durable, easy to operate and relatively inexpensive. The parameters generally monitored during energy audit may include the following:

Basic Electrical Parameters in AC & DC systems - Voltage (V), Current (I), Power factor, Active power (kW), apparent power (demand) (kVA), Reactive power (kVAr), Energy consumption (kWh), Frequency (Hz), Harmonics, etc.

Parameters of importance other than electrical such as temperature & heat flow, radiation, air and gas flow, liquid flow, revolutions per minute (RPM), air velocity, noise and vibration, dust concentration, Total Dissolved Solids (TDS), pH, moisture content, relative humidity, flue gas analysis - CO₂, O₂, CO, SO_x, NO_x, combustion efficiency etc.

4. Present TNPL Working process

In a bottoming cycle, the primary fuel produces high temperature thermal energy and the heat rejected from the process is used to generate power through a recovery boiler and a turbine generator. Bottoming cycles are suitable for manufacturing processes that require heat at high temperature in furnaces and kilns, and reject heat at significantly high temperatures. Typical areas of application include cement, steel, ceramic, gas and petrochemical industries. Bottoming cycle plants are much less common than topping cycle plants. The Figure below illustrates the bottoming cycle where fuel is burnt in a furnace to produce synthetic rutile. The waste gases coming out of the furnace is utilized in a boiler to generate steam, which drives the turbine to produce electricity refer a figure4.1.



3.4 Maximising System Efficiency:

Once the energy usage and sources are matched properly, the next step is to operate the equipment efficiently

4.1 Important Technical Parameters for Cogeneration:

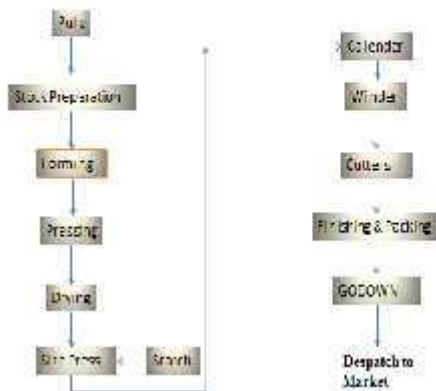
- 1.Heat-to-Power Ratio:
- 2.Quality of Thermal Energy Needed:
- 3.Load Patterns
- 4.Fuels Available
- 5.System Reliability:

Some energy consuming facilities require very reliable power and/or heat; for instance, a pulp and paper industry cannot operate with a prolonged unavailability of process steam. In such instances, the cogeneration system to be installed must be modular, i.e. it should consist of more than one unit so that shut down of a specific unit cannot seriously affect the energy supply.

5.THERMAL PLANT HANDLING IN TO PAPER INDUSTRY

This plant is designed to receive mill with whole bagasse of 50% moisture from the sugar mills. Disc screens, moist Depithers and a self-propelled twin bagasse boom stacker.

PROCESS IN PAPER MACHINE

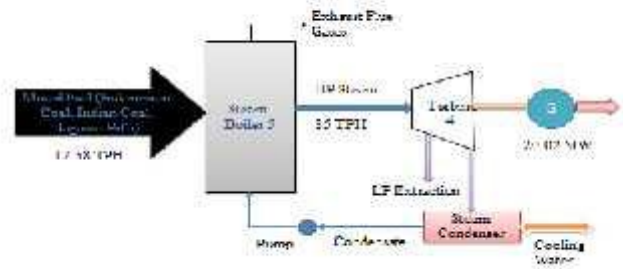


Bagasse received from sugar mills through trucks. The unloaded bagasse is conveyed and screened in classifiers and depithed to remove the pith. The depithed bagasse is stored in open yard through a self propelled boom stacker. The pith is transferred through conveyors to boilers to be used as fuel.

6.PRESENT UNIT SYSTEM

Small mills use direct contact evaporation, after concentration of about 45-50% has been achieved in the indirect contact evaporator, especially when processing non wood black liquors. Hot flue gas from the recovery boiler heats a film or spray of black liquor. This technique can also evaporate to maximum 65% dry solids content due to the steeply increasing liquor viscosity at higher dry solids contents.

Cogeneration Diagram



24.62 MW Cogeneration Unit at TNPL

7.OPTIMIZED THERMAL PLANT HANDLING IN TO PAPER INDUSTRY

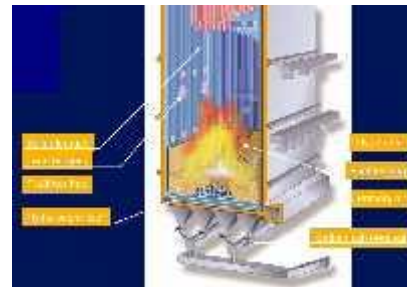


TABLE I.1 Specification detail boiler

Boiler Details:	
Water tube boiler	
Natural circulation type	
Atmospheric fluidized bed combustion	
Make	: CVL
Steaming Capacity	: 90 TPH
Steam Pressure	: 64 kg/cm ²
Steam Temperature	: 485°C
Fuel Used	: Indonesian coal, Indian coal and Pith
Composition of Mixed Fuel (% by mass)	
Carbon	: 40.13%
Hydrogen	: 3.4%
Oxygen	: 12.67%
Sulphur	: 0.59%
Nitrogen	: 0.55%
Moisture	: 30.37%
Ash	: 12.29%
O ₂ % in flue gas	: 6%
CO% in flue gas	: 0%
CO ₂ % in flue gas	: 11%
Flue gas temp	: 140°C
Bed Ash%	: 93.8%
Fly ash%	: 86%
Fuel firing rate	: 17.58 TPH
GCV of fuel:	17029.59 kJ/kg

8. SUCCESSIVE OF PROCESS ENERGY

1. LP steam extracted from TG-4 is utilized by Paper Machine III for drying purpose.
2. Drying of paper in Paper Machine III:
3. Purpose of drying is to remove residual water in the sheet by evaporation.
4. In Conventional paper machines, the thermal energy for drying is transferred to the paper by passing the paper web through a series of large diameter rotating steam filled cylinders.
5. This extensive dryer section is the most expensive part of the paper machine.
6. It is also costly to operate because of the high energy consumption in terms of steam requirement.

Maximum LP steam extracted from TG-4

= 720 T/day

LP Steam required by Paper machine III

= 600 T/day

= 25 T/hr

Steam Pressure for drying process

= (3-3.5) kg/cm²

Steam Temperature for drying process

= 150°C

Condensate Return to boiler

= 595 T/day

The condensate that forms inside the dryer cylinders is removed by a specially designed siphons assembly.

Criteria of Performance in Dryer Section:

Two measurements are important in assessing the performance of a dryer sections. They are:

1. Evaporation Drying rate which is measured as pounds of water evaporated per hour per square foot of dryer surface contacted, or in Metric terms, Kgs of water evaporated per ton per square meter of the dryer surface.

2. Steam Economy which is the number of units of water evaporated per unit of steam. It is measured normally as thousands of BTUs per pound of water evaporated or KJ per kg. The evaporation drying rate is generally influenced by steam pressure used inside the drying cylinders.

9. CONCLUSION

This chapter deals with conclusions based on the results and discussions of previous chapter. Since it is not possible to cover all the aspects of any research work, so the suggestions for the further study in the field of mixed cycle are also presented in subsequent sections:

The various conclusions derived from the study are as follows-

1. Mixed cycle offers high plant efficiency and plant specific work compared to basic gas turbine cycle

2. There is an appreciable enhancement in the mixed cycle specific work (12 to 16%) and efficiency (2 to 4%) over the basic gas turbine cycle but at the complexity of plant.

3. The performance of SIIcRGT cycle is better than the all considered configuration

4. The Heating flow requirement increases with the increase in turbine inlet temperature (TIT).

[1] Andreas Poullikkas, , "Operating cost and water economy of mixed air steam turbines", Applied Thermal Engineering, vol. 25, pp. 1949-1960. 2005

[2] Bannister R. L., Cheruvu N. S., Little D. A. and Mcauiggan G., "Development requirements for an advanced gas turbine system", J. Eng. Gas Turbines Power, ASME, vol. 117, pp. 724-733. 1995

[3] Bhargava R., Bianchi M., Peretto A., Spina P. R., "A feasibility study of existing gas turbines for recuperated, intercooled, and reheat cycle", ASME, Journal of Engineering for Gas turbines and Power, vol.126, pp 531-544. 2004

[4] Bolland O., , "A comparative evaluation of advanced combined cycle alternatives", ASME, J. Eng. Gas Turbines Power, vol. 113, pp. 190-197. 1991

[5] Bolland O., Stadaas J. F., 1995, "Comparative evaluation of combined cycles and gas turbine systems with water injection, steam injection, and recuperation", Journal of Engineering for Gas Turbines and Power, vol. 117, pp. 138-145.

[6] Chiesa P., Lozza G., Macchi E. And Consonni S., "An assessment of the thermodynamic performance of mixed gas-steam cycles. A: Water-injected and HAT cycles", Journal of Engineering for Gas Turbines and Power, ASME , vol. 117, pp. 449 - 455. 1995

[7] Chiesa, P., Lozza, G., Macchi, E. and Consonni, S., "An assesment of the thermodynamic performance of mixed gas-steam cycles: Part B-Water injected and HAT cycles," ASME, Journal of Engineering for Gas turbines and Power, vol.117, pp. 499-508. 1995

[8] Dechamps P. J., , "advanced combined cycle alternatives with the latest gas turbines" ASME, Journal of Engineering for Gas turbines and Power, vol.120, pp. 350-357. 1998

[9] El - Masri M.A., 1988, "GASCAN - An interactive code for thermal analysis of gas turbine systems" ASME, Journal of Engineering for Gas Turbines and Power , vol. 110, pp. 201-209.

[10] El-Masri M.A., 1986, "On thermodynamics of gas turbine cycles: Part 3- Thermodynamic potential and limitations of cooled reheated-gas-turbine combined cycles," ASME, Journal of Engineering for Gas Turbine and Power, vol.108, pp 160-169.

[11] Fukue I., Aoki S., Aoyama K., Umemura S., Merola A., Noceto M., and Rosso M., 1994, "A new high-efficiency heavy-duty combustion turbine 701F", Journal of Engineering for Gas Turbine and Power, Five Year plan i.e. by 2011-12 and over 250