Analysis of the ambient air environment of the steam power plant industry

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Abstract. Steam power plants is one industry that produces electrical energy needed by the community, electrical energy is needed to improve the welfare of the wider community. The negative environmental impacts caused by this industrial activity include the impact of environmental pollution, both the physical-chemical, biological, economic-socio-cultural and public health environment living around the industrial activity site. The negative impact is mainly caused by the use of coal fuel which emits entropy which can affect the quality of the environment. In this research, we want to know the negative impact of the activities of the steam power industry on ambient air quality around the location of the activity. The experimental research method was conducted to determine the effect of coal use on the quality of the ambient air environment quantitatively. Methods of environmental quality analysis using laboratory tests and matching test results with national quality standards. Possible cause of the low levels of entropy in the steam power plant industry is the suitability of the type of electric power steam engine that is still classified as the latest technology with low rank coal used by the industry.

Keywords: ambient, coal, environment, industry, steam power plant

1. Introduction
The steam power plant is an industry that produces electricity which is then supplied and distributed to the wider community, both for government agencies, the private sector and the private community [1, 2]. The steam power plant industry studied has a capacity of 3 x 315 megawatt with a capacity index of 0.8. This power plant uses 4,200 Kcal/kg of low calorie coal (low rank coal) with a total coal consumption of 4,273,390 tons/year. The process of electricity production in the industrial system of steam power plants is explained briefly below [3, 4]. Coal fuel system in coal fuel demolition activities; coal fuel for the benefit of the steam power plant industry imported from the islands of Sumatra and or Kalimantan, transported by ship or barge and then unloaded at the jetty that currently exists at the location of the steam power industry. Then the coal is distributed with a conveyor belt using a ship unloader to junction house (JH). At JH there is a telescopic chute that serves to pour coal from the conveyor belt into the coal yard of the steam power plant industry [1, 3]. The amount of coal accommodated at coal yard is around 240,000 metric ton with elevation between (10.5 - 12) meters. The need for coal for the operational activities of the steam power plant industry is 12,000 tons/day for 3 generating units. Therefore, in one day there will be an additional (1-2) coal barges with a capacity (7,500 - 12,000) DWT which will demolish the existing jetty [3, 5]. Characteristics of coal and high speed diesel oil (HSD); the type of coal used is 4,273,390 tons of low rank coal for 3 units of power plants [3, 4]. The coal used contains sulfur levels of about (0.33 - 0.35) % by weight and has 4,200 kilo
calories. As a supporting fuel and initial fuel used fuel oil HSD. Boiler, turbine and generator systems; coal from the coal yard is dredged and transported to the boiler and forwarded to the coal bunker and then to the coal feeder which serves to regulate the amount of flow to the pulverizer where coal is milled as needed to be a very fine powder [4, 6]. This coal powder is mixed with hot air from the primary air fan (PA Fan) and taken to the coal burner which blows the coal powder into the combustion chamber for combustion and burning like gas to convert water into steam. The hot air used by PA Fan is supplied from the forced draft fan (FD Fan) which compresses hot air after being passed through the air heater, the FD Fan also supplies air to the coal burner to support the coal combustion process [4, 7]. The heat generated will be absorbed by the steam pipes or water walls into saturated steam or wet steam which is then heated with a super heater. Then the steam is flowed into the high pressure turbine (HPT) high pressure turbine, where the steam will be pressed through the nozzle to the turbine blades [6, 7]. The power from the steam hits the turbine blade and makes the turbine spin [4, 6]. After going through HPT, steam is returned to the boiler to be reheated in the re heater before the steam is used in HPT and low pressure turbine [3, 6]. The low pressure turbine shaft is coupled with a generator rotor, and the rotor in a cylindrical electromagnetic rotates when the turbine rotates [2, 4, 6]. The generator is wrapped in a generator stator, and this stator is rolled using a copper bar. Electricity is generated in copper bars on the stator by the rotor electromagnet through the rotation of the magnetic field [4, 6, 7]. The results of the production of electric energy, the industrial steam power plant is channeled to the Java-Bali System using a 150 KV transmission to the substation, and from this substation the electrical energy is then distributed to consumers [3, 5]. Boiler characteristics; boilers used in the form of subcritical natural circulation steam drum boiler type, by a maximum continuous evaporation capacity of 1025 tons per day and superheated steam pressure and temperature are 17.5 Mpa and 541°C [2, 5]. Turbine characteristics; the turbines used are subcritical, single shaft, double casing, double exhaust steam, reheat condensing. Generator characteristics; turbine operations on MCR (maximum continuous rating) from 51 Hz to 485 Hz, at load rates and power factors with a voltage range of 0.95 to 1.05 pu operational above, the power factor ranges from index 0.80 to index 0.95 [4, 6, 7].

2. Literature Review

2.1. Management system for bottom ash entropy and fly ash
Entropy in the form of fly ash and bottom ash arising from the combustion process of coal in the furnace is a product by process that should lead to zero concept, but the facts are always there [8, 9]. The management, fly ash carried on the flue gas will be captured in the EP (electrostatic precipitator) which will then be exhaled by the compressor to the fly ash silo [9, 10]. While the bottom ash will be flowed directly from the bottom of the boiler furnace into the bottom ash silo through the conveyor belt [8, 9]. Dust arising from the combustion system is sucked out of the boiler by the I.D Fan and passed through the electrostatic precipitator (EP) which can capture ± 99.5% of fly ash; then the dust electrode system is exhaled to the chimney which has a height of 275 m [3, 5]. In EP, electrons are released into a collecting plate so that fine particles are pulled into the filter and then used for various uses [3, 5]. Ash waste as entropy, both fly ash and basic ash are accommodated in a special place called ash valley (ash collecting plate so that fine particles are pulled into the filter and then used for various uses)

2.2. Water and waste water management systems
Water treatment system; raw water for the needs of power plants in the steam power plant industry as much as 81,390 m³/hour or about 22.6 m³/second is taken from sea water [9, 10]. Some of the seawater, which is 390 m³/hour, is processed beforehand so that it meets the requirements for boiler water use and for various operational needs of other steam power plants [11, 12]. The water used for the boiler comes from sea water will be processed into fresh water by using a desalination installation. The water from desalination production before flowing into the boiler is treated first at the water treatment plant using a mixed bed system [9, 10]. The process used for desalination is using multiple effect desalination technology, which is water treatment technology to remove salt or minerals using desalination and
condensation methods \[8, 9\]. The remaining 299 m³/hour will continue to flow out of the membrane called concentrate or reject, and the quality of concentrate water or reject water is the same quality as the quality of feed water, it’s just that the salt content of concentrate water is higher than that of feed water \[10, 11\]. Thus the reject water is not waste water and then the reject water is put back into the sea, and most of the taken sea water, which is as much as 77,080 m³/hour is used to cool the condenser \[10, 13\]. Sea water that has been used to cool the condenser has a high enough temperature because it is discharged through canal discharge as heat waste water into the sea \[13, 14\]. Wastewater treatment system; waste water arising from the activities of the steam power plant industry comes from a variety of activities, namely used water condenser coolers, leachate water from coal and land fill, demineralization waste water, condensate polishing plant waste water, domestic liquid waste and oil spills \[9, 10, 11\]. Each of the above wastewater has different characteristics, so that waste treatment is segregated, and used water condenser coolers contain relatively high temperatures, passed down through the cooling ducts \[8, 10, 12\]. Leachate and demineralized wastewater containing hazardous and inorganic substances will be treated in a waste water treatment plant (WWTP), so that the wastewater that comes out of the WWTP will meet the required liquid waste and water quality standards \[13, 14\]. Domestic liquid waste is managed using biological WWTP equipment, while oil spills from power houses and HSD, oil tanks containing oil as much as 6 m³ / hour are treated with an oil catcher system and oil separator \[10, 11\]. Water from oil catchers and oil separators and demineralized regeneration wastewater will be treated in a separate WWTP \[11, 13\]. Meanwhile, leachate produced from a coal yard is collected in a settling basin. The coal yard construction itself has been coated with HDPE (high density poly-ethylene) and geotextile to prevent intrusion of leachate into the ground \[14, 15\]. The effluence of the WWTP is reused to prevent flying dust from blowing in the wind \[13, 14, 15\].

2.3. Implementation of environmental management

The negative environmental impact that will occur due to coal combustion is a decrease in ambient air quality at the site and around the location of the activities of the steam power plant industry \[10, 11\]. The source of the impact of the reduction in ambient air quality comes from the activities of coal unloading and stockpiling, the activities of landfill ash from coal combustion, and coal combustion activities and coal dust resuspension \[10, 11, 12\]. The goal of environmental management is to prevent and minimize the negative impacts of decreasing ambient air quality which in turn can have a continued impact on environmental health, including human health living in the vicinity of the steam power plant industry \[4, 8, 9\]. The yard stick for the success of environmental management from the influence of the activities of the steam power plant industry is Government regulation number 41 of 1999 concerning air pollution control (GR.41/1999.APC) \[16\]. The location of environmental management is carried out at: i) the location of the activities of the steam power industry, ii) at the location of sources of emission, iii) at the coal dock location, at the coal yard location, iv) at the point of transporting coal from the dock to the location Steam power plant industry, and v) in locations along the conveyor belt, and vi) in residential settlements around the steam power plant industry. The period and time of environmental management is carried out for each activity of unloading and stockpiling coal, landfill residual coal combustion ash, coal combustion activities and resuspension of coal dust during the operational activities of the steam power plant industry takes place \[13, 16\]. Management actions that must be taken to manage air quality from the effects of coal combustion activities in the steam power industry include: i) at the time of unloading and moving coal from a barge to a coal dump, it must be wet, ii) watering the coal dump with water, iii) watering the driveway to the ash dump, and iv) using a closed ash transport truck \[17, 18, 19\].

3. Methods

The experimental research method use to determine the effect of coal use on the quality of the ambient air environment quantitatively \[6\]. The type of environmental impact monitored is the negative impact of decreasing ambient air quality in and around the activities of the steam power plant industry \[4, 8\]. Sources of environmental impacts monitored are ambient air quality degradation derived from coal demolition and stockpiling activities, landfill coal combustion ash accumulation, and coal combustion activities and coal dust resuspension, and exhaust flue gas emissions at the location of the steam power plant industry \[1, 2, 3\]. The purpose of monitoring environmental quality is to monitor ambient air
quality around the activity area and conduct an evaluation of the effectiveness of environmental management and sources of impact on ambient air quality [9, 14, 19]. Benchmarks of impact whether the impact has exceeded environmental quality standards or not based on the magnitude of the meters allowed by GR.41/1999.APC [16]. Ambient air quality parameters monitored include carbon monoxide (CO), hydrocarbons (HC), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), particulate matter (PM₂.5), total suspended particulate (TSP) and lead (Pb); while the microclimate parameters monitored are temperature, humidity, wind direction and speed and weather conditions. Methods for research environmental quality are; air sampling using Hi-vol sampler and gas implinger; microclimate measurement using in site measurement method; and the results of laboratory analysis are compared with the quality standards as stated in GR.41/1999.APC and the results of previous monitoring [9, 14, 16, 19]. The time of environmental quality monitoring is done every 3 (three) months during the operational activities of the steam power plant industry. The location for environmental quality monitoring is at: UA.1 (at the site of the steam power industry); UA.2 (to the north of the site of the steam power industry activities); UA.3 (to the south of the steam power industry site); UA.4 (to the west of the site of the steam power industry); UA.5 (in settlement around the site of the steam power industry); UA.6; (in settlement around the site of the steam power industry); UA.7; (in settlement around the site of the steam power industry); and UA.8 (in settlements around the site of the steam power industry).

4. Result and discussion
Based on data from the measurement of the quality of the environment in environmental monitoring to 2018 period; it turns out that all ambient quality parameters are below the quality standard and still meet the quality standards as required by GR.41/1999.APC [16]. The distribution of ambient air quality parameters in the surrounding monitoring location tends to be lower than the quality standard. Following below is a compilation of the results of the examination and testing of ambient air quality around the footprint of the steam power industry activities.

Table 1. Results of ambient air quality monitoring in the steam power plant industry

| No. | Parameter                      | Unit | UA-1   | UA-2   | UA-3   | UA-4   | UA-5   | UA-6   | UA-7   | UA-8   | Air pollution control |
|-----|--------------------------------|------|--------|--------|--------|--------|--------|--------|--------|--------|-----------------------|
| 1   | Sulfur Dioxide (SO₂)          | µg/Nm³ | 30.12  | 23.80  | 20.96  | 30.68  | 29.43  | 19.63  | 16.50  | 20.36  | 900                   |
| 2   | Carbon monoxide (CO)          | µg/Nm³ | 4.124  | 3.815  | 3.918  | 4.181  | 4.033  | 3.506  | 3.437  | 3.895  | 30.000                |
| 3   | Nitrogen Dioxide (NO₂)        | µg/Nm³ | 20.87  | 14.54  | 16.00  | 14.63  | 34.99  | 8.59   | 11.91  | 26.47  | 400                   |
| 4   | Hydrocarbons (HC)             | µg/Nm³ | 131    | 118    | 124    | 137    | 118    | 111    | 105    | 105    | 160                   |
| 5   | Dust (TSP)                    | µg/Nm³ | 201    | 213    | 224    | 199    | 128    | 48     | 45     | 84     | 230                   |
| 6   | PM₁₀ (Particle < 10 µm)       | µg/Nm³ | 85     | 90     | 96     | 64     | 64     | 21     | 15     | 42     | 150                   |
| 7   | PM₃,5 (Particle < 2.5 µm)     | µg/Nm³ | 41     | 43     | 44     | 30     | 43     | 11     | 8      | 21     | 65                    |
| 8   | Lead (Pb)                     | µg/Nm³ | 0.33   | 0.35   | 0.40   | 0.31   | 0.05   | 0.20   | 0.22   | 0.03   | 2                     |

Source: laboratory analysis results, November 2018.

Based on table 1. results of ambient air quality monitoring the industry of steam power plant turned out that none of the ambient air quality parameters has exceeded the environmental quality standards as required by GR.41/1999.APC [16].
Distribution of SO₂ air quality parameters in settlement environment of the site of steam power industry tends to be stable and below the quality standards as required by GR.41/1999.APC [16]. Distribution of air quality parameters NO₂ in the site of the steam power plant industry tends to be stable and below the quality standards as required by GR.41/1999.APC [16].

Distribution of CO air quality parameters in the site of the steam power plant industry tends to be stable and below the quality standards as required by GR.41/1999.APC [16]. Distribution of HC air quality parameters in the site of the steam power plant industry tends to be stable and below the quality standards as required by GR.41/1999.APC [16].
Environmental quality conditions are represented by the distribution of dust air quality parameters (TSP) within the steam power plant industry site. The distribution of dust air quality parameters (TSP) within the steam power plant industry site fluctuates and is below the quality standard as required by GR.41/1999.APC [16]. Environmental quality conditions are represented by the distribution of PM10 air quality parameters around the site of the steam power plant industry. The distribution of PM10 air quality parameters within the steam power plant industry site and in the residents' settlement fluctuates and is still below the quality standard as required by GR.41/1999.APC. The concentration of PM10 pollutants in the human settlements is lower than the concentration of PM10 in the tread of the steam power plant industry [16].

Environmental quality conditions are represented by the distribution of air quality parameters PM2.5 around the footprint of the steam power plant industry. The distribution of PM2.5 air quality parameters in the footprint of the steam power plant industry and in settlement residents fluctuates and is still below the quality standard as required by GR.41/1999.APC. PM10 pollutant concentration in the settlement is lower than the concentration of PM10 in the site of the steam power plant industry [16]. The condition of environmental quality is represented by the distribution of air quality parameters lead around the site of the steam power plant industry.
industry site and in the settlement fluctuates and is below the quality standard as required by GR.41/1999.APC [16].

![Figure 9. Trend of ambient air pollution distribution in activities of steam power plant industry](image)

The concentration of lead pollutants in the settlement population is lower than the concentration of lead in the Tread Industry of the steam power plant. Analysis and evaluation of environmental quality trends; the ambient air quality parameter values in the monitoring period of the 2018 at 8 (eight) monitoring locations tended to decrease. All ambient air quality parameters tend to decrease and meet the quality standards as required by GR.41/1999.APC [16].

5. Conclusion
All ambient air quality test parameters monitored in 2018 (SO2, CO, NO2, Lead, Dust, PM10 and PM2.5) meet the quality standards as required by GR.41/1999.APC. The results of ambient air quality monitoring in 2018, showed that all air quality parameters were still below the quality standard as required by GR.41/1999.APC. Thus it can be stated that the proponent of the steam power plant industry has fulfilled and complied with the implementation of environmental management as required by the applicable laws and regulations, including compliance in carrying out and improving the implementation of environmental management plans and environmental monitoring plans. Possible cause of the low levels of ambient air pollution in the steam power plant industry is the suitability of the type of electric power steam engine that is still classified as the latest technology with the calorific value of coal used by the industry.

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