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ANALYSIS OF THE EFFECT OF COAL QUALITY ON STEAM PRESSURE PRODUCED BY BOILER ENGINES IN PT. SINAR MEADOW INTERNATIONAL INDONESIA

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Graphical abstract

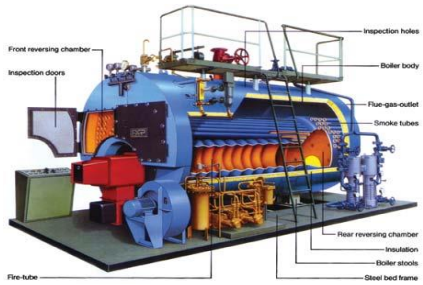

Figure 1. Fire Tube Boiler

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Abstract

In general, coal fossil fuel reserves are the main load in the industry, especially in the use of boiler engines. Coal comprises carbon, hydrogen, oxygen, nitrogen, sulfur, and mineral compounds. A boiler engine is a machine that produces high-pressure water vapor by heating water through fuels such as coal. The water vapor can then be used for various purposes, such as heating oil in the oil manufacturing industry, especially PT. Meadow Rays. Steam is an effective and inexpensive medium for transferring heat to a process. Coal plays an important role in the operation of boiler engines because coal is one of the fuels that is often used in the heating process. The quality of the coal can affect the quality of the steam produced by the boiler engine. Suitable coal shape for boilers at PT. Meadow rays are generally solid or solid, such as chunks, fractional coal, or bituminous coal that has a large coal size that has a mesh size between 3.2 mm to 6.3 mm or about 1/8 to 1/4 inch. This is because the solid, dense form of coal has a higher density and lower porosity, so it can retain heat better and provide a smaller surface for the combustion process. Coal users must be provided to PT. Sinar Meadow must have a minimum calorie of 6300 kcal/kg, for the efficiency and safety of the boiler at PT. Meadow Rays. Therefore, paying attention to the coal quality used in boiler engines is important to produce high-quality and efficient steam.

Keywords: Boiler, Coal

Abstrak

Pada umumnya diindustri khususnya dalam penggunaan mesin boiler menggunakan cadangan bahan bakar fosil batu bara sebagai beban utama. Batubara tersusun atas karbon, hidrogen, oksigen, nitrogen, sulfur, dan senyawa- senyawa mineral. Mesin boiler berfungsi untuk menghasilkan uap air yang bertekanan tinggi dengan memanaskan air melalui bahan bakar seperti batu bara. Uap air tersebut kemudian dapat digunakan untuk berbagai macam keperluan, seperti pemanasan minyak yang digunakan pada industri manufaktur minyak khusunya PT. Sinar Meadow. Batu bara memegang peranan penting dalam pengoperasian mesin boiler, karena batu bara adalah salah satu bahan bakar yang sering digunakan dalam proses pemanasan. Bentuk batu bara yang cocok pada boiler di PT. Sinar Meadow umumnya berbentuk pejal atau padat, seperti bongkahan, batu bara pecahan, atau batu bara bitu minus yang memiliki ukuran batu bara sebesar memiliki ukuran mesh antara 3,2 mm hingga 6,3 mm atau sekitar 1/8 hingga 1/4 inci. Hal ini karena bentuk batu bara yang pejal dan padat memiliki kepadatan yang lebih tinggi dan porositas yang lebih rendah, sehingga dapat menahan panas lebih baik dan memberikan permukaan yang lebih kecil untuk proses pembakaran. Pengguna batu bara yang harus disedikan pada PT. Sinar Meadow harus memilik kalori minimal 6300 kcal/kg, demi efisensi serta keaman pada boiler yang terdapat pada PT. Sinar Meadow. Oleh karena itu, penting untuk memperhatikan kualitas batu bara yang digunakan dalam mesin boiler untuk menghasilkan uap yang berkualitas tinggi dan efisien.

Kata kunci: *Boiler*, Batubara
Doi: http://dx.doi.org/10.62870/timer.v2.i1. 26163

1.0 INTRODUCTION

In general, in the industry, especially in the use of boiler engines, using coal fossil fuel reserves as the main load [1]. Coal is composed of carbon, hydrogen, oxygen, nitrogen, sulfur, and mineral compounds. A boiler engine is a machine that functions to produce high-pressure water vapor by heating water through fuels such as coal. The water vapor can then be used for various purposes, such as heating oil used in the oil manufacturing industry, especially PT. Meadow Rays. Steam is an effective and inexpensive medium for transferring heat to a process. Coal plays an important role in the operation of boiler engines, because coal is one of the fuels that is often used in the heating process. The quality of the coal can affect the quality of the steam produced by the boiler engine [2]. The higher the quality and calories in the coal, the more efficient the combustion and the higher the temperature and pressure of the steam produced. This is because coal with high calories will burn more easily and release a greater amount of energy. In contrast, low-calorie coal will be harder to burn and produce less energy. Therefore, it is important to pay attention to the quality of the coal used in boiler engines to produce high-quality and efficient steam. In addition, regular maintenance and maintenance of boiler engines is also necessary to ensure the performance and reliability of boiler engines. Boilers are also equipment that must be managed and maintained very well because there is a risk of overpressure which results in waste in the boiler with coal fuel and a decrease in the effectiveness of the boiler itself [3-13].

Figure 2. Fire Boiler Tube PT.Sinar Meadow

2.0 METHODOLOGY

2.1 Boiler Engine Specification

A coal boiler is a machine or tool used to produce steam or heat energy by using coal as a fuel. The coal heating process produces exhaust gases containing carbon dioxide, nitrogen, and sulfur dioxide. The exhaust gas is then passed through the boiler and flows through the pipes, resulting in steam that is used for various purposes, such as heating or power generation. The coal boiler used at PT. Sinar Meadow, i.e. Fire Tube Boiler: A boiler with a fire pipe located inside a tube or shell. The exhaust gases produced from burning coal pass through the pipes and heat the water around them. Coal boilers have advantages in terms of efficiency, durability, and the ability to generate great energy. The specification for the 12.5-ton coal boiler machine is found in PT. Simar Meadow has specifications, including:

Capacity	: 12.5 tons/hour
Working pressure	: 16 bar
Average working temperature	: 180-200°C
Fuel	: Coal
Boiler type	: Fire tube
Efficiency	: Minimum 80%.

2.1 Identify Problems Using Fishbone Diagrams

A fishbone diagram is a visual tool used to identify and analyze the causative factors or root causes of a problem or problem. This diagram is called fisbone because its shape resembles a fishbone, with a horizontal centerline representing the problem to be solved and vertical branches representing the factors that can be the cause of the problem, in which case we will discuss the results of a steam press on a boiler. Obstacles or problems that are commonly encountered in boiler machines in PT.. Sinar Meadow, which is when the boiler engine does not produce hot steam that is not in accordance with the needs and SOPs in the factory. It can be seen from the diagram above that where the quality value of coal has a great influence on the boiler engine. Coal that has poor quality will affect the steam output produced by the boiler engine. Where this makes the performance of the engine itself not work optimally as possible, so this makes the steam needs in the factory not met. This also affects the work efficiency in the boiler where the engine does not work as it should, which later makes this a bigger loss. Therefore, it is necessary to supervise and check coal as boiler engine fuel, which will make the boiler engine performance more efficient and also not cause more losses to the factory, especially at PT. Meadow Rays

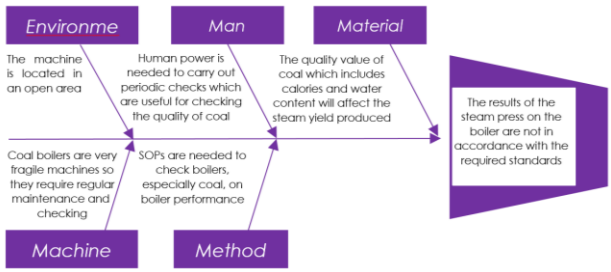

Figure 3. Diagram Fishbone

3.0 RESULTS AND DISCUSSION

3.1 Data Acquisition

A number of data generated in practical work are obtained which will later be used as material for

research or case studies. This data can help problems that occur in the company, as well as help in developing solutions or recommendations that can be applied in the future. Then this data also functions as a material for the development of knowledge and skills

Tabel 1. Types of Coal Used

Types of Coal	Calorie (kkal/kg)	Carbon Element C	Water Content	Sulfur Content	Ash Content
Bituminous PT. Anugrah Kairos Makmur	6300	84%	6%	0,6%	8%
Bituminous PT. Anugrah Central Coal	6400	86%	5%	0,5%	7%
Bituminous PT. Anugrah Kairos Makmur	6000	81%	9%	0,7%	9%
Bituminous PT. Anugrah Kairos Makmur	6300	83%	7%	0,6%	8%

Tabel 2. PT. Anugrah Kairos Makmur Calorie 6300

Schedule	Steam Press Bar	ID Fan Speed RPM	FD Fan Speed RPM	STROKER SPEED HZ	COAL TOTAL TON	O_2 %	O_2 %	FW TEMPT ℃	Steam Ton Ton
Monday	14,7	44	28,5	40	3701	10,6	8,2	176,2	3567
Tuesday	14,6	43	36,4	23	3692	11,6	7,7	184,8	3752
Wednesday	14,9	41	36,8	39	3692	13,2	7,3	187,4	5052
Thursday	13,9	39	25,3	10	3701	11	6,5	182,3	3782
Friday	15	44	21,4	26	3697	12,9	9,5	180,8	2892

Tabel 3. PT. Anugrah Central Coal 6400

Schedule	Steam Press Bar	ID Fan Speed RPM	FD Fan Speed RPM	STROKER SPEED HZ	COAL TOTAL TON	O_2 %	O_2 %	FW TEMPT ℃	Steam Ton Ton
Monday	13,3	39	28,5	40	3174	10,6	9,3	179,5	3504
Tuesday	14,5	43	21	13	3699	11,7	7,8	184,9	3345
Wednesday	14,8	32	23,4	15	3724	14,3	7,4	178,5	2997
Thursday	15,1	31	27,6	28	3706	12,5	78,5	182,6	3484
Friday	14,7	41	36	32	3868	13,8	8,5	183,4	2754

Tabel 4. PT. Anugrah Kairos Makmur Calorie 6000

Schedule	Steam Press Bar	ID Fan Speed RPM	FD Fan Speed RPM	STROKER SPEED HZ	COAL TOTAL TON	O_2 %	O_2 %	FW TEMPT ℃	Steam Ton Ton
Monday	10,7	50	38,6	10	3390	13,6	6,7	176,6	1996
Tuesday	8,9	41,5	38,3	11	3403	16,4	6,3	168,6	1978
Wednesday	11,2	45	40,6	10	3382	14,1	4,3	170,1	2280
Thursday	8,3	40	37,5	11	3410	13,9	8,3	173,5	2196
Friday	9,5	50	39,6	10	3395	11,9	8,5	163,4	2029

Tabel 5 PT. Anugrah Kairos Makmur Calorie 6300

Schedule	Steam Press Bar	ID Fan Speed RPM	FD Fan Speed RPM	STROKER SPEED HZ	COAL TOTAL TON	O_2 %	O_2 %	FW TEMPT ℃	Steam Ton Ton
Monday	14,1	42	34,8	40	3755	12	6,7	179,9	3567
Tuesday	13,8	43	36	35	3749	10,5	7,3	181,2	3956
Wednesday	13,5	42	35,7	40	3775	11,6	8,3	185,6	3107
Thursday	14,8	42	34,8	40	3695	10,8	6,7	181,8	3284
Friday	13,9	42	35,6	38	3685	12,1	8,2	183,4	3136

It can be seen from the table above that the use of coal in PT. Sinar Meadow uses bituminous coal which is distinguished by the number of calories where there are three, namely Bituminous PT. Anugrah Kairos Makmur calories 6300, Sub Bituminous PT. Anugrah Central Coal calories 6400, Sub Bituminous PT. Anugrah Central Coal calories 6000, Sub Bituminous PT. Kairos Makmur Grace 6300 calories. On the table of PT. Anugrah Kairos Makmur calorie 6300 can be seen has a good steam compression result, which has a yield of 14.7 bar on Monday, 14.6 bar on Tuesday, 14.9 bar on Wednesday, 13.9 bar on Thursday, 15.0 bar on Friday, where this proves that PT. Anugrah Kairos Makmur calorie 6300 has good quality, which can meet the needs of PT, Sinar Meadow, which has an operational boiler standard of 12 bar. Then, on the table of PT. Anugrah Kairos Makmur calorie 6400 can be seen that it has a good steam compression result which has a yield of 13.3 bar on Monday, 14.5 bar on Tuesday, 14.8 bar on Wednesday, 15.1 bar on Thursday, 14.7 bar on Friday, where this proves that PT. Anugrah Kairos Makmur calorie 6300 has a significant quality which is very good where it can supply the needs of PT, Sinar Meadow which has an operational standard boiler of 12 bar with an average steam pressure requirement of 3000 tons. Then on the table of PT. Anugrah Kairos Makmur 600 calories can be seen that it has a significant decrease in steam pressure results where it has a yield of 10.7 bar on Monday, 8.9 bar on Tuesday, 11.2 bar on Wednesday, 8.3 bar on Thursday, 9.5 bar on Friday, where this proves that PT. Anugrah Kairos Makmur 6000 calories has poor coal quality which cannot meet PT, Sinar Meadow which has a boiler operational standard of 12 bar. This is because the coal used has a small calorific value compared to several other types, then from the influence of the water content of the coal itself which makes the coal not burn perfectly so that this makes steam production not in accordance with the standard. It can be seen in the table that coal has a higher water content of 9%. It can also make a mess in the boiler because stones that have sticky properties will stick to the fire pipes so that they can create deposits that can later reduce the performance of the boiler itself. Then, from the results of the waste produced on coal that does not burn completely, having a large truck will cause losses to the factory due to combustion that requires more fuel. It can be seen in the table that the needs of factories that usually produce 3000 tons of steam have decreased, namely having a yield of 1996 tons on Monday, 1978 tons on Tuesday, 2280 bar on Wednesday, 2196 tons on Thursday, and 2095 tons on Friday. This makes the pressure needed in the oil heating production room not full, so that the production at the plant meets the required target.

Then, on the table of PT. Anugrah Kairos Makmur calorie 6300 can be seen has a good steam compression result, which has a yield of 14.1 bar on Monday, 13.8 bar on Tuesday, 13.5 bar on Wednesday, 14.8 bar on Thursday, 13.9 bar on Friday, where this proves that PT. Anugrah Kairos Makmur calorie 6300 has good quality, which can meet the needs of PT, Sinar Meadow, which has an operational standard boiler of 12 bars and the needs met of 3000 tons per day. Therefore, to ensure that the steam pressure generated by the boiler remains optimal, it is necessary to carry out regular maintenance and maintenance on the boiler and combustion system. In addition, the selection of the right type of coal and the use of emission control

technology can also help improve the combustion efficiency and steam pressure in the boiler. By carrying out these steps, the steam pressure in the boiler can be optimized and the efficiency of energy production can be improved.

3.2 Comparison of Steam Press Value with Total Coal

In this study, tables and graphs were obtained after we collected data on the boiler engine. So a comparison of the values of steam press with total coal is produced.

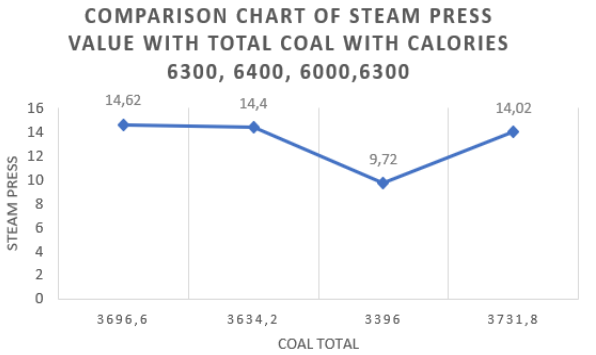

Figure 4. Comparison Chart of Steam Press with Total Coal

The graph above discusses the comparison of the value of the steam press with total coal. In the graph, it can be seen that the graph was obtained from coal users with calories of 6300, 6400, 6000, and 6300. Where in the graph there are different steam press and total coal values. In the use of 6300 calories in the first week has the largest average value of steam press and total coal compared to others. Where this is proven to have a steam press value of 14.62 bar and a total coal of 3696.6 kg. Where this result proves that coal with 6300 calories has the best results compared to other types of coal. Then, the use of 6400 calories in the second week had an average value of steam press and coal total of 14.4 bar and total coal of 3634.2 kg. This proves that more calories does not mean that it has better value efficiency; it can be compared to coal, with 6300 calories in the first week; this may be due to several factors that will be discussed in the next sub-chapter.

Then, the use of 6000 calories of coal in the third week has the smallest average value of steam press and total coal compared to others. Where this is proven to have a steam press value of 9.72 bar and a total coal of 3396 kg. Where this result proves that coal with 6000 calories has the worst results compared to other types of coal. This will be discussed further in the next sub-chapter. Then in the use of 6300 calories of coal in the fourth week had an average value of steam press and total coal of 14.02 bar and total coal of 3731.8 kg. Where this result proves that coal with 6300 calories has always the same yield even though it has the same caloric value. This will be discussed further in the next sub-chapter

3.3 Comparison of Steam Press Value with Steam Ton

In this practical work, tables and graphs were obtained, where the tables and graphs were obtained after we took data on the boiler machine. So that a comparison of the values of steam press with steam press is produced.

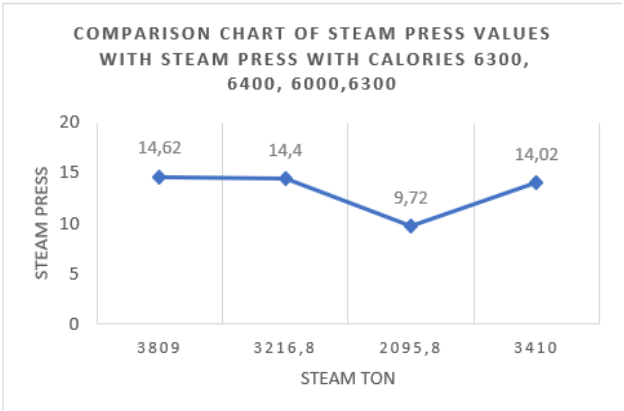

Figure 5. Steam Press Comparison Chart with Total Coal

The graph above discusses the comparison of the value of the steam press with total coal. In the graph, it can be seen that the graph was obtained from coal users with calories of 6300, 6400, 6000, 6300. Where in the graph there are different steam press and total coal values. In the use of 6300 calories in the first week has the largest average value of steam press and total coal compared to others. Where this is proven to have a steam press value of 14.62 bar and a total coal of 3809 tons. Where this result proves that coal with 6300 calories has the best results compared to other types of coal. Then, the use of 6400 calories in the second week had an average value of steam press and coal, totaling 14.4 bars and total coal of 3216.8 tons. This proves that more calories does not mean that it has better value efficiency; it can be compared to coal, with 6300 calories in the first week; this may be due to several factors that will be discussed in the next sub-chapter. Then, the use of 6000 calories of coal in the third week has the smallest average value of steam press and total coal compared to others. Where this is proven to have a steam press value of 9.72 bar and a total coal of 2095.8 tons. Where this result proves that coal with 6000 calories has the worst results compared to other types of coal. This will be discussed further in the next sub-chapter. Then in the use of 6300 calories of coal in the fourth week had an average value of steam press and total coal of 14.02 bar and total coal of 3410 kg. Where this result proves that coal with 6300 calories has always the same yield even though it has the same caloric value.

3.4 Graph of Coal Usage on Steam Ton

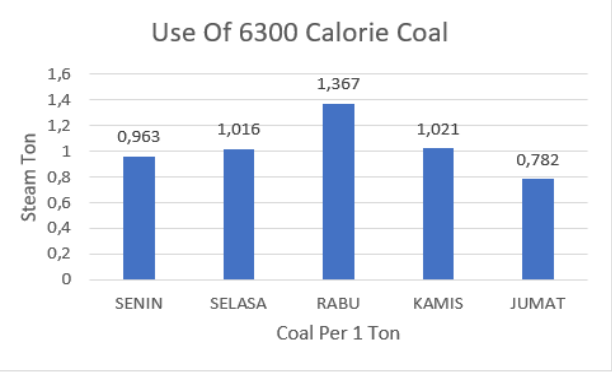

Figure 6. Graph of Coal Consumption 6300 Calories

The graph above discusses the comparison of coal used every week. Where this graph will discuss how much coal in one ton will produce steam tons. What can be seen in the graph above is the use of coal with a caloric value of 6300 in the first week. In the graph, data was produced where on Monday a steam press value of 0.963 tons was produced for coal users of 1 ton, on Tuesday a steam press value of 1.016 tons was produced for coal users of 1 ton, on Wednesday a steam press value of 1.367 tons was produced for coal users of 1 ton, On Thursday, a steam press value of 1.021 tons was produced for coal users of 1 ton, on Friday a steam press value of 0.782 tons was produced for coal users of 1 ton

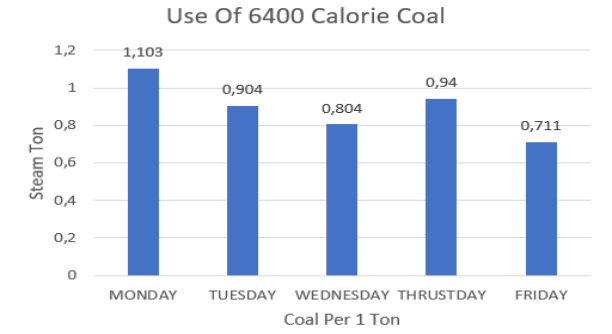

Figure 7. Graph of Coal Consumption 6400 Calories

Where the graph above discusses the comparison of coal every week. Where this graph will discuss how much coal in one ton will produce steam tons. Where can be seen in the graph above is the use of coal with a caloric value of 6300 in the first week. In the graph, data was produced where on Monday a steam press value of 1.103 tons was produced for coal users of 1 ton, on Tuesday a steam press value of 0.904 tons was produced for coal users of 1 ton, on Wednesday a steam press value of 0.804 tons was produced for coal users of 1 ton, On Thursday, the steam press value was 0.94 tons for coal users of 1 ton, on Friday the steam press value was 0.711 tons for coal users of 1 ton.

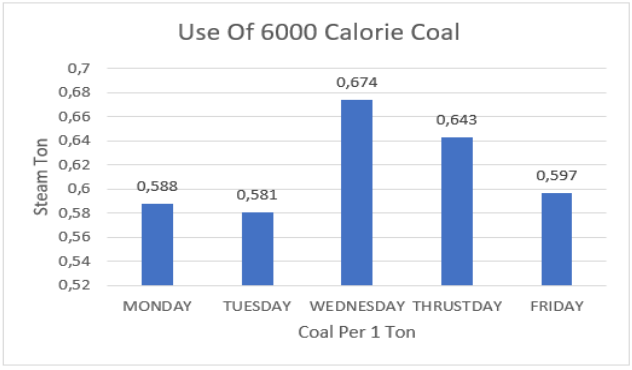

Figure 8. Graph of Coal Consumption 6000 Calories

Where the graph above discusses the comparison of coal every week. Where this graph will discuss how much coal in one ton will produce steam tons. Where can be seen in the graph above is the use of coal with a caloric value of 6300 in the first week. In the graph, data was produced where on Monday a steam press value of 0.588 tons was produced for coal users of 1 ton, on Tuesday a steam press value of 0.581 tons was produced for coal users of 1 ton, on Wednesday a steam press value of 0.674 tons was produced for coal users of 1 ton, On Thursday, a steam press value of 0.643 tons was produced for coal users of 1 ton, on Friday a steam press value of 0.597 tons was produced for coal users of 1 ton.

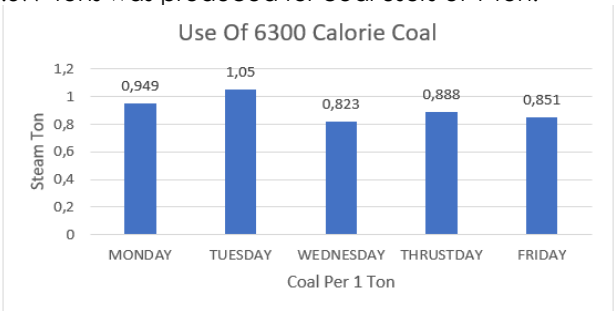

Figure 9. Graph of Coal Consumption 6300 Calories

Where the graph above discusses the comparison of coal every week. Where this graph will discuss how much coal in one ton will produce steam tons. Where can be seen in the graph above is the use of coal with a caloric value of 6300 in the first week. In the graph, data was produced where on Monday a steam press value of 0.949 tons was produced for coal users of 1 ton, on Tuesday a steam press value of 1.05 tons was produced for coal users of 1 ton, on Wednesday a steam press value of 0.823 tons was produced for coal users of 1 ton, On Thursday, a steam press value of 0.888 tons was produced for coal users of 1 ton, on Friday a steam press value of 0.851 tons was produced for coal users of 1 ton.

4.0 CONCLUSION

In this study, there is a conclusion, which is based on the implementation of practical work at PT. Meadow

rays on the boiler section. The following is the conclusion of the practical work this time:

1. The parameters of calorific value and quality of coal in the boiler are one of the important factors that need to be considered in the process of burning coal in the boiler. The calorific value of coal indicates how much energy it can produce when burned. The higher the calorific value of the coal, the more efficient the combustion that occurs in the boiler. The calorific value of measured coal can vary depending on the type of coal used, so it is necessary to conduct periodic testing to ensure that the boiler is operating efficiently. In addition, the calorific value of coal can also be affected by other factors such as moisture, ash content, and sulfur in the coal. At PT. Sinar meadow uses bituminous coal

2. A coal boiler is an equipment used to produce steam by utilizing heat energy generated from burning coal. The way a coal boiler works generally consists of several stages, including:
   - Filling coal into boiler
     The coal is fed into the boiler through a separate coal supply system, such as a screw feeder or conveyor. Coal filling needs to be done regularly to ensure sufficient coal supply for the combustion process.
   - Coal burning
     Once the coal is filled in the boiler, the combustion process begins. The burning coal will produce heat, which will be transferred into the water in the pipes inside the boiler. In this stage, adjustments are also made to the amount of air entering the boiler to ensure that coal combustion occurs optimally.
   - Heating of water in boiler pipes
     The heat generated from the burning of coal will be transferred into the water in the boiler pipes. This heated water will then produce steam.
   - Exhaust gas from combustion
     The gas produced from burning coal will be released through a chimney system. Before the gas is discharged, the gas will go through a purification stage to reduce the sulfur content and particles that can pollute the environment.
   - Use of steam
     The steam produced from the water heating process will be used for various purposes, such as turning electric generator turbines, heating water for industrial purposes, heating rooms, or for other production processes.

   The way this coal boiler works is a cycle that repeats continuously during the boiler in operation. In the process, it is crucial to keep the boiler in optimal condition so that it can operate efficiently and safely. This includes monitoring temperature and pressure, regular cleaning of boiler pipes, and regular maintenance.

3. The calorific value of coal has a significant influence on the performance of steam boilers. The higher the calorific value of coal, the more efficiently the boiler can produce the steam needed. This is because the higher the calorific value of coal, the more energy is generated when the coal is burned, so the boiler can utilize that energy to produce steam with a greater amount and pressure. On the other hand, if the calorific value of coal is low, then the boiler will need more coal to produce the same amount of steam. This can result in increased operational costs, decreased efficiency, and increased greenhouse gas emissions. In addition, the calorific value of coal can also affect the quality of the steam produced by the boiler. Coal with a low calorific value usually produces steam with a higher moisture content, which can result in reduced boiler efficiency and damage to the piping system. Therefore, the selection of the right type of coal with a calorific value that suits the boiler's needs is essential to ensure optimal and efficient boiler performance.

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