Designing Work Facilities In Dust Disposal Station (Silo Ash) To Reduce Air Pollution And Ease Maintenance With Quality Function Deployment (QFD) Method

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Abstract. PT. ABC has an ash handling system to collect, distribute, store and capture dust when the combustion process in the boiler burner has been completed so that the gas coming out of the clean chimney and coal dust is not polluted. Given the importance of this equipment, it is necessary to create a reliable and efficient system to improve generator performance for customer satisfaction. On the line ash handling system from ESP to the ash silo that serves the temporary collector before being taken to ash disposal for waste. Each equipment is expected to work optimally so that the dust handling system runs according to its function. The root fan under the silo ash is a very risky position when viewed from the current condition. The current position causes the fan filter to become dirty and requires high maintenance time and cost because the filter life is reduced (replaced too quickly). Disposal of ash (silos) has a significant impact on the environment around the station which causes air pollution which makes the surrounding engine conditions contaminated by dust, making maintenance difficult. Seeing this condition, designs that can reduce air pollution and facilitate maintenance are root fan removal, engineering design in truck shelters, and engineering designs on the ash silo holder frame. This design is able to reduce air pollution while facilitating maintenance because it reduces fly ash.

1. Introduction
PT. ABC has an ash handling system that functions to collect, distribute, store and catch dust (ESP) when the combustion process is finished in the boiler's combustion chamber so that the exhaust gas coming out of the chimney is clean and not polluted coal dust. Furthermore, the dust is stored in the ash dosage area to avoid air pollution in the area of the plant. The line ash handling system from ESP to the ash silo serves as a temporary collector before being taken to the ash dosage for disposal. Ash silo is equipped with some important equipment that is root fan for fluidization system, electric heater for fluidization air heater, the silo for coal dust, unloading equipment, blowdown equipment. Each equipment is expected to work optimally so that the dust handling system runs according to its function.

Root fan fluidization under the ash silo is very risky position when viewed from its current position. The current position causes the fan filter to be dirty and requires high maintenance time and cost because the filter life is reduced (replaced too quickly). In addition to problems in the filter, root fan is also often dirty due to unloading dust attached to the fan equipment parts, which resulted in the age of short fan
material or quickly experience the replacement of his part. Seeing the working environment conditions resulting from the disposal of this waste then the authors do engineering design in the work environment at the bus station.

2. Research Method
Research is conducted on a company that produces electricity. The type of research conducted is a descriptive correlation and associative research that explains the facts of the field of the object under study. The study was conducted on ash silo system. The primary data collected in this study is the design size measured directly in the field. The design facilitation of the equipment used the quality function deployment procedure.

3. Results And Discussion
3.1. Root Fan Transfer
Laying the root fan that was originally in the middle right beside the truck that holds dust. This laying situation causes the root fan to be filled with dust and the tendency of engine damage is easy to happen with this condition. Root fan under the ash silo is the very risky position when viewed from existing at this time. The current position causes the fan filter to be dirty and requires high maintenance time and cost because the filter life is reduced (replaced too quickly). In addition to problems in the filter, the fan is also often dirty due to unloading dust attached to the parts of the fan equipment, which resulted in the age of short fan material or rapid replacement.

After modification at unloading fly ash in ash silo area then root fan will be avoided from fly ash contamination because its position has been moved away from fly ash unloading area. Equipment maintenance is important to ensure the sustainability of production, equipment utilization and, production efficiency [10]. Maintenance of foot fan filter will be more effective because the filter age increases the length and ensure the preventive is easier even at the same time unloading and preventive maintenance. The condition before the modification is done on the line ash silo on the root fan to the truck carrying. The old design of root fan can be seen in Figure 1.

![Figure 1. Old Design Offline Root Fan.](image-url)
Perform calculation analysis of the root of the old fan so that if the occurrence of the root fan location change does not change the value of the KPa of this system.

**Known:**
- Pipe diameter: \( D = 8 \, \text{cm} \)
- Pipe Length: \( L = 9.5 \, \text{m} \)
- Flow: \( Q = 8 \, \text{m}^3/\text{min} \)
- Kinematic viscosity of air: \( \nu = 1.5 \times 10^{-5} \, \text{m}^2/\text{s} \)
- Elevation: \( 5 \, \text{m} \)
- Gravity: \( g = 9.81 \)
- Fluid Velocity:
  \[
  V = \frac{Q}{A} = 1.6 \, \text{m/s}
  \] ................................. (1)
- Reynold number
  \[
  \text{Re} = \frac{VD}{\nu}
  \] ................................. (2)
- Fluid Velocity:
  \[
  \text{Re} = \frac{1.6 \times 0.08}{1.5 \times 10^{-5}} = 8.53
  \]
- Because \( \text{Re} > 2000 \) means laminar flow.
- Headloss:
  \[
  H_f = \frac{32\nu VL}{gD^2}
  \] ................................. (3)
  \[
  = \frac{32 \times 1.5 \times 10^{-5} \times 1.6 \times 9.5}{9.82 \times 0.08^2} = 0.117 \, \text{m}
  \]
  \[
  p_A \frac{\gamma}{\gamma} + \frac{V_A^2}{2g} + Z_A = p_B \frac{\gamma}{\gamma} + \frac{V_B^2}{2g} + Z_B + H_f
  \] ................................. (4)
- For \( VA = VB \),
  \[
  p_A \frac{\gamma}{\gamma} + 0 = 0 + 5 + 0.117
  \]
  \[
  p_A \frac{\gamma}{\gamma} = 5.117
  \]
  \[
  p_A = 5.117 \times 9.81 = 50.01 \, \text{Kpa}
  \]

The design that is done that can be seen in Figure 2 and root fan position as follows.
3.2. Engineering Design on Dust Container Truck

Engineering design is a creative process for analyzing problem factors, predicting different solutions, evaluating results, determining the optimal solution [9,11]. Engineering design in terms of air pollution in the ash silo station is done on a dust truck. The method used is QFD. Quality Function Deployment (QFD) is a method to develop and improve the quality of product design by considering customer needs and satisfaction [5,6,7]. As for the discussion that is:

The results of QFD method can be seen in Figure 4 and 5 as follows.
3.3. Engineering Design on Ash Silo Base Framework

Design engineering in terms of air pollution is also done on ash silos. The method used is brainstorming, to generate a more creative solution, which is useful as the initial step of designing [4]. While the results of brainstorming are as follows:

Figure 4. House of Quality Design Trucks.

Figure 5. The Design on a Closed Position Truck.
1. Where on the ash silo stand frame in the zinc cap on the right and left side.
2. Rubber cover on the front and rear so that the truck can move back and forth to adjust the lid on the truck to the ash silo hole so that the flash can be reduced and air pollution is reduced.
3. The inside and right sides of the right side are not covered so as not to cover the CCTV on the ash silo station.

The results of brainstorming can be seen in Figure 6 as follows.

![Figure 6. Design of Ash Silo Framework.](image)

4. Conclusion
Ash handling system that serves to collect, channel, store and catch dust (ESP) when the combustion process is completed in the combustion chamber of the boiler is finished so that the exhaust gas coming out of the chimney is clean and not polluted coal dust. Engineering design is the total activity necessary to establish and define solutions to previously unsolved problems, or new solutions to pre-solved problems in a different way. Removal of root fan can facilitate the maintenance of the machine so that the longer life of the machine. Engineering design on dust collection trucks and environmental ash silo stations can reduce air pollution for workers and work environment. This engineering design requires a cost but also produces a good impact for the work environment of the dust station (ash silo).

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