Mini incinerator water treatment plant (IPAL) innovation

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Abstract. To reduce the landfill load against the accumulation of waste, incineration can be one solution, but in the process of combustion of trash, it causes an adverse impact in the form of air pollution. The purpose of this study is to treat wastewater using a filter on the incinerator. Wastewater treatment utilized is a filtration process using filtering media in the form of zeolite and activated carbon. It is expected that the addition of the filter can reduce the content of harmful particles in the incinerator combustion water. The design method used is the design method VDI 2221. The results of the study are (1) Design of a wastewater treatment plant (WWTP) on a mini incinerator by selecting the 4th variation on the grounds that the test results show that the 4th variation is the most optimal, (2) The results of the combustion wastewater test results on the incinerator, there are 3 items still above the threshold are BOD, COD and TSS.

1. Introduction
Hazardous and Toxic Waste (B3) is a material that we use every day from food and beverage packaging, medical needs, to electronics. Currently B3 waste is a threat to the environment and human survival. Based on the data obtained from the Ministry of Environment and Forestry in the 2017-2018 timeframe period regarding national waste management in Jakarta, the amount of waste dumped in landfills with forecasts is 11,680 tons / day. According to Government Regulation No.74 of 2001 regulating Hazardous and Toxic Substances (B3) in Indonesia, B3 chemicals are grouped into 209 usable B3 chemicals, 45 B3 chemicals that are limited in use and 10 B3 chemicals that are prohibited for use. In order to reduce the burden of landfill on waste accumulation, incineration can be one solution [1].

Burning rubbish as a solution but from the process of burning the rubbish has a bad impact in the form of air pollution. Changes in the air environment caused by air pollution, namely the entry of pollutants (in the form of gases and small particles / aerosols) into the air. Pollutants enter the air naturally from burning waste. The concentration of air pollution causes respiratory problems, irritation of the eyes and ears, the emergence of certain diseases and disorders of visibility [2].

The combustion chamber is one of the solid waste combustion operations units that can both reduce volume and reduce the weight of the waste quite large. To achieve maximum volume reduction, a combustion chamber is needed to be able to burn further waste and a combustion chamber that has a high enough temperature above the point of combustion of the burned waste [3].

Based on the explanation above, the waste processing equipment such as incinerator can be used as a solution. But the use of incinerators still has a negative impact on the environment. Because the results of combustion still cause harmful exhaust gases, an effort to reduce airborne pollutants is to use a water scrubber from flue gas that still contains pollutant particles that need to be managed with wastewater treatment. Wastewater management can use a filtration technology filter with the direction of flow from...
top to bottom (down flow) is widely applied to small-scale communities [4]. From the description above, the authors conducted a research on the treatment of liquid waste by using filters on incinertors. Wastewater treatment used is the filtration process using a filtering medium in the form of zeolite and activated carbon. It is expected that the addition of these filters can reduce the content of harmful particles in incinerator combustion water.

2. Methods

The method used in this study is the VDI 2221 (Verein Deutcher Ingenieure) method. The VDI 2221 method is one method for solving problems and optimizing the use of materials, technology and economic conditions. This method is expected to make it easier for designers to manage existing designs without having to master in detail [5]. The VDI 2221 method is divided into 7 stages, which are grouped into 4 phases, including:

1. Clarification of Task
2. Determination of Conceptual Design
3. Embodiment Design
4. Detail Design

Arief [6] states that all of the above design needs can be accommodated by the use of the VDI 2221 method. Design using the VDI 2221 method is a method for solving problems and optimizing the use of materials, technology and economic conditions. Ideas and knowledge are basic sources of product design to meet consumer demand and for the benefit of all parties.

3. Results and discussion

This research is the development of an existing incinerator by adding a liquid waste filtration system that is useful for filtering harmful particles in water to be discharged into the environment. The initial stage of designing a liquid waste filter used in an incinerator according to VDI 2221 is a clarification of task by making a wish list. show as Table 1, where that requirement needed for standard incinerator system.

Table 1. List of water filter design requirements on incinerators.

| Parameter               | Specification             | Demand (D) | Wish (W) |
|-------------------------|---------------------------|------------|----------|
| Shape Geometry          | Length                    | D          |          |
|                         | Wide                      | D          |          |
|                         | High                      | D          |          |
| Kinematics              |                           | D          |          |
| Force Need              |                           | D          |          |
| Energy                  | Electricity source        | D          |          |
|                         | Adjustable Energy with needs | D      |          |
| Material                | Heat Resistance Material   | D          |          |
|                         | Easy to collecting        | D          |          |
|                         | Lightly material          | D          |          |
|                         | Cheap material            | D          |          |
| Ergonomic               | Can be produce on small industry | W |          |
|                         | Proportional shape        | W          |          |
| Assembly                | Easy to assembly          | W          |          |
| Treatment System        | Replacement of filter media | W |          |
|                         | Low routine maintenance   | W          |          |
| About cost production   | Low production cost       | W          |          |

3.1. Conceptual design

The incinerator used has the capacity for small industries and housing. Only has one combustion chamber and has a rack that is used to store wet trash. The filter on the incinerator is used as a filter for
water to be discharged into the environment. Function is the relationship between input and output on a system that will perform certain tasks. Whereas sub-functions are the translation of functions into simpler functions. Both are referred to as function structures.

In this design it has been determined that a liquid waste filter will be designed for the incinerator. At this stage the function structure needs to be made which states how the workflow in the filter is. The overall function, the energy input to carry water through the pump in the form of electrical energy and the resulting output is water that has been filtered on a filter that will be discharged into the environment. As shown in the figure 1 below, the outline of the development system starts from input to output.

![Figure 1. The entire function of the water filter on the incinerator.](image)

3.2. Embodiment design

Then determine the sub-functions to describe the overall function in order to facilitate the incorporation of various solution principles. After obtaining the principle of the solution it is necessary to be analyzed again, so that in the concept design stage not too many evaluations are carried out. Which simple of solution sub function principled has developed as shown on table 2 below:

| No | Sub Function                  | A          | B                      | C          |
|----|-------------------------------|------------|------------------------|------------|
| 1  | Filter Body                   | -          | -                      | -          |
| 2  | Nanotech of water filter      | Activated  | Membrane              | -          |
|    | Carbon                        |            |                        |            |
| 3  | Filtering Media               | Activated  | Activated carbon and zeolites | -          |
|    | carbon                        |            | and zeolites           |            |
|    | zeolites, gravel, and sand    |            |                        |            |
| 4  | Position of NanoTech          | Near Scrubber | Next to the pump | Under the filter |
|    | Water tank                    | -          | -                      | -          |
| 6  | Pipe                          | ½ inci     | ¾ inci                 | -          |

After making the principle of sub-function solutions, it is necessary to do a combination to form the most supportive system in the form of several variants.

Based on the principle of the solution done above, several combinations or variations can be obtained:

1). Variant 1 : A1, A2, A3, A4, A5, A6
2). Variant 2 : A1, B2, B3, B4, B5, B6
3). Variant 3 : B1, B2, B3, B4, B5, B6
4). Variant 4 : B1, A2, B3, C4, B5, B6

To determine the variants to be continued in the design process, a selection must be made. The selection of variants can be done using selection charts or the selection of variant solutions.

3.3. Detail design

After determining the appropriate variant to be developed, detailed design is carried out. Design that have been developed and applied in the field as pre-test models can be seen in the CAD design drawings in the figures 2 below:
Figure 2. Design of water filter design on incinerator.

Selection of Variations by using a selection chart or selection of solution variants then variants of Variants 4: B1, A2, B3, C4, B5, B6 are chosen with the reason of the test results

3.4. Prototype testing

After the prototype is successfully made, then it will be tested on the results of the water filter design on the incinerator. The test aims to find out firsthand how the process of burning garbage, combustion exhaust gas, combustion water, and how the filter works during the combustion process takes place.

Tests carried out by burning various types of waste and several times the combustion process. The first test is testing the smoke or exhaust gas from combustion of B3 solid waste. The second test is testing the combustion water. Testing is done at the Regional Health Laboratory (LABKESDA) shown as Table 3.

| No | Parameter       | Unit | Result | Standard Value | Method                           |
|----|-----------------|------|--------|----------------|----------------------------------|
| 1  | Ph (Eksitu)     | -    | 7,25   | -              | SNI No 06-6989.11.2004           |
| 2  | BOD             | mg/L | 190    | 30             | IK. 17/PP16.5-Air-17025/Labkesda |
| 3  | COD             | mg/L | 274    | 100            | IK. 18a/PP16.5-Air-17025/Labkesda|
| 4  | TSS             | mg/L | 38     | 30             | IK. 05/PP16.5-Air-17025/Labkesda |
| 5  | Fat gross oil   | mg/L | 2,12   | 5              | SNI No.06-6989.10.2011           |
| 6  | Ammoniac        | mg/L | 3,68   | 10             | SNI No.06-6989.30.2005           |

Based on the table above items that are still above the threshold are BOD, COD and TSS, the next step is to compare the four variations to get optimal results. Selection of Variations by using a selection chart or selection of solution variants then variants of Variants 4: B1, A2, B3, C4, B5, B6 are chosen with the reason of the test results.
Based on the analysis of the data above, the test results for variant 4 were chosen because it is the most optimal filtering water.

4. Conclusion
The results of testing for variant 4 are BOD 110 mg / L, COD 274 mg / L, and TSS 11 mg / L. In the test results of variant 4 is the most optimal filter variant in breaking down COD & BOD and is able to reduce the value of TSS because it has many filters in filtering mud, sand and ash resulting from incinerator combustion.

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