Research Article

Design of Clean Water Piping in Cibeureum, Cimahi, West Java

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Abstract: Piping planning needs to be done to simplify the water distribution process. Starting from the inlet to the oulet. The piping design process is carried out according to field conditions. The implementation is carried out in areas in the area of KP2A (Water User and User Groups), RW 14, Cibeurum Village, South Cimahi. The existing condition is that there are 2 water source pipes (1.8 liters / second) from artesian directly to Toren without any filtering process, there is a water reservoir measuring 1.6m x 2m x 2.2m x 3 tubs. This water capacity to distribute 180 families. The planning of the piping starts from the pipe coming out of the water source, entering the toren, until the backwash dirty water disposal pipe is discharged out, as well as adjusting to the dimensions of the existing water tank. The existing water tanks remain and are not damaged. Some of the important components needed in this installation include 4 toren, PVC pipe, watermur, valve, reducer, elbow, all of which are located around the site. The piping installation on 4 toren with the same water source is the installation mechanism of the toren inlet pipe, toren backwash oulet pipe and toren backwash inlet pipe, so that when the backwash process occurs, replacement of filter media, and repair of toren, it will not affect the another toren.The advantage of this piping design is that the cleaning process on one toren can be done without disturbing the other toren. Also during the cleaning / maintenance process on one toren it can be done without disturbing the other toren.

Keywords: PVC piping, valve, watermur, reduser

1. Introduction

Water is a very important element in human life, but along with technological developments and the increasing human population it affects the availability and quality of clean water that humans need. So that various efforts have been made to get clean water, one of which is by utilizing ground water by drilling and sucking it using a pump.

However, the water obtained still does not have good water quality (raw water) as required by health standards, as stated in 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 Needs, Swimming Pools, Solus Per Aqua, and Public Baths. Hygiene Water Sanitation is used for personal hygiene maintenance such as bathing and toothbrushes, as well as for washing foodstuffs, grave utensils, and clothing, it can also be used for drinking water raw water.

The filtering process needs to be done to obtain raw water. There are several existing water filtering processes, but in this case the water filtering process that will be made is a simple and natural water filtering process, namely by using tools and materials that are widely available in the market, and with easy and understandable piping designs. by society.

Design of piping construction that accommodates existing conditions in the field. Several field conditions are taken into consideration:

- Availability of place dimensions.
- Ease of installation
- Ease of replacement of parts / materials
- Ease of washing filter media
- Availability of materials for field piping
- Pipe installation safety

The piping design uses standard raw materials available and easily available in the market, such as: Paralon pipe, T connection, L connection, Water nut, Toren ring nut, Sock socket, Elbow, valve, Vlock shock.

The problem of dirty water in the KP2A (Water User and Utilization Group) area, RW 14, Cibeureum Village, South Cimahi, West Java, has long been a complaint of the people of the area. The city government of Cimahi, through the Housing and Settlement Area Service (DPKP), has built an Artesis Pump well, but because the water that comes out is still dirty and unfit for use. The community through KP2A has made improvements to water quality, but the result is the water is still dirty.

Through a partnership between the Department of Mechanical Engineering, Faculty of Engineering, Widyatama University and the DPKP of Cimahi City, facilitated by KP2A, conducted discussions to solve the dirty water problem. Furthermore, the Dean of the Faculty of Engineering together with the Lecturer in the Department of Mechanical Engineering, guided by the DPKP, conducted a location survey and conducted a discussion, inputting solutions to solve dirty water.

Lecturers of the Mechanical Engineering Study Program under the direction of the Dean of the Faculty of Engineering, will carry out scientific studies, namely research to overcome dirty water with the experimental method of Factorial design and Yates's Algorithm9(Rivas et al., 2019).

It is hoped that with joint research, among others:

- DPKP Cimahi City as the budget provider,
- Widyatama University Engineering Faculty, especially the Mechanical Engineering Study Program as an Educational and Research Institute,
- Support from the user community, namely KP2A RW 14, Cibeureum Village, Cimahi Selatah, for the construction of the pipeline.

For Widyatama University, this joint research is very helpful in increasing partnership cooperation, especially in the field of Research and Community Service, with the user, in this case the Cimahi City DPKP. So it is hoped that the research results will be utilized and felt by the wider community.

2. Water

Water is a very important element in human life, but along with technological developments and the increasing human population it affects the availability and quality of clean water that humans need. So that various efforts have been made to get clean water, one of which is by utilizing ground water by drilling and sucking it using a pump.

However, the water obtained still does not have good water quality (raw water) as required by health standards, as stipulated in the Regulation of the Minister of Health of the Republic of Indonesia No.32, 2017, regarding Environmental Health Quality Standards and Water Health Requirements for Hygiene Purposes. Sanitation, Swimming Pool, Solus Per Aqua, and Public Baths. Hygiene Water Sanitation is used for personal hygiene maintenance such as bathing and toothbrushes, as well as for washing foodstuffs, grave utensils, and clothing, it can also be used for drinking water raw water.

Table 1. Physical Parameters in Environmental Health Quality Standards for Water Media for Sanitation Hygiene Purposes.

No	Required parameters	Unit	Quality standards (maximum levels)
1	Turbidity	NTU	25
2	Color	TCU	50
3	Total Dissolved Solid	mg/l	1000
4	Temperature	^{o}C	Air Temperatur ±3
5	Taste		Tasteless
6	Smell		Odorless

Source: Permenkes RI no. 32 tahun 2017

Table 2. Biological Parameters in Environmental Health Quality Standards for Water Media for Sanitation Hygiene Purposes

o	Required parameters	Unit	Quality standards (maximum levels)
	Total coliform	CFU/100 ml	50
	E. coli	CFU/100 ml	50

Source: Permenkes RI no. 32 tahun 2017

Table 3. Chemical Parameters in Environmental Health Quality Standards for Water Media for Sanitation Hygiene Purposes

No	Required parameters	Unit	Quality standards (maximum levels)
Required			
1	pH	mg/l	6,5 – 8,5
2	Iron	mg/l	1
3	Fluorida	mg/l	1,5
4	Kesadahan ($CaCO_3$)	mg/l	500
5	Mangan	mg/l	0,5
6	Nitrat, as N	mg/l	10
7	Nitrit, as N	mg/l	1
8	Sianida	mg/l	0,1
9	Deterjen	mg/l	0,05
10	Total pesticides	mg/l	0,1
Additional			
1	Mercury	mg/l	0,001
2	Arsenic	mg/l	0,05
3	Cadmium	mg/l	0,005
4	Chromium (valensi 6)	mg/l	0,05
5	Selenium	mg/l	0,01
6	Zinc	mg/l	15
7	Sulfate	mg/l	400
8	Lead	mg/l	0,05
9	Benjena	mg/l	0,01
10	Organic substances ($KMNO_4$)	mg/l	10

Source : Permenkes RI no. 32 tahun 2017

3. Design

A. Existing conditions:

– There are 3 water reservoirs (p = 220 cm, w = 160cm, h = 200 cm)

– There are 2 pipes (@ 3 in) as a source of water, where the water is directly flowed into a reservoir without purifying the water.

– Debit 1.8 liter / second.

– Project location: KP2A (Group of Water Users and Users), RW 14 Kelurahan Cibeureum, Cimahi

– 200 households of water users.

– Source of water, Artesis

– Water quality, yellow and smelly

B. Filtering

The filtering used is the experimental method with factorial design and the following results are obtained:

– The filter media variables consist of activated carbon, ferrolyte and zeolite

– The optimal composition of 100% by weight is 60% activated carbon, 50% ferrolyte, 50% Zeolite.

– From the results of the calculation of the density of the media, the composition of the weight of the media per toren is:

No	Media	composition	weightt
1	Active Carbon	60%	60 Kg
2	Ferrolyte	50%	50 kg
3	Zeolite	50%	50 kg

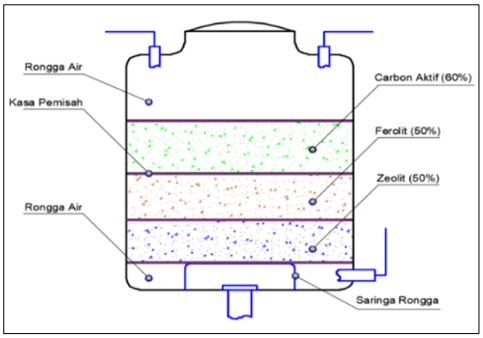

Fig-1 Fitering

C. Piping System

The applied piping system is adapted to field conditions. So that it affects the construction that will be made.

From the results of field observations, there are 2 sources of water coming out of the pipe, each pipe with a diameter of 3 ", the total discharge is 1.8 liters / second. There are 3 reservoirs with dimensions of 220 x 160 x 200 cm each.

The piping system starts from the water that comes out of the water source pipe until the water comes out of the toren, namely:

– Water distribution piping from the main pipe.
– Simultaneous piping and water filtration mechanisms (Toren 1, 2, 3 and 4)
– Piping and water filtration mechanism at water source 1 (pipe -1)
– Piping and water filtration mechanism at water source 1 (pipe -2)
– Piping and Cleaning Mechanism (back wash)

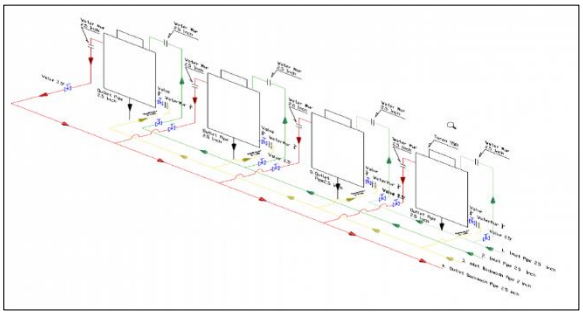

Fig-2 Piping system

1) Inlet Piping.

There are 2 inlet pipes with a diameter of 2 in, namely the inlet pipe-1 entering Toren 1 and 2, and the inlet pipe-2 m entering toren 3 and 4 (green line).

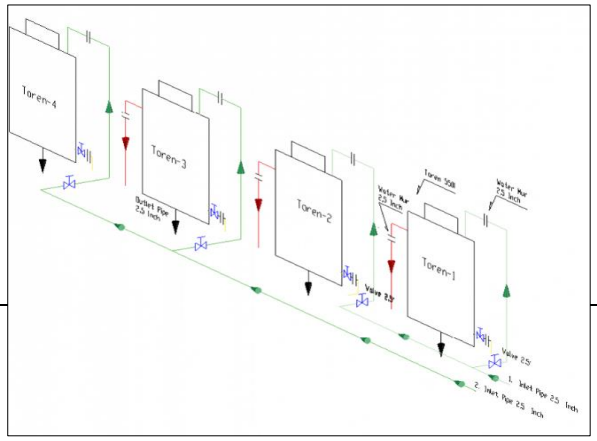

Fig-3 Inlet Piping

2) Backwash piping

Backwash mechanism piping design, through 2 in pipe, which is divided into 4 toren (yellow line). Clean water is pushed by the pump into the lower toren. Dirty water from backwash comes out through the upper pipe (red color).

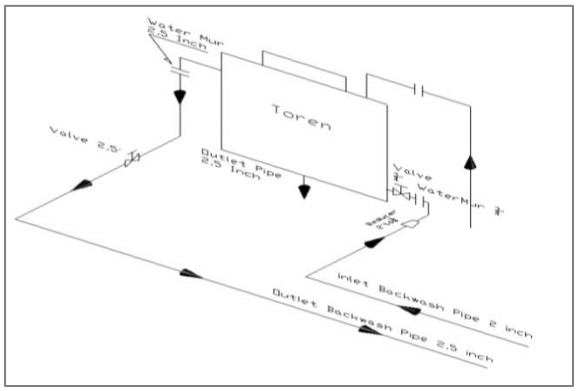

Fig-4 Backwash Piping.

3) Filtering mechanism, Inlet pipe (1)

Dirty water from the water source enters Toren-1and Toten-2 through the inlet pipe (1).

The position of the inlet pipe valve (Vi-1 and Vi-2) and the oulet pipe (Vo-1 and Vo-2) is open. Meanwhile, the other pipes are closed (Vob-1, Vob-2, Vib-1, Vib-2) closed.

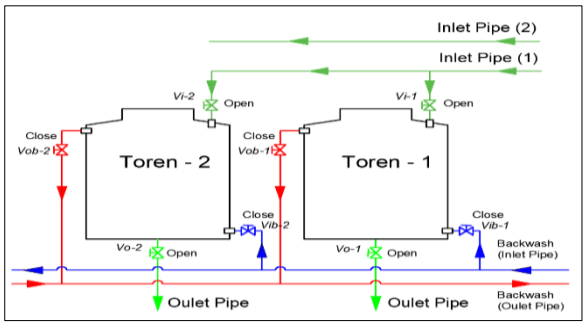

Fig-5 Filtering mechanism, Inlet pipe (1)

4) Filtering mechanism, Inlet pipe (2)

Dirty water from the water source enters Toren-3 and Toten-4 through the inlet pipe (2).

The position of the inlet pipe valve (Vi-3 and Vi-4) and the oulet pipe (Vo-3 and Vo-4) is open. Meanwhile, the other pipes are closed (Vob-31, Vob-4, Vib-3, Vib-4) closed.

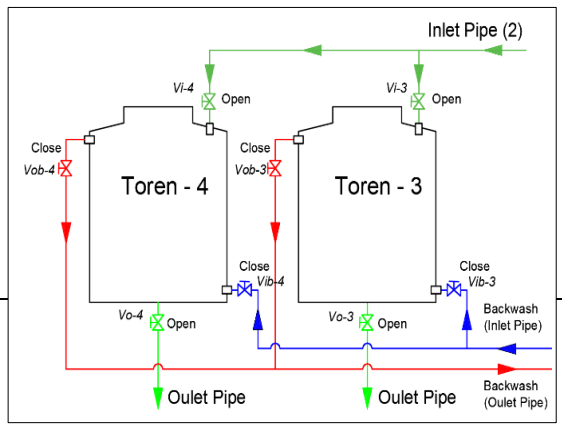

Fig-6 Filtering mechanism, Inlet pipe (2)

5) Media cleaning mechanism (Back wash)

Clean water is pushed by the pump through the backwash inlet pipe, into each toren (valve Vib-1, Vib-2, Vib-3, and Vib-4).

To clean one of the toren, open one of the backwash inlet valves. (eg Vib-3), from a water source, enters Toren-3 and Toten-4 via the inlet pipe (2). Then open the backwash oulet valve (eg Vob-3). Close all other valves (Vi-3 and Vo-3*)*

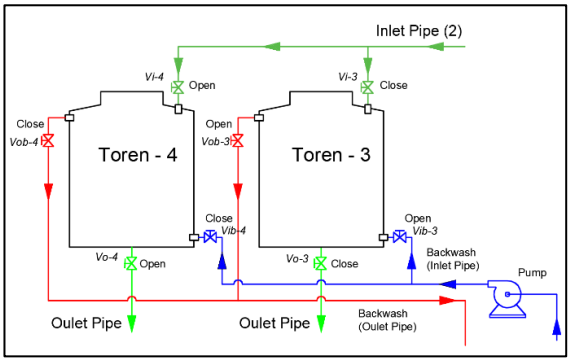

Fig-7 Cleaning Mechanism (Toren-3)

4. Result and evaluation

Table-4 Design results

No	Material	Spesification	Note
1	Toren Plastik	550 liter	Toren 1,2,3,4
1	Pipe PCV	∅ 2,5 inch	Pipe line
2	Pipe PVC	∅ 2 inch	Pipe line
3	Pipe PVC	∅ 3/4 inch	Pipe line
4	Valve (PVC)	∅ 2,5 inch	*Vi-1,2,3,4; Vo-1,2,3,4*
5	Valve (PVC)	∅ 2 inch	*Vob-1,2 3,4*
6	Valve (PVC)	∅ 3/4 inch	*Vib-1,2,3,4*
7	Water Mur (PVC)	∅ 2,5 inch	
8	Water Mur (PVC)	∅ 2 inch	
9	Water Mur (PVC)	∅ 3/4 inch	
10	Elbow PVC	∅ 2,5 inch	
11	Elbow PVC	∅ 2 inch	

12	Elbow PVC	∅ 3/4 inch	
13	Reducer PVC	∅ 2 to 3/4 inch	
14	Socket Drat	∅ 2 inch	

The piping design is designed when cleaning (backwash) on one toren, it will not affect the water filtering process on another toren. Likewise, when there is damage or repair to one toren, the other toren still functions.

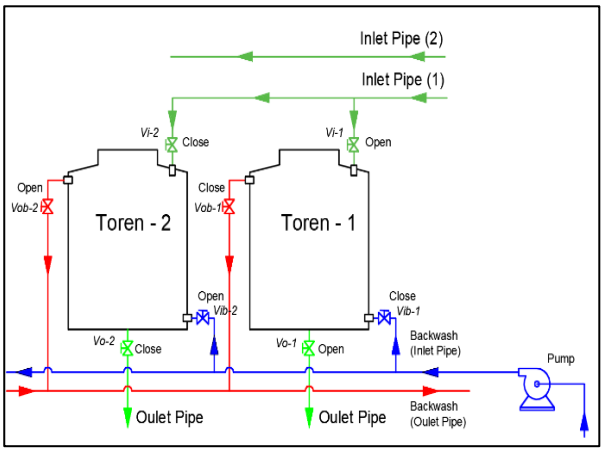

Fig-8 Backwash Mechanism (Toren-2)

When going to backwash the Toren-2, the Vib-2 and Vob-2 valves are open, while the Vi-2 and Vo-2 valves are closed. The pressurized water from the pump flows and enters the Vib-2 valve, and there is pressure from below the toren, so that the dirt will rise and enter the Vob-2 valve.

The following is a table of valve positions during the backwash process.

Table-5 Position of the Backwash Process Valve.

Line Pipe	Valve*	Toren-1	Toren-2	Toren-3	Toren-4
Inlet Pipe	Vi-1	Close	Open	Open	Open
	Vi-2	Open	Close	Open	Open
	Vi-3	Open	Open	Close	Open
	Vi-4	Open	Open	Open	Close
Outlet Pipe	Vo-1	Close	Open	Open	Open
	Vo-2	Open	Close	Open	Open
	Vo-3	Open	Open	Close	Open
	Vo-4	Open	Open	Open	Close
Inlet Back wash	Vib-1	Open	Open	Open	Open
	Vib-2	Close	Close	Open	Open
	Vib-3	Close	Open	Close	Open
	Vib-4	Close	Open	Open	Close
Outlet Back wash	Vob-1	Open	Open	Open	Open
	Vob-2	Close	Close	Open	Open
	Vob-3	Close	Open	Close	Open
	Vob-4	Close	Open	Open	Close

Note : *)

Vi : Valve Inlet pipe (Toren 1, 2, 3, 4)

Vo : Valve Outlet pipe (Toren 1,2,3, 4)

Vib : Valve Inlet pipe backwash (Toren 1, 2, 3, 4)

Vob : Valve Oulet pipe backwash (Toren 1, 2, 3, 4)

Other processes backwash, piping design is designed, when there is damage or replacement of one toren, it will not affect the filtering process of the other toren. This is because the piping installation of each toren has been equipped with a flange (water nut).

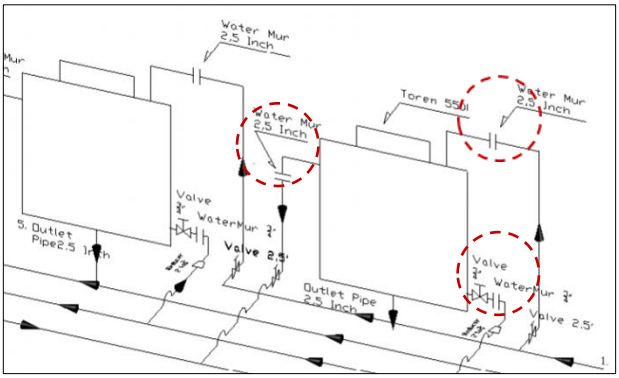

Fig. -9 Position of water nut / flange.

Piping installation process

Fig 10. Piping installation process

Fig 11. Position of water nut (Flange)

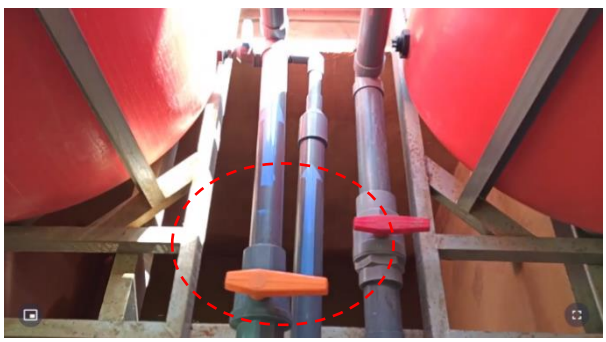

Fig 12. Position of valve

5. Conclusion

The piping installation on 4 toren with the same water source is the installation mechanism for the watermur of the inlet toren pipe, toren backwash oulet pipe and toren backwash inlet pipe, so that when there is a backwash process, replacement of filter media, and repair of toren, it will not affect the another toren. Each toren can work independently without interfering with the filtering process of other toren.

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