RESEARCH ARTICLE
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The Engineering of Chlorinating Device to Disinfect The Conventional Well

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ABSTRACT

Well water is one of the main resource of drinking water for the large people, especially for those who do not abonnement of PDAM (The regional corporation which suplies water need). To determine whether the well water physically polluted or not, it can be done by testing the smell, colour and taste. Whereas, to know the level of pollution both chemically and biologically, laboratory test is performed. To purify water from pathogen bacteria, the cause of waterborne deseases, it is necessary to conduct disinfecting activity to make well water safe to drink by the people. This study was experimental research. The purpose of the research was to design a chlorine injection device applied in a conventional well water, to make it safe to consume by the people. The research design was one group pre and post-test design. Then the effectiveness of the function of the device was analyzed by identifying the difference of concentration of the disinfectant (chlorine) to produce chlorine residue, smell, taste and the decrease of colifom bacteria from well water, in line with the standard of Ministry of Health No. 492 /Reg.IV/2010 about the qualification of the quality of drinking water. The result of the research on the dimension of device chlorine injection, in the form of PVC pipe 2 dm^3 and 50 cm in length, completed by silicate sand (3 kg). PVC Ø ¾ , cap, doublé screw sock, disinfectant chlorine and the wieght of device is 3,6 kg. Working principle of this device was the putting of chlorine diffusely in the well wáter. The chlorine injection device type A with the chlorine concentration 10.39 g was sable to desinfect well wáter for 6 days with the average chlorine residue 0.212 ppm. While, chlorine injection device type B was able to desinfect well wáter for 16 days by using 20.97 g of chlorine. The capacity of the device was for 1000 L and the device will make the well wáter inodorous, tasteless, and free from coliform bacteria, this is in line with the standard of Ministry of Health No. 492 /Reg.IV/2010 about the qualification of the quality of drinking water. To increase the capacity of function of chlorine injection device, it is important to conduct a testing on well water in rainy season , the volume of water more than 1000 L, the content of chlor in the chlorine, the endurance of the divice, and the different level of pollution.

Keywords: Conventional well water, Chlorine residue, Chlorinating

INTRODUCTION

Getting healthy water is increasingly difficult, because of being polluted by various human activities, not only waste from household activities, but also industrial and the other ones which are discharged into the environment(1).

Well water is one source of drinking water for those who do not take the drinking water from local drinking water companies (PDAM). The existence of the total content of coliform in the dug well water can be the cause of waterborne disease. The considerations to use the disinfectant such as chlorine are because it is cheap, affordable and easy to get.

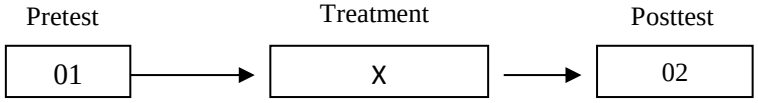
To overcome such a social problem, it is necessary to design a chlorinator injection with chlorine disinfecting material so that the water supply problem from dug wells can be overcome. The concept of chlorination is an attempt to disinfect water from the life of microorganisms in water using chlorine. Chlorination aims to keep the water in good condition or to improve the physical and chemical condition, taste and odor of the water. In addition to eradicate bacteria and microorganisms such as amoeba, algae and others, chlor can also oxidize metal ions such as Fe2+ Mn2+ to Fe3+ Mn4+. Chlor is derived from Chlor (Cl_2), NaOCl, Ca $(OCl)_2$, (Chlorine) gas or HOCl (Hypochloric acid) solution. There would be a quick hydrolysis reaction when the compounds react ordissolve into water(2).

The benefits of using Chlorine: easy to obtain, relatively cheap, easy to use, several hour - disinfection power after affixing. However, it is necessary to understand the disadvantages of using Chlorine, that over use of chlorine will cause body irritation, cause unpleasant odor and taste in water, in the form of powder, easily blown

away by the wind. The objective of this research was to design chlorinator injection tool for well water to be consumed by society.

METHODS

This research used one group pretest - postest design.



O1: Total content of coliform, chlorine residue, pH, odor, taste,, before disinfection with chlorinator.
X: The settlement of water treatment in chlorine injection tool
O2: The residual content of chlorine, pH, odor, taste, after disinfection process with chlorinator tool

Figure 1. The research design

The sample of research was dug well water in Rejomulyo Village, Madiun City. The research procedure was: 1) Preparation (included the supply of filter materials (sand), chlorine injection equipment type A and type B, and various PVC pipes and fittings); 2) Designing the chlorinator (preparation and a joined-built chlorinator treatment apparatus (appendix 1) with the following specifications: chlorine injection type A chlorine injection type B).

The experiment implementation was: 1) Preparing tools and materials, 2) Measuring the volume of the well water, 3) Checking the residual content of chlorine, pH, temperature,total coliform, odor and taste, in the well water before the disinfection process begins, 4) Putting type A chlorine injection tool 20 cm deep in the bottom of the well, 5) Calculating disinfection detention time, 6) Checking the content of chlorine residue, odor and taste, in well water after disinfection process with time variation: (after 1 day, 2 days, 3 days, 4 days, 5 days, 6 days, 7 days, 8 days, 9 days, 10 days), 7) Analyzing the results of the examination of the effectiveness and capacity of the chlorinator using 4 wells, 8) Repeating the sequence of work points no.4 to 7 for a type B chlorine injection tool, 9) Data processing and analysis of the results of the measurement before and after treatment namely the measurement of residual chlorine, total coliform, pH, temperature, odor, taste of the well water.

RESULTS

Basically, the design of a type A and type B chlorinator injection appliance was the same. One thing that makes different was the amount of chlorine included in the apparatus. Both type A and B chlorinator injection devices, provided 4 time - result of laboratory test for each. Completely, chlorinator injection tool used in this study can be explained as follows.

Table 1. Specification of type A and type B chlorinator injection tools

No	Component	Specification of devices
1	PVC Pipe ¾“	Chlor container 50 cm long, hole 2 mm, total amount of 26 pieces at the center position of the pipe and 20 pieces in the position 12 cm from the right and left edge
2	PVC Pipe 2 "	Silica sand container, 50 cm long, given 2 mm diameter hole, in the border position.
3	Cap ¾ “	Pvc pipe lid ¾" as chlorine safety
4	Cap 2"	Pvc pipe lid 2" as sand and density safety
5	Silica sand	Filter media and chlorine diffusion which will control chlorine expenditure. Diameter of sand ≤ 2 mm and density 2.08 kg / l, the weight of sand used 3 kg. Before being used, it is disinfected with 0.2 ppm chlorine residue
6	Tools’s weight	3.6 kg consist of 0.6 kg PVC and 3 kg of sand
7	Chlorine	Disinfectant materials (50% powder active materials) used to kill bacteria in dug well water.
8	Chlorine needs	Chlorine required in accordance with laboratory test results type A 10.39 g and type B 20.97 g

Table 2. Result of recapitulation data of chlorine needed, chlorine residue in the dug well and the chlorine injection

No	Kind	Code	Chlorine wells used (g)	Residual chlorine of well water is average (ppm)	The remaining chlorine in the tool (g)	
1	Chlorine injection tipe A	A1	9.71	0.19	3.2	Resilience of residual product of chlorine well water 6 days
		A2	8.68	0.24	2.9	
		A3	10.90	0.25	3.1	
		A4	11.00	0.19	1.9	
		A5	11.66	0.20	2.7	
	Average		10,39	0,214		
2	Chlorine injection tipe B	B1	21.00	0.21	5.6	Resilience of residual product of chlorine well water 6 days
		B2	18.66	0.24	7.5	
		B3	24.81	0.22	6.7	
		B4	20.58	0.20	7.8	
		B5	19.78	0.18	7.5	
			20.97	0.212		

DISCUSSION

The Conditions of Well Water

To determine the selection of wells based on location (regionally), relatively equal water volume, well depth from soil surface 6 till 7 m, 3 till 4 m plastered well wall, 1 m water depth or well water volume is 708 till 866 l. Average needs of clean water 120 l / person / day.

The sample of well water of the respondent uses an electric pump with power 100 to 125 watt and discharge ≤ 30 l / minute. The smaller residents are (3 to 5 persons), the least amount of water they need (360 to 600 l), and it makes the well water remain steady as they do not take it all at the same time. Therefore the water needs can be fulfilled and there is a balance between the demand and the availability of the well water source.

The disinfection result of dug well water using chlorine injection tool can be described as follows:

a. Water well treated by chlorine injection type A
   After being treated using 10,39 g chlorine average, the result is 0,214 ppm in average (table 2) and last just in 6 days. Based on Regulation of the Minister of Health No. 492 / Menkes / Per / IV / 2010 regarding: drinking water quality requirements, the chlorine residue <0.7 ppm[3]. While on the 7th day (seven) to 10 (ten) the remaining chlor in well water does not qualify anymore. Physically the well water is odorless and tasteless. Based on laboratory test in this research indicates that chlorine residue in well water 0.17 ppm able to eliminate coliform, while the rest of chlorine 0.35 ppm have caused peculiar smell of chlorine and aesthetically should be avoided. The chlorine residue found in water indicates the loss of pathogenic bacteria such as coliform, E coli[4].
   The process of defusion that occurs is the solution / concentration of chlorine will pass through a sand filter, then through the hole that has been designed (Ø 2 mm), before spreading into the well water. The sand filter on a type A chlorine injection appliance is used to restrict the rapid spread of chlorine solution / concentration. The design of the sand density and the number and diameter of the holes in this tool can work well, but the concentration of chlorine inside the tool just last in 6 days.
b. Water well by treating chlorine injection type B
   The average of chlorine residue in this well water 0.212 ppm (table 2) last for 16 days with an average chlorine placement of 20.97 g (Table 2), increase 267% from type A chlorine injection. Physically the rest of chlorine in well water more than 0.30 ppm creates a bit of typical chlorine odor and this has once gotten protests from the owner of the well. However, the chlorine smell disappeared after overnight stay. While the residual concentration of chlorine less than 0.3 ppm does not cause a typical chlorine odor. From this experience it is necessary to note the chlorine purity (%), the manufacturer's product, the chlorine capturing power and the expected chlorine residue and the defuser ability from the design of the tool used.

Specification of Chlorine Injection Tool

Design A type of chlorine injection tool A and B principally is the same. That make it different is the amount of chlorine that is put in the tool. The tool specification is 50 cm length and Ø 2.5 dim, suitable for a dug

well in ± 100 cm width so that can freely to install the tool. The placement of the chlorine injection tool on the dug well is 20 cm from the bottom of the well or parallel to the foot piping section heat section of the pump.

The tool specifications listed in table 1 has gone through a series of testing processes of various changes, modifications to the above specifications. This is related to the diameter of the hole, the number of holes, the density of sand and the concentration of chlorine used. Less diameter and holes cause inhibited defusion process. On the other hand, excessive amount will result in the excessive chlorine residue of the well water and odors. The density of sand in chlorine injection is useful to inhibit the rapid spread of the solution / concentration of chlorine. If it is too dense, there will be a delay in spreading chlorine in well water, the chlorine residual concentration is too low. Meanwhile, the less sand density will impact in the chlorine dispersal which is too quick and the chlor concentration in the well water may be over the requirement. In addition, well water smells chlorine.

Sand to be inserted in the tool must be disinfected first so that when being put into well water no more reduces the required chlorine concentration. It is important to do so that the calculation of chlorine requirement can produce the rest of chlor well.

Based on observations after the chlorine injection tool is removed from the well, physically, it can be seen that there is yellowish white chlorine attached in the outer side of ¼ number of pipe holes of chlorine injection type A. And so is chlorine injection type B that has more amount that are ½ number of pipe holes.

Chlorine Residue in Chlorine Injection

Based on the results of table 2, chlorine residues which removed from chlorine injection tool after being lifted from dug wells. The residue is available in a small pipe (Ø ¾ dim) removed, dried under the sun and then weighed. The specifications of chlorine residue can be explained as follows: Chlorine residue color is more turbid yellowish, not smelly, smoother than the original condition, not yet known chlor level (in%), the sand, which initially black turned to spotty black. The type A chlorine injection residual average weight is about 25% (2.76 g) from the former weight of (10.39 g) and the B type is about 30% (7.02 g) from the former weight of (20.97 g).

The design of the chlorine injection tool

The design of the chlorine injection tool in this study is the result of repetitive testing to obtain the design specification as it is now (table 1). Modifications that have designs and factors that affect each other namely:

a. The length and diameter of the PVC pipe used
b. The number and diameter of the defuser hole,
c. The level of sand density,
d. The chlorine needs corresponds to the volume of the well water
e. The resistance of the tool to produce the expected residual chlor.

The five factors are mutually influence and interrelated to produce well water based on Regulation of the Minister of Health No. 492 / Menkes / Per / IV / 2010 regarding: drinking water quality requirements[3].

CONCLUSION

Conclusion

1. Design Results of chlorine injection tool with 2 dim PVC, 50 cm long pipe dimension, equipped with silica sand, PVC Ø ¾, lid, inside out deep drat, chlorine disinfectant and tool weight 3.6 kg
2. Type A chlorine injection tool is able of disinfect well water for 6 days with chlorine 10.39 gr and residual Chlore of 0.214 ppm whereas chlorine injection type B is able of disinfect for 16 days using chlorine 20.97 gr and the rest of chlorine well 0.212 ppm with a capacity of 1000 l will produce dug wells water that are odorless, tasteless and free of coliform bacteria.

Suggestion

1. It is necessary to further investigation about the use of this chlorine injection tool for the water well capacity of more than 1000 l in the rainy season with different chlorine variation, levels of endurance and pollution levels.
2. It should be further investigated the use of pills disinfectant to obtain effective and durable chlorine residue.
3. It is necessary to further investigation about the use of different level of active chlorine (%) for the application of dug well water that is various in volume.

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