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The Most Effective and Efficient Filter Media Formation for Clean Water Treatment

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Abstract:

This research employs an experimental approach at either laboratory or pilot scale. Data collection involves water treatment using various filter media formations, with observation of each medium's performance in contaminant removal. Data analysis is qualitative, including evaluation of filtration effectiveness and analysis of operational parameters such as filtration efficiency, water discharge, and filter media lifespan. Water samples are sourced from the water to be treated, and evaluation criteria involve comparing contaminant removal by each filter medium formation, while efficiency is assessed based on operational parameters used. The primary objective is to select the most effective and efficient filter medium formation for clean water processing. The research outcomes have been validated in a laboratory setting. Laboratory experiments on each component demonstrate their ability to operate effectively.

Keywords: *filter media, water treatment, effectiveness, efficiency.*

Introduction

Water is an indispensable resource for sustaining life, essential for human health, ecological balance, and socioeconomic development. Access to clean and safe water is a fundamental human right, yet millions of people worldwide still lack access to adequate water supplies. Clean water treatment plays a critical role in addressing this challenge by removing contaminants and pathogens from water sources, ensuring its suitability for consumption, sanitation, and various industrial and agricultural purposes.

The importance of clean water treatment is underscored by its multifaceted impact on public health, environmental conservation, and economic prosperity. Contaminated water poses significant risks to human health, causing waterborne diseases such as diarrhea, cholera, and typhoid fever, particularly in regions with inadequate sanitation infrastructure. Moreover, polluted water bodies threaten aquatic ecosystems, compromising biodiversity and ecosystem services essential for human well-being.

Population growth, rapid urbanization, industrialization, and agricultural intensification have exacerbated water quality issues, leading to increased pollution and degradation of water resources. Industrial discharges, agricultural runoff, untreated sewage, and improper waste disposal contribute to water contamination, posing significant challenges for water management and treatment.

Climate change further compounds these challenges, altering precipitation patterns, increasing the frequency and intensity of extreme weather events, and exacerbating water scarcity and quality issues. Rising temperatures can accelerate chemical reactions and biological processes in water bodies, affecting water quality parameters such as dissolved oxygen levels and nutrient concentrations.

Addressing water quality concerns requires a comprehensive approach that encompasses pollution prevention, watershed management, and robust water treatment systems. Clean water treatment technologies play a crucial role in safeguarding public health and environmental integrity by removing pollutants, pathogens, and harmful chemicals from water sources.

Filter media are integral components of clean water treatment systems, acting as barriers to contaminants and facilitating the removal of suspended solids, organic matter, and microorganisms from water. Various types of filter media, including sand, activated carbon, gravel, and anthracite, offer distinct filtration capabilities and are selected based on the specific contaminants present and treatment objectives.

Research Objectives

The objectives of this research are:

1. Increased Water Treatment Effectiveness: By analyzing the formation of filter media, we can identify the combination that is most effective in removing certain contaminants in clean water. This will increase the effectiveness of the water treatment process by ensuring that the filter media formation used is able to filter contaminants with high efficiency. Thus, the urgency of this research is related to the need to improve water processing capabilities to achieve established quality standards.

2. Optimizing Resource Use: Research on effective and efficient filter media formation will also help in more optimal use of resources. By finding the right combination of filter media, we can reduce the use of energy, water and chemicals used in the processing process. This will help reduce operational costs and environmental impacts associated with clean water treatment. The urgency of this research is related to the need to develop sustainable and environmentally friendly water treatment technology.

3. Cost Savings and Operational Efficiency: By using effective and efficient filter media formation, water treatment can be carried out at lower costs and higher efficiency. Proper filter media formation will reduce losses and costs associated with frequent filter replacement or repair. In addition, an efficient processing process will minimize the time and effort required to achieve the desired results. This will reduce operational costs and increase the overall efficiency of the water treatment system.

Materials and Methods

The materials for the filter media used in this research are: activated carbon, ferrolite, manganese, and activated sand. The water to be treated is taken from drilled wells in the Kubu Raya district, West Kalimantan Province, Indonesia

The research method that will be carried out for this research activity is as follows:

a. Filtering media formation and composition: The research design was experimental. On This stage uses a laboratory scale or pilot scale for testing the various filter media formations and compositions, by changing the order of the filters media include; manganese, activated sand, ferrolite, and activated carbon.

b. Data Collection: Data collection is done by treating water using different filter media and observing the performance of each filter media in removing contaminants.

c. Data Analysis: The data collected will be analyzed quantitatively. Analysis includes an evaluation of filtration effectiveness, that is, the ability to remove contaminants by each filter media formation.

d. Parameters to be measured: Parameters that need to be measured include;

- Filter media efficiency: the ability to remove contaminants (e.g., suspended particles, organic materials, heavy metals) by each filter media.

- Water discharge: Changes in discharge that occur in the system during water treatment with filter media.

- Filter Media Life: Evaluate the filter media's service life before requiring replacement or maintenance.

e. Filter Media Effectiveness and Efficiency Evaluation Criteria:

- Effectiveness: Evaluation of the effectiveness of filter media can be done by comparing the ability to remove contaminants by each filter media formation. The higher the ability to remove contaminants, the more effective the filter media formation is in filtering clean water.

- Efficiency: The efficiency of filter media formation can be assessed based on the operational parameters used, such as flow rate, contact time, maintenance time. The goal is to achieve high efficiency in the water treatment process, where the formation of filter media provides optimal results using minimal resources.

To make it easier to understand, this research method can be seen in the flow chart diagram (Figure 1).

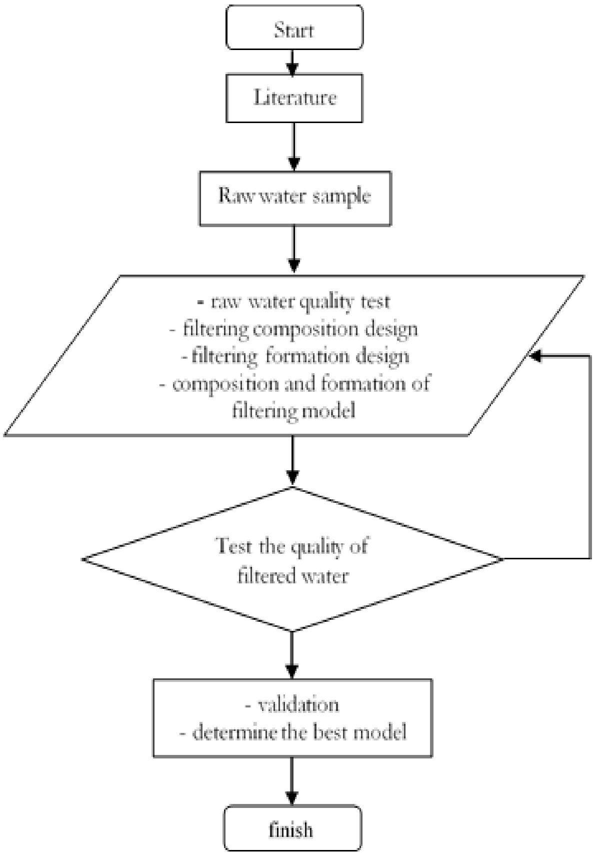

Figure 1. Research Flow Chart Diagram

Results

The results obtained from this research in the form of source (raw) water and processed water are as follows:

Table 1. Filters formation and water parameters

No	Filter formation	Q (l/det)	Parameter	Value	Unit
1	A – B – C – D	0,00625	pH turbidity color odor	7,26 3,04 99 odorless	mg/l NTU TCU
2	D – C – A – B	0,00847	pH turbidity color odor	7,23 5,34 98 odorless	mg/l NTU TCU
3	C – A – D – B	0,00826	pH turbidity color odor	7,32 11,6 147 odorless	mg/l NTU TCU
4	B – D – A – C	0,00840	pH turbidity color odor	7,34 2,86 67 odorless	mg/l NTU TCU

5	Raw water	0,01852	pH turbidity color odor	7,06 25,90 225 odor	mg/l NTU TCU

Note: A = activated carbon; B = ferrolite; C = manganese; D = activated sand; Q = water discharge.

Based on the Regulation of the Minister of Health of the Republic of Indonesia No. 32 of 2017, concerning Environmental Health Quality Standards and Water Health Requirements for Sanitation Hygiene, Swimming Pools, Solus per Aqua, and Public Baths, the requirements for clean water are as follows:

Table 2. Clean Water Quality Standard

No	Parameter	Unit	Standard (Max. value)
1	Turbidity	NTU	25
2	Color	TCU	50
3	Odor		odorless
4	pH	mg/l	6,5 – 8,5

Source: Permenkes No. 23 of 2017

Discussion

From the data above, based on the values of laboratory examination results for several clean water parameters, then we compare which ones meet the standards the most or are closest to the standard values of clean water quality standards stipulated in the Republic of Indonesia Minister of Health Regulation No. 23 of 2017 as follows:

- The permissible pH range for clean water is between 6.5 to 8.5. Therefore, the closer to the middle value of the range is the better.
- The limit for clean water turbidity is set at a value less than 5 NTU. In this case, a combination with lower turbidity would be more appropriate.
- The color limit for clean water is also set in the standard with a value of less than 50 TCU. A lower value or closer to the allowable limit would be better.
- The odor limit for clean water has been set in the standard that the water is odorless. The less smelly the water, the better the water.
- In the context of clean water or water quality, "discharge" refers to the volume of water flowing through a channel or water source in a certain time period. Discharge is measured in units of volume per time, for example liters per second (l/sec) or cubic meters per hour (m^3/h). The more discharge that passes through the filter, the better the filter arrangement.

Based on the results of the discussion above, we can determine that the effective and efficient filter media formation for clean water treatment is formation/variation/combination 4, because:

- Formation 4 has a pH value that is close to the middle of the allowable range.
- Formation 4 has a low turbidity value, in accordance with standard limits.
- Formation 4 has a relatively low color value, close to the permitted limit.
- Formation 4 has the largest discharge value.
- Formation 4 can be used for ± 7 days before filter media cleaning is required.

Conclusion

Based on the results and discussion above, we can obtain the following conclusions:

a. The most effective and efficient filter media performance evaluation is formation/variation/combination 4, with filter order; ferrolite, activated sand, activated carbon, manganese.

b. Optimizing resource use, by using 4 formation/combination/variation filter media, we can reduce operational costs and negative impacts on the environment from water treatment.

c. Formation/combination/variation 4 improves the quality of raw water closer to the clean water standards required in the Republic of Indonesia Minister of Health Regulation No. 23 of 2017, includes eliminating odors, tastes, colors, and reducing dangerous contaminants in water.

d. The results of this research provide new insights into more effective and efficient use of filter media, which can be used as a guide for technology development and best practices.

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Conflict of Interests

No conflict of interest.

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