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Analysis Of The Head Loss Phenomenon Values In Straight Pipelines With Silica Sand Variations As Filtration

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A B S T R A C T

In this reseaerch, the tool design and analysis of the head loss phenomenon in the filtration sys- tem experiment was done to determine the effect of head loss caused by variations in silica sand andsilica sand composition. This design was also made to determine the performance of the head loss experimental device on the filtration system. Head loss is a loss of pressure caused by fluid friction in the pipe, or it can also be caused by changes in the shape and dimensions of the pipe, such as in pipe joints. In this design, most use sand as one of the main filter media, with 3 variations of Very Fine sand 0.05-0.1mm, Medium 0.1-0.25mm, Coarse 0.5-1.0mm, and 3 various compositions PS 50% KA 50%, PS 70% 30%, PS 80% 20%. In designing the head loss test channel using a variationof filtration to know the value of head loss in the filtration system, a digital water meter to measure the water discharge is used to measure the pressure at the inlet (ṁin) and pressure at the outlet (ṁout). This tool is also designed in a modular way (disassembly), where in the experiment varia- tion and without filtration can be used interchangeably. Experiments carried out using filtration produced an average theoretical value on the composition of PS 50% KA 50% sand with a variationof Very Fine silica sand 0.05 – 0.1 mm smaller than the composition of PS 70% KA 30% and PS 80% KA 20% with a variation of Very Fine silica sand 0.05 – 0.1 mm and a variation of Very Coarse silica sand 0.5 – 1.0 mm. Meanwhile, the higher headloss value shows the composition of PS 50% KA 50% with variations of Very Coarse Silica Sand 0.5 – 1.0 mm. 3) In the data collection experi- ment using the Design Of Experiment (DOE) Factorial, the P-Value for Composition was 0.965 > 0.05 indicating an insignificant condition and the P-Value for Sand 0.006 > 0.05 indicated a signifi-cant condition. The factorial chart shows the condition that sand (B) greatly influences the occur- rence of head loss in water flow.

Keywords: *Headloss, Filtration, DOE Factorial*

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1. Introduction

Filtration is the process of separating solid particles from a liquid by passing the liquid through a filter medium or partition in which the solids are retained. It is possible to construct a portable water purifier with modified filters for improved water quality. The function of this research is to provide poor quality water supply to become a good quality water source. Portable filters are easy to use and maintain due to their simple shape and easy removal of the filter element.

The filtration method is an appropriate technology that is simple, effective, efficient and inexpensive, filtration is also commonly used as an experimental tool for learning media. Filtration is also an initial process for the separation between liquids and solids, and is a form of a mixture of 2 or more substances that are not of the same nature but have relatively large size dispersed particles (colloids). In the filtration process, a filter media with a certain particle size is used. Because there is a pressure difference between the inside pressure and the outside pressure, the separation process in filtration can be carried out.

Removing particles that cannot be absorbed by activated carbon, activated carbon is one of the filter media that can be used together with other technologies in water filtration systems. Filter sand, activated carbon, zeolite, bioball, green sand, and manganese are some examples of filter media

The size of sand according to the USDA classification (1938) is divided into:

1) *Very coarse sand* : 1,0–2,0 mm
2) *Coarse sand* : 0,5–1,0 mm
3) *Medium sand* : 0,25–0,5 mm
4) *Fine sand* : 0,1–0,25 mm
5) *Very fine sand* : 0,05–0,1 mm.

The specific gravity of various soil types ranges from 2.65 to 2.75 which is usually used for non-cohesive soils. Meanwhile, non-organic cohesion ranged from 2.68 to 2.72. On the specific gravity values of various types of soil where the soil has different specific gravity.

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Table 1. Soil Specific Gravity

An example of a column heading	Specific Gravity
Gravel	2.65 - 2.68
Sand	2.65 - 2.68
Inorganic Silt	2.62 - 2.68
Organic Clay	2.58 - 2.65
Inorganic Clay	2.68 - 2.75
Humse	1.37
Peat	1.25 – 1.80

The requirements for the sand used are that the sand must be clean, not mixed with soil and dirt. Sand before being used as a filter media, should be washed thoroughly. The type and amount of media used in Dual Media filtering. The use of 2 filter media such as anthracite and sand.

Table 2. Design criteria by using dual media filter

character	Score	
	Average (cm)	Type
Anthrasite Medium		
Depth	46-61	61
effective size	0,9-1,1	1
uniform coefficient	1,6-1,8	1.7
Sand Medium		
Depth	15-20,5	15
effective size	0,45=0,55	0,5
uniform coefficient	1,5-1,7	1,6

1.1. Solid Substance

a solid substance that can absorb large enough dispersed particles in liquids in the adsorption method, has many advantages, namely strong, clean to produce, and relatively inexpensive. Carbon molecules that have undergone carbonization and activation to increase their absorption capacity are referred to as activated carbon. During the process, water, gas and hydrogen are removed from the physical surface. This activation is due to the energetic structure generated when free radicals on the carbon surface interact with particles containing oxygen and nitrogen.

Activated carbon is one form of granules or powder from granules located in coal, coconut shell charcoal, or other materials that can be burned at excessive temperatures. The over temperature heater is conditioned in a closed chamber so that there is no loss of heat in the carbon content material which is carbonized and no longer oxidized. Activated carbon in the water filter has the property of removing micro-sized grains which include natural ingredients, odors and colors, as well as metal content of iron (Fe) and manganese (Mn).

The mechanism of activated carbon adsorbs substances that cause them to be misplaced, also known as adsorption technique. Activated charcoal has a useful lifestyle until the top of the activated charcoal becomes saturated or it can't last much longer. this condition indicates that the activated carbon in the filter must be replaced.

Activated carbon or often referred to as activated charcoal is charcoal that has a certain level of absorption of dissolved organic matter, color, odor, taste and other substances. This activated carbon has two forms according to the size of the granules, namely powdered activated carbon and granular activated carbon (granules). Powdered activated carbon whose grain size is less than or equal to 325 mesh. Meanwhile, granular activated carbon has a granular diameter larger than 325 mesh.

Quartz sand has a combined composition of SiO_2, Fe_2O_3, Al_2O_3, TiO_2, CaO, MgO, and K_2O, translucent white or other colors depending on the impurity compounds, hardness 7 (Mohs scale), specific gravity 2.65, melting point 17 -150oC, hexagonal crystal form, specific heat 0.185.

1.2. Silica Sand

One of the ingredients in the sand is the mineral quartz in which there is silicic acid (SiO_2), hereinafter often referred to as quartz sand which has a hardness of 7 on the Mohs scale, specific gravity selected 2.65, melting point 1715 0C, hexagonal crystal form , thermal conductivity 12-100 0C. Quartz sand can be very effective at filtering out silt and other water contaminants.

Quartz sand (SiO_2) is used to remove silt or soil and sediments obtained from the source. In this media, materials containing impurities or materials that are different from the microbes in this media are filtered. Works well to remove physical properties like turbidity or sludge and odors. Silica sand is generally used as a filter in the initial range. The only treatment for silica sand filter media is the back wash method approach. The back wash method is a form of preventive maintenance that allows filter media to be reused

1.3. Arrangement of Filter Media

The composition of the silica sand-activated carbon and activated carbon-silica sand filter media with each filter media size of 0.005mm–0.1mm. The decrease in Fe content with silica-activated carbon sand filter media on media with a diameter of 0.6-1.18mm was 89.511% and on a diameter of 1.18-2.36mm was 83.013%. Arrange the filter media with a white sponge with a thickness of 0.005m on the top layer, then silica sand with a thickness of 0.2m, covered with white sponge with a thickness of 0.005m on the top layer, then silica sand with a thickness of 0.2m covered with white sponge with a thickness of 0.005m as a separator between the filter media and the next arrangement is activated carbon with a thickness of 0.2m, coated with a white sponge with a thickness of 0.005m as a separator with gravel buffer media with a thickness of 0.05m which is at the bottom layer.

The filter thickness is 40cm, with a filter media thickness of 20cm silica sand and 20cm of activated carbon. Whereas silica sand media with a height of 10cm has a turbidity removal efficiency of 42%, a height of 30cm with a removal efficiency of 57%, a height of 50cm with an efficiency of 62%.

2. EXPERIMENTAL SETUP AND PROCEDURES

This equipment is designed in a modular way by using 8 sockets in the design with filtration, each design on the fittings and measuring devices are connected using a socket to facilitate disassembly according to the channel that will be tested. Testing with a filtration system uses 2 flowmeters to determine the pressure before and after using filtration (P in and P out), the other components are only used as water flow so that the flow position remains stable. The length of the design support board is 80cm and 160cm wide. The installation drawings can be seen in Figure 2.1

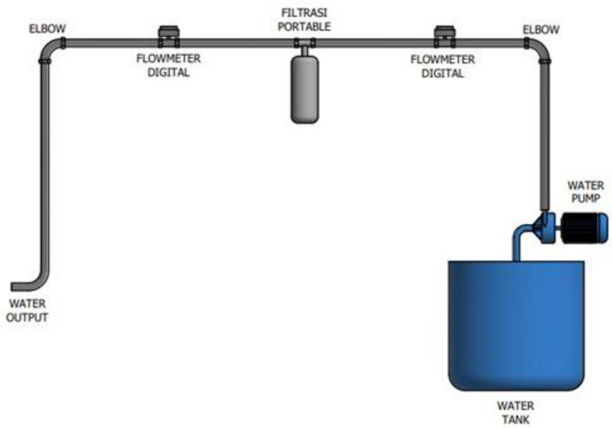

Figure 2.1 Installation design with filtration

2.1 Variation of Filtration Arrangement

The experimental design used in the analysis of the head loss phenomenon on a filtration system experimental device with the specifications of a cartridge length of 260mm, width of 64mm and a sponge of 25mm.

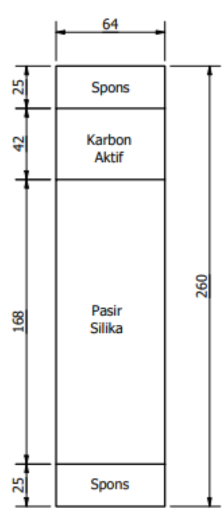

Figure 2.2 Installation design with filtration

The first comparison uses the variation arrangement used in empty cartridge filtration with a percentage of 80%: 20%. Silica Sand as much as 80% (168mm) and 20% Activated Carbon (42mm). the second comparison uses the arrangement of variations used in empty cartridge filtration with a percentage of 70%: 30%. Silica Sand as much as 80% (168mm) and 20% Activated Carbon (42mm). the third comparison uses the variation arrangement used in empty catride filtration with a percentage of 50%: 50%. On Silica Sand as much as 50% (105mm) and 50% Activated Carbon (105mm).

3. Experimental Result

Based on the results of experimental tests on the design average head loss with a variation of Very Fine Silica Sand 0.05–0.1 mm, it results in a head loss value condition in the composition of PS 80% KA 20%. smaller than the composition of PS 50% KA 50% and PS 70% KA 30%. While the composition of PS 50% KA 50% produces the greatest head loss. Such a result is because the faster the flow rate, the higher the value produced by the digital flowmeter, and the composition of PS 80% KA 20% filtration that is installed does not cause head loss that is too large to produce a small flow rate.

The results of subsequent experimental tests on the design mean head loss with a variation of Medium silica sand 0.1–0.25 mm resulted in a condition where the head loss value for the composition of PS 70% KA 30% was smaller than the composition for PS 80% KA 20% and PS 50% KA 50%. While the composition of PS 50% KA 50% produces the greatest head loss. Such results are due to the faster the flow rate, the higher the value produced by the digital flowmeter, and the composition of the PS 70% KA 30% filtration installed does not cause too much head loss resulting in a high flow rate.

Subsequent experimental tests on the design mean head loss with a variation of Very Coarse silica sand 0.5 – 1.0 mm resulted in a condition where the head loss value in the composition of PS 80% KA 20% was smaller than the composition of PS 50% KA 50% and PS 70% KA 30%. While the composition of PS 50% KA 50% produces the greatest head loss. Such a result is due to the faster the flow rate, the higher the value produced by the digital flowmeter, and the composition of PS 80% KA 20% filtration installed does not cause too large a head loss resulting in a high flow rate.

Design testing of head loss without filtration produces conditions with a high average head loss value due to the absence of head loss which inhibits it so that the flowmeter value that comes out is quite high.

3.1 Chart Of Main Effects Plot

The optimal factorial effects plot level chart can be determined and seen from the graph of the average calculation results for the composition and sand levels. Figure 4.17 is a graph of the response obtained from Minitab 19 based on the average value of the composition and silica sand.

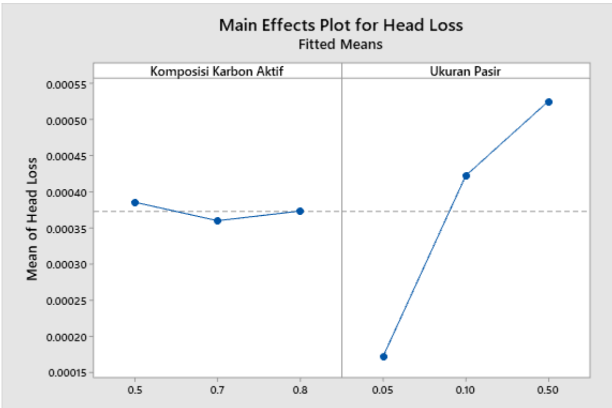

Figure 3.1 Installation design with filtration

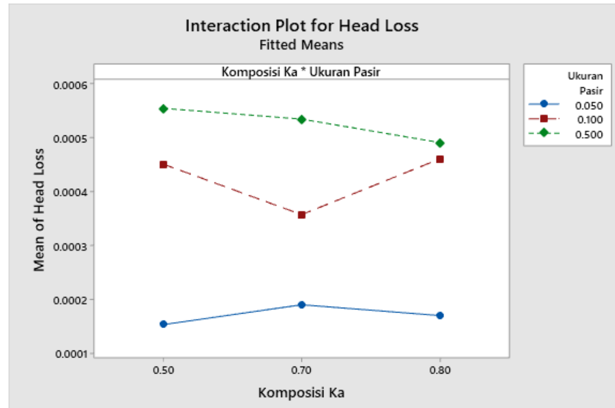

Figure 3.2 Installation design with filtration

The optimal factorial effects plot level chart can be determined and seen from the graph of the average calculation results for the composition and sand levels. Figure 3.1 is a graph of the response obtained from Minitab 19 based on the average value of the composition and silica sand.

Determination of the optimal level used in this factorial analysis is based on the characteristics of the resulting head loss value which results in the smaller the resulting head loss value, the better it is to use because the smaller the head loss value results, the better the resulting water flow. Based on Figure 3.1 it is known that the optimal conditions on the Main Effects Chart are listed as the condition for the head loss value for the PS 70% KA 30% (7030) composition which shows a smaller number and for the PS 50% KA 50% composition which shows a higher head loss value. the biggest. For the results of the Main Effects Chart plot of sand on very fine silica sand 0.05 – 0.10 mm (0.05) shows the smallest value and Very Coarse 0.5 – 1.0 mm (0.50) shows the most big.

3.2 Chart Of Interaction Plot

The optimal interaction plot can be determined and seen from the graph of the average calculation results for the composition level (5050.7030 and, 8020) and sand (0.05, 0.1 and, 0.5). Figure 3.2 is a plot of the responses obtained from Minitab 19 based on the average values for composition and sand.

The optimal level used in this factorial analysis is based on the characteristics of the resulting head loss value which results in the smaller the resulting head loss value, the better it is to use because the smaller the head loss value results, the better the resulting water flow. Based on Figure 4.18, it is known that the optimal conditions in the interaction plot results are indicated by the condition that the head loss value for the PS 50% KA 50% (5050) composition shows a smaller number and for the PS 80% KA 20% composition which shows a higher head loss value. the biggest. For the Main Effects results of sand on very fine silica sand 0.05–0.10 mm (1) shows the smallest value and Very Coarse 0.5 – 1.0 mm (3) shows the biggest value.

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