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Energy Performance of Steam Generation Unit with Using Non-Renewable Fossil Fuel Like Imported (Indonesian) Coal at Spectrum Dyes and Chemicals Private Limited, Palsana-Surat

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Abstract:- Now a day's competition to became power fuel nation is increase industrialization and develop various process or methods for Energy sector. Due to increases energy demand with suitable use of Energy is important for any developing nation. The current case study work is an account of Energetic performance of steam generation unit like Boiler in the Spectrum Dyes and Chemicals Private Limited. The capacity of the Boiler for the steam generation 10 T/Hr. (2 Unit) and 6 T/hr. (1 Unit) coal fired boiler supplied by Rajdeep Boiler, Sachin. After completing the whole 1st law analysis of the Boiler plant has been presented

The analysis carried out by using first law for a particular steam generation unit. There are useful assumption is required to analysis during calculations which is introduced in these performance calculations. Microsoft Excel is used for computer programs are developed for performance calculation energetic analysis of a steam generation plant. The PIE chart is graphical represent to energy flow in the system and the losses in the various components during normal operating condition have been identified. The analysis shows that the 1st law efficiency of Boiler Plant with solid Imported (Indonesian) coal fired boiler is 81.43%.

Keywords:- *Steam Generation Plant, Non-Renewable Fuel, Burning, Energetic Performance Indirect Method, Effective Calculation, PIE Chart.*

I. INTRODUCTION

The Energy demand is increases after Second World War at this stage to become powerful nation various source of invention in war area as well as power generating unit and device is develop. Most of the power is produced Hydro energy which is the oldest technology in this word. Every day the demand of Energy uptake in the business, transport, framing equipment and house hold sectors increased continuously. Now, a day's Oil and natural gas, hospitality and computer and network related services using more demand of power so various source of energy is required to meet the demand.

Limited resources are is available for the India. Limited resources may available at maximum 100 years for Mining Coal and Gas and oil for limited years. Energy, the capacity to do work which is stored and transit type energy which is depending upon their path in thermodynamic property.

The present work is an attempt to present such in depth thermodynamic analysis of a Boiler in the Spectrum Dyes and Chemicals Pvt. Ltd., PALSANA." The steam is generated in 10 T/hr. capacity at 8.5 kg/cm^2 pressure which is achieved by coal fired boiler supplied by Rajdeep Boiler Pvt. Ltd. Surat (2 Unit). The total force analysis of the plant is complete out based on collect useful reading over a time 3 weeks {June - 2024}. The energy destruction of different devices and the valuable hint given to for increasing energy efficient of the steam generating unit. Based on energy analysis PIE chart for the pictorial representation of energy distribution in various components of the plant are given and discussed.

II. THEORETICAL CONSIDERATIONS OF ENERGY

The main work is to analysis of Energy is based on 1st law and 2nd law of Thermodynamics with their advantages and Disadvantages. The aim of converting of mass is used to discover out the mass flow rate for a given capacity and sizes of various components.

- *General Overview of a Boiler System*

A steam generator or **boiler** is, a closed vessel made of steel. Main function of steam generator is to transfer the heat of fuel produced is to water, and generate into steam. Water is easily available at surrounding but proper treatment of water is necessary due to life of tube depending its performance. Volume of steam is increase more than volume of water during the converting into steam so special care is required or hand with care.

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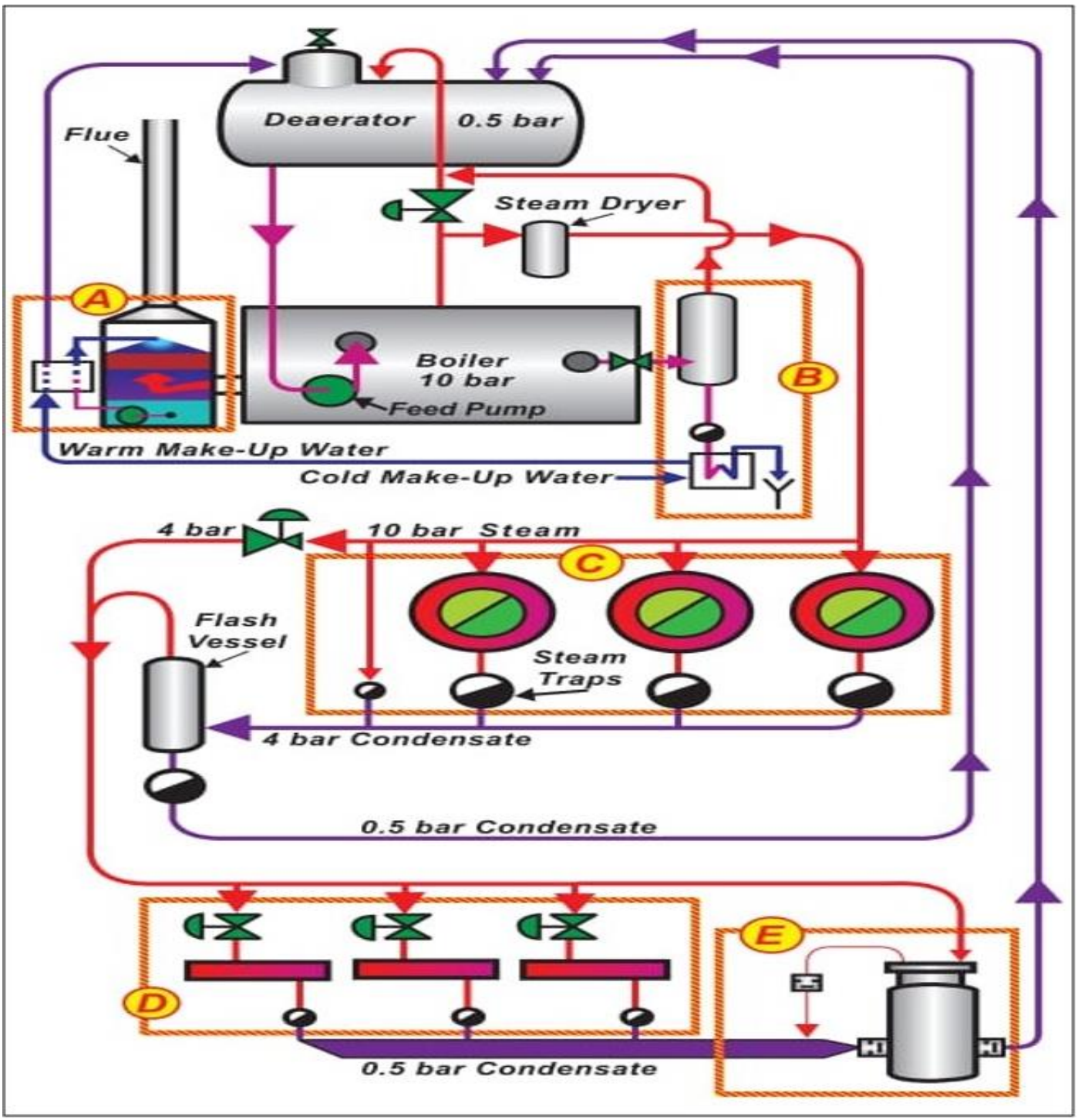

Fig 1 Steam Generation Unit Room Schematic

Liquid state is convert into gaseous state due to given heat is known as Evaporation. Heat is transferred from one body to another by means of (1) **Conduction**,(2) **Convection**, (3) **Radiation**.

A steam generation unit is a major device or core of the various firm as well as Fossil fuel power station firms because the steam is the central plasma for the functioning media for fossil fuel power station firms. So that steam generation unit is very important or most efficient device .

There are total 2 nos. (10 TPH) of boiler manufactured by Rajdeep Boiler, Sachin in this plant and also one more (6 TPH) boiler in SPECTRUM. Boiler plant is the heart of SPECTRUM as it supplies the necessary and required steam to other chemicals plants for production and units for their processes.

- *Non –Renewable Fossil Fuels*

Fuel means Hydrocarbon, containing mostly carbon and hydrogen substance in it. Heat source burning with the help of oxygen in the atmospheric air and release giant hotness is known as chemical energy.

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The different types of fossil fuels like liquid, solid and gaseous fuels are available for burning in steam generation units, furnaces and other combustion equipments. The selection of right type of fuel depends on various factors such as availability, storage, handling, pollution and landed cost of fuel. The knowledge of the fuel properties helps in selecting the right fuel for the right purpose and efficient use of the fuel.

There are two methods: **Ultimate analysis** and **Proximate analysis**. The ultimate analysis determines all coal component elements, solid or gaseous and the proximate analysis deter- mines only the fixed carbon, volatile matter, moisture and ash percentages.

The ultimate analysis is determined in a properly equipped laboratory by a skilled chemist, while proximate analysis can be determined with a simple apparatus.

➢ *Act of Burning (Combustion)*

It means chemical combination of oxygen, in the air and hydro carbons. When sufficient quantity of oxygen burns with carbon, produced carbon dioxide and gigantic amount of heat is release. Some time amount of air is main part or make key role of the combustion process during the requirement of Theoretical air or Excessive air for complete Combustion.

➢ *The Goal of Satisfactory Burning is to Discharge all of the Heat in the Fuel which are*

- Sufficient given Temperature for fuel
- Turbulence of the fuel and oxygen
- Time give for complete combustion.

Too much, or too little fuel with the available combustion air may potentially result in unburned fuel and carbon monoxide generation. A very specific amount of O_2 is needed for perfect combustion and some additional (excess) air is required for ensuring complete combustion. However, too much excess air will result in heat and efficiency losses.

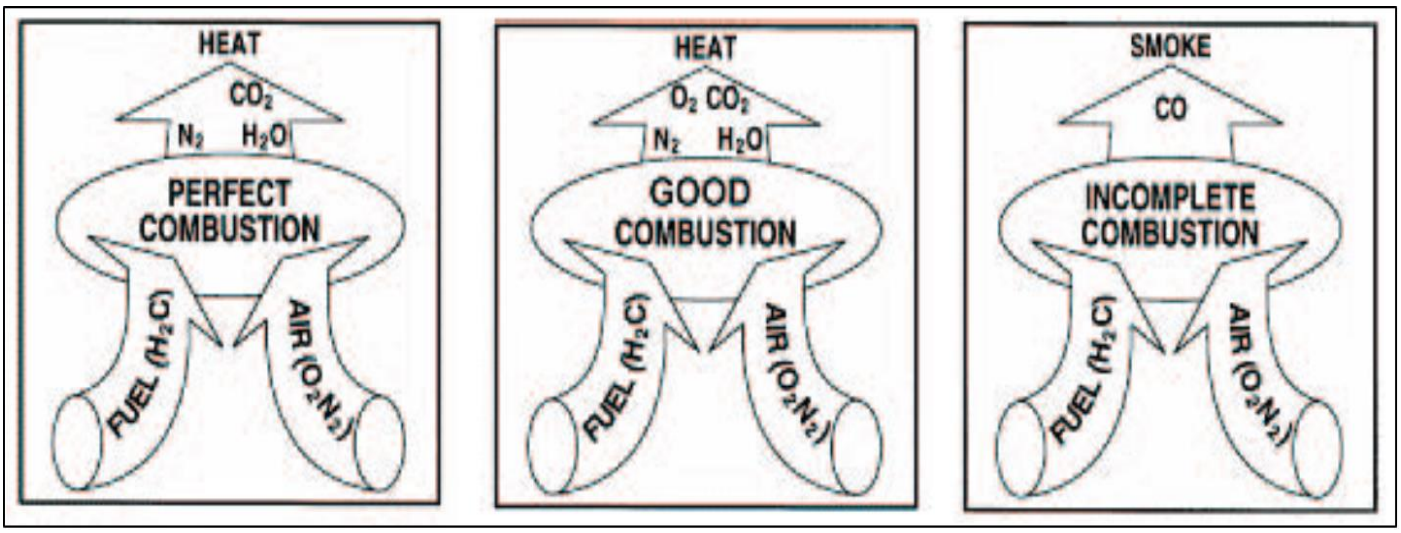

Fig 2 3 T's of Combustion

Not all of the heat in the fuel are converted to heat and absorbed by the steam generation equipment. Usually all of the hydrogen in the fuel is burned and most boiler fuels, allowable with today's air pollution standards, contain little or no sulfur. So the main challenge in combustion efficiency is directed toward unburned carbon, which forms CO instead of CO_2.

III. ENERGY EVALUATION A CASE STUDY

An Energy evaluation is carried out for a Boiler in Spectrum Dyes and Chemicals Private Limited, PALSANA. The evaluation is delivering on part load condition. The evaluation of this steam generating unit is core for the aim of the plant. Now for this evaluation method 1st law as well as 2nd law calculation of steam generation plant has been addressed. All the required important data for the evaluation are taken from plant.

The details Boiler plant in Spectrum Dyes and Chemicals Private Limited, PALSANA is depicted in plant layout given as based on different system and Boiler plant to continue running the stem generation unit. The capacity of boiler to generation of steam is 10 T/hr at 8 kg/cm^2 pressure, Temperature 145 ^{0}C which is achieved by imported coal fired boiler.

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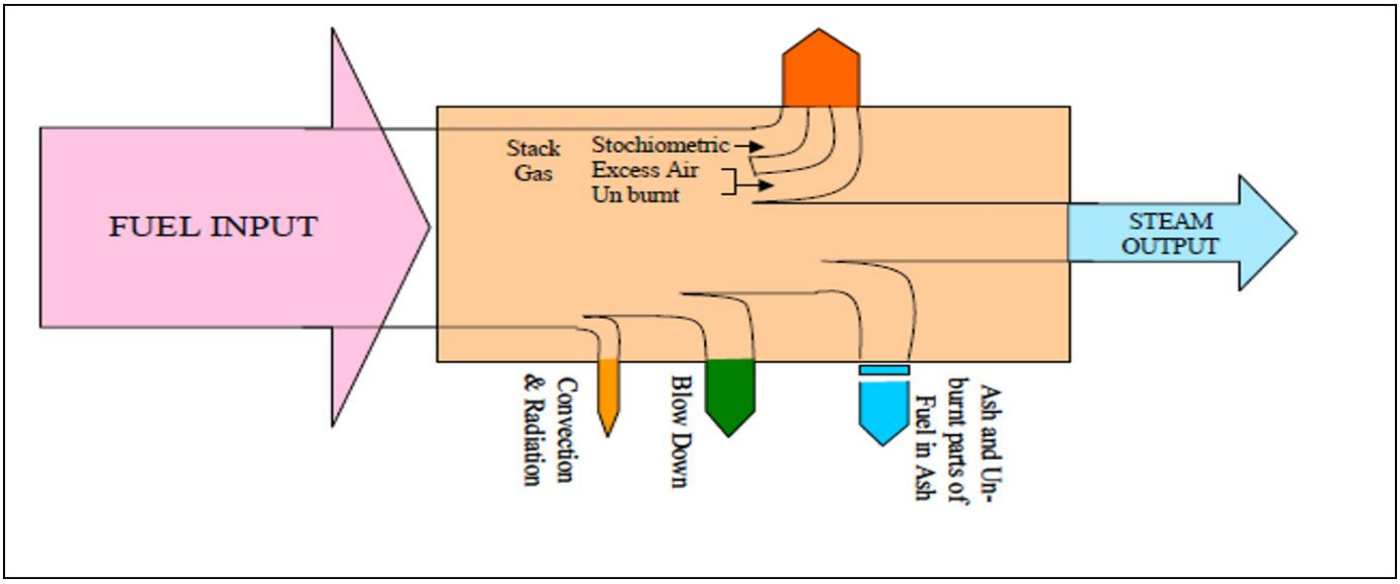

Fig 3 Energy Balance Diagram of Boiler

In order to carry out energy evaluation of steam generation plant, the plant is divided in to control volumes, chosen in most cases, so that the thermodynamic boundaries coincide with the particular unit of the plant. In the power plant, no automatic data acquisition system is available; hence pressure and temperatures for various terminal points are taken from the indications available in the central control panel (ccp) at the interval of one hour. In order to increase the accuracy of the indications, The average flow is found by the average of the difference of four consecutive readings for period of one hour.

Thus, after making initial preparations as mentioned above, all the plant personal are synchronized to take the readings during the test period. Average values of data acquired during the above tests are compiled and tabulated.

➢ *The Indirect Method Testing*

The efficiency can be measured easily by measuring all the losses occurring in the boilers using the principles to be described. The disadvantages of the direct method can be overcome by this method, which calculates the various heat losses associated with boiler. The efficiency can be arrived at, by subtracting the heat loss fractions from 100. An important advantage of this method is that the errors in measurement do not make significant change in efficiency.

Thus if boiler efficiency is 90%, an error of 1% in direct method will result in significant change in efficiency. i.e. 90 ± 0.9 = 89.1 to 90.9. In indirect method, 1% error in measurement of losses will result in Efficiency = 100 - (10 ± 0.1) = 90 ± 0.1 = 89.9 to 90.1.

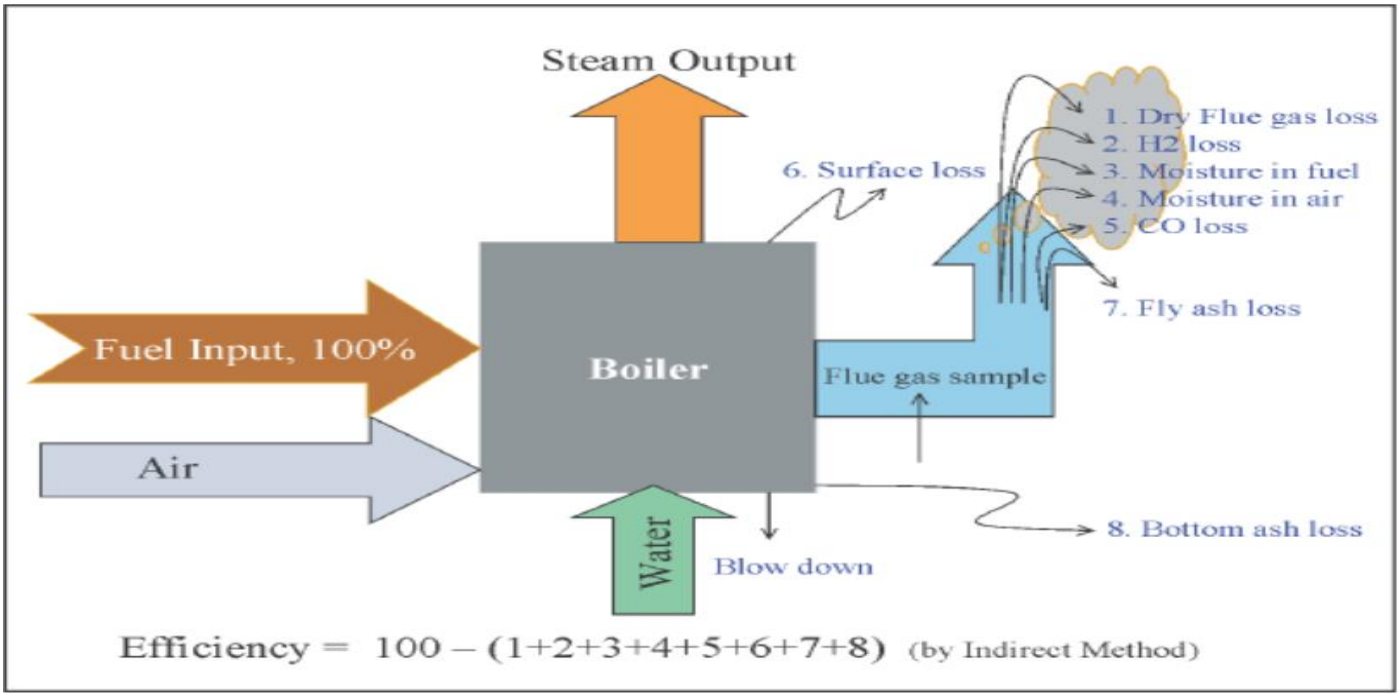

Fig 4 The Indirect Method Testing

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Indirect method is also called as heat loss method. The efficiency can be arrived at, by subtracting the heat loss fractions from 100. The standards do not include blow down loss in the efficiency determination process.

➢ *The following Losses are Applicable to Liquid, Gas and solid fired Boiler*

- L1 - Loss due to dry flue gas (sensible heat)
- L2 - Loss due to hydrogen in fuel (H_2)
- L3 - Loss due to moisture in fuel (H_2O)
- L4 - Loss due to moisture in air (H_2O)
- L5 - Loss due to carbon monoxide (CO)
- L6 - Loss due to surface radiation, convection and other unaccounted*.
- L7 - Unburnt losses in fly ash (Carbon)
- L8 - Unburnt losses in bottom ash (Carbon)

Boiler Efficiency by indirect method = 100 - (L1 + L2 + L3 + L4 + L5 + L6 + L7 + L8)

➢ *The Data Required for Calculation of Boiler Efficiency using Indirect Method are:*

- Ultimate analysis of fuel (H_2, O_2, S, C, moisture content, ash content)
- Percentage of Oxygen or CO_2 in the flue gas
- Flue gas temperature in °K (T_f)
- Ambient temperature in °K (T_a) & humidity of air in kg/kg of dry air
- GCV of fuel in kJ/kg
- Percentage combustible in ash (in case of solid fuels)
- GCV of ash in kJ/kg (in case of solid fuels)

Table 1 Heat Balance

SUMMARY OF HEAT BALANCE FOR NON-RENEWABLE FOSSIL FUEL LIKE IMPORTED (INDONESIAN) COAL FIRED BOILER			
Input / Output parameter		**kJ / kg of Imported coal**	**% Loss**
Heat input	=	15120	100
Losses in Boiler			
1. L_1	=	698.54	4.62
2. L_2	=	574.56	3.80
3. L_3	=	226.8	1.50
4. L_4	=	19.65	0.13
5. L_5	=	427.89	2.83
6. L_6	=	27.21	0.18
7. L_7	=	169.34	1.12
8. L_8	=	662.25	4.38
Boiler Efficiency = 100 – ($L_1 + L_2 + L_3 + L_4 + L_5 + L_6 + L_7 + L_8$) = **81.43 %**			

IV. RESULT AND DISCUSSION ON ENERGY EVALUATION

The efficient evaluation of steam generation unit is analyzed after detecting out the various losses, which take place in a Boiler. According to thermodynamic First law analysis shows the efficiency of the Imported (Indonesian) coal fired Boiler is 81.43%. This causes loss of 18.564%.

As per the evaluation of PIE chart for every Boiler unit for fuel used which is shown in figure for different types of losses in every steam generation unit with fuel has been prepared.

As per consider that the plant is operating under part load condition, total fuel energy utilized by every unit is taken as 100 units for reference purpose for the energy evaluation of steam generation unit.

According to Pie chart for steam generation unit which is gives the pictorial representation of the different losses of the energetic divide which is maximum in dry flue gases (stack losses). We can show that in the diagrams 100% input energy of fuel supply and at the last 10% to 30% of the output of energy is various losses and then remaining energy is supplied to steam. Here, we can find that most of the energy wastage in the chimney out or exhausts.

The 1st law efficiency has been calculated for fuel used in Boiler, which is shown in Table. Efficiency is lower due to considerable energy losses with stack gases.

Table 2 Energy Losses Due to Fuel used in Boiler

Fuel	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**	**L7**	**L8**	**Total**	**Efficiency**
Imported (Indonesian) Coal	4.6	3.8	1.5	0.1	2.8	0.1	1.1	4.3	18.5	81.43%

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Table 3 Heat Wastage in Fuels used in Boiler (kJ/kg of Fuel)

Fuel	L1	L2	L3	L4	L5	L6	L7	L8	Total	Heat Input	Available Heat	%
Imported (Indonesian) Coal	698.5	574.5	226.8	19.6	427.8	27.2	169.3	662.2	2806.2	15120	12313.7	81.43

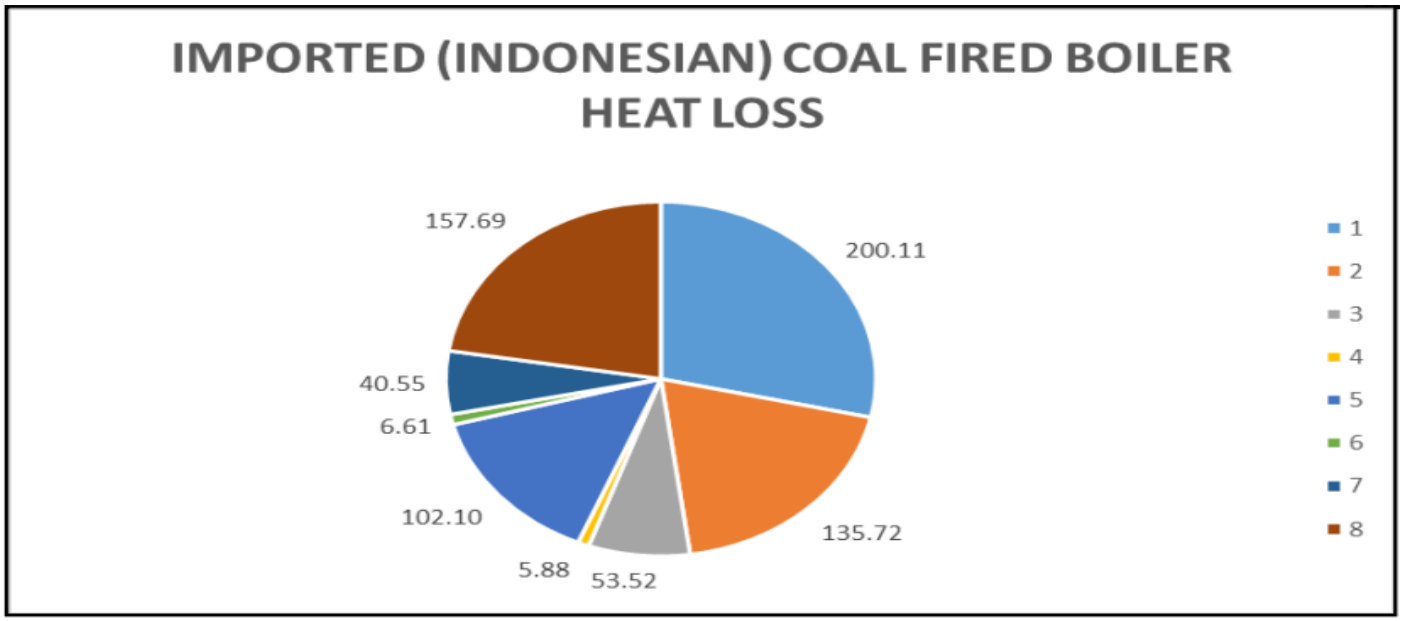

Fig 5 PIE Chart for Energy Wastage due to Solid Fuel (kJ/kg of Fuel)

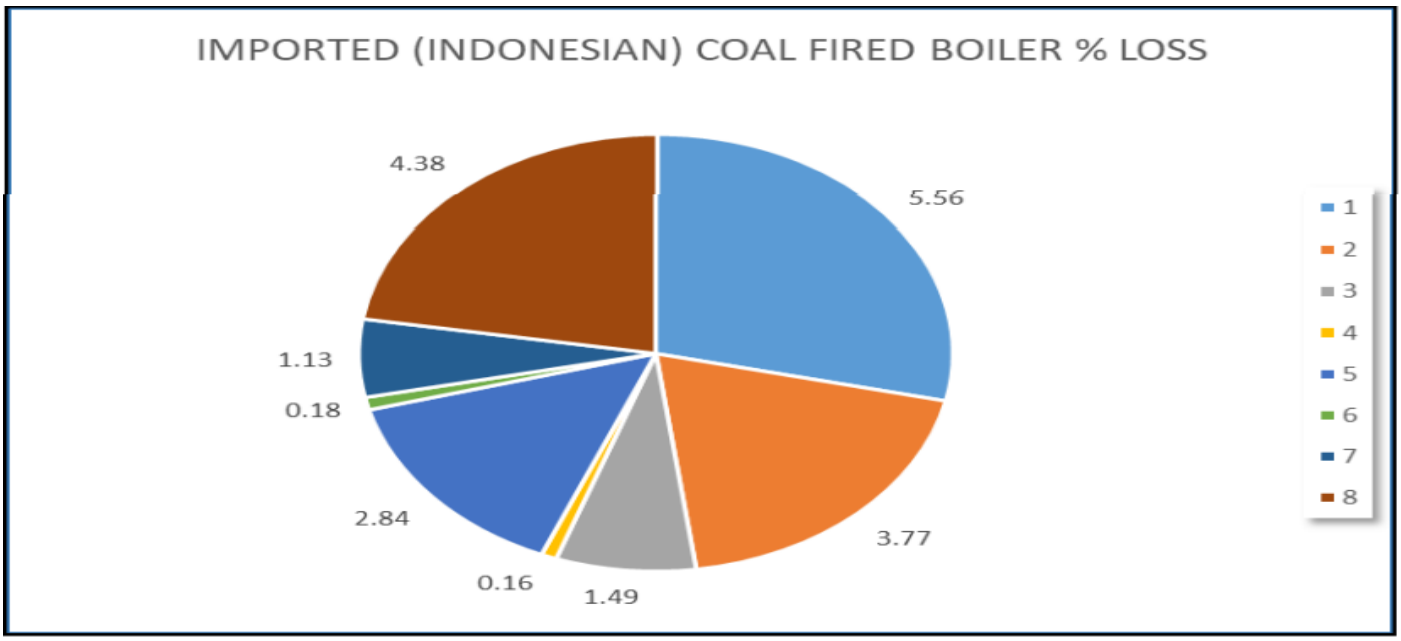

Fig 6 PIE Chart for Energy Losses due to Solid Fuel used

V. CONCLUSION

The following conclude are finding out from the energetic performance of the Boiler plant at SPECTRUM DYES AND CHEMICALS PVT. LTD., PALSANA.

- From the energy analysis of the steam generation unit, it is finding that the energy calculation different losses as 18.56%. The 1st law efficiency of the steam generation unit is 81.44%.
- We can found that it is a big change in calculation of efficiency which so the big amount of energy degradation.
- This examination result gives that burning of fuel combustion process is 100% effective and heat changes is also highly effective but the chimney out flue gases take maximum amount of heat lost so performance of the steam generation unit low.

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- For complete combustion of fuel is give maximum amount of heat released fuel which is given to warm feed water for fast process and to reduce losses by insulate furnace for overall performance of plant.
- If mixing of the fuel with other fuel like bagasse which can reduce the price of fuel and to reach steam generation unit efficiency nearest to actual fuel used by industry. We can reduce pollution norms and also follow steps can given by GPCB (Gujarat Pollution Control Board).

SCOPE OF FUTURE WORK

This work represents the systematic attempt to apply the methodology of energy analysis of Boiler plant. Though this study has focused only on the energy analysis of Boiler plant which use for power generation, but it is possible to extent this methodology for analysis large process plant which utilizes steam for process heating in Various chemical plant and Hot air gas (HAG) plant which hot air is used various chemical drying and then packaging process for powder form in plastic bag for final product.

Therefore, incorporating the energy performance of the chemical process plant in the evaluate steam generation unit, more accurate calculation of energy consumption of fuel can be realized. In theoretical and practical calculation of efficiency is differ due to various losses in industry plant and to increases its better performance fuel used in boiler is content more carbon percentage and reduce various steam trap and steam pipe loss at various areas so if all this moisture steam loss is collected in common pipe by the help of steam extraction pump and this is return back to boiler feed water so heat given by feed water is reduced and some of the input heat saving.

According to given data 1kg of coal is burnt produce 4 kg/cm^2 of steam as per their record so total 24 hours approx. 30 Ton coal is used which is Rs.1, 42,197 / kg, so 1kg/cm^2 steam is produce at cost of Rs.1.5. so losses of steam, water, oil and other manintance of machinery is must require to control that to prevent the losses during the steam generation.

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I take this chance to my theoretical knowledge express brief and sincerely and learn various things in industry for different thermal system utility plant work smoothly by proper functioning procedure by **Mr. PundlikBhavsar (Dy. Manager – HR, P & A.)** and his team.

I felt during my training period in Spectrum Dyes and Chemicals Private Limited, Boiler Plant that a certain relation between theoretical knowledge and experience exist. There is a definite balance between the two leading to a safe and better process and increased productivity.

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