CHAPTER II

LITERATURE REVIEW

Water is renewable resources (Kodoatie, 2002). Based on its location water was classified into surface water and ground water (UU No. 7 about Water Resources, 2004). Many benefits are given by water i.e. cooking, washing, bathing, industrial, farming, and transportation. Water should meet some requirements to be used for a particular purpose i.e. drinking water and fresh water. The requirements of drinking water quality are shown in Table 2.1; this type of water can be drunk directly. While Table 2.2 shows the requirements of fresh water quality. This type of water should be boiled first (Regulation of Health Minister No. 416/MEN.KES/ PER/IX/1990 about Requirements and Monitoring of Water Quality).

Table 2.1 Drinking Water Requirement

No.	Parameter	Unit	Max. Allowable content	Note
A. Physical				
1	Odor	-	-	odorless
2	Dissolved content	Mg/L	1000	-
3	Turbidity	NTU unit	5	-
4	Taste	-	-	tasteless
5	Temperature	0^oC	$\pm 3^oC$	-
6	Color	TCU unit	15	-
B. Chemical				
Inorganic chemical				
1	Mercury	mg/L	0.001	
2	Aluminum	mg/L	0.2	
3	Arsan	mg/L	0.05	

(Source: Regulation of Health Minister No. 416/MEN.KES/ PER/IX/1990 about Requirements and Monitoring of Water Quality)

Table 2.1 Drinking Water Requirement (Cont')

No.	Parameter	Unit	Max. Allowable content	Note
4	Bakium	mg/L	1	
5	Iron	mg/L	0.3	
6	Fluoride	mg/L	1.5	
7	Cadmium	mg/L	0.005	
8	$Caco_3$	mg/L	500	
9	Chloride	mg/L	250	
10	Chromium, valence 6	mg/L	0.05	
11	Manganese	mg/L	0.1	
12	Natrium	mg/L	200	
13	Nitrate, as n	mg/L	100	
14	Nitrite, as n	mg/L	1	
15	Silver	mg/L	0.05	
16	Selenium	mg/L	0.01	
17	Zinc	mg/L	5	
18	Cyanide	mg/L	0.1	
19	Sulfate	mg/L	400	
20	Sulfide (as h_2s)	mg/L	0.05	
21	Copper	mg/L	1	
22	Metal	mg/L	0.05	
Organic chemical				
1	Aldrin and dieldrin	mg/L	0.0007	
2	Benzene	mg/L	0.01	
3	Benzo (a) pyrene	mg/L	0.00001	
4	Chloroform (total isomer)	mg/L	0.0003	
5	Chloroform	mg/L	0.03	
6	2.4-D	mg/L	0.1	
7	DDT	mg/L	0.03	
8	Detergent	mg/L	0.05	
9	1.2-dichloroethene	mg/L	0.01	
10	1.1-dicloroethene	mg/L	0.0003	
11	Heptachlor and heptachlor epoxide	mg/L	0.003	
12	Hexacholobenzene	mg/L	0.00001	
13	Gamma-hch (lindane)	mg/L	0.004	
14	Methoxychlor	mg/L	0.03	

(Source: Regulation of Health Minister No. 416/MEN.KES/ PER/IX/1990 about Requirements and Monitoring of Water Quality)

Table 2.1 Drinking Water Requirement (Cont')

No.	Parameter	Unit	Max. Allowable content	Note
15	Pentachlorophenol	mg/L	0.01	
16	Pesticide total	mg/L	0.1	
17	2.4.6-trichloropenol	mg/L	0.01	
18	$KmnO_4$	mg/L	10	
Microbiology				
1	Koliform feces	per 100 ml	0	
2	Total coliform	per 100 ml	0	95% of checked sample. Sometimes can be 3 per 100 ml water sample, but not in a row
Radio active				
1	Gross alpha activity	Bg/L	0.1	
2	Gross beta activity	Bg/L	1	

(Source: Regulation of Health Minister No. 416/MEN.KES/ PER/IX/1990 about Requirements and Monitoring of Water Quality)

Note:
mg = milligram
ml = milliliter
L = Liter
Bg = Beguerel

NTU = Nepnelometrik Turbidity Units
TCU = True Color Units
Heavy metal is dissolved metal

Table 2.2 Fresh Water Requirement

No.	Parameter	Unit	Max. Allowable content	Note
A. Physical				
1	Odor	-	-	odorless
2	Dissolved content	Mg/L	1000	-
3	Turbidity	NTU unit	5	-
4	Taste	-	-	tasteless
5	Temperature	0^oC	$\pm 3^oC$	-
6	Color	TCU unit	15	-

(Source: Regulation of Health Minister No. 416/MEN.KES/ PER/IX/1990 about Requirements and Monitoring of Water Quality)

Table 2.2 Fresh Water Requirement (Cont')

No.	Parameter	Unit	Max. Allowable content	Note
B. Chemical				
Inorganic chemical				
1	Mercury	mg/L	0.001	
2	Arsan	mg/L	0.05	
3	Iron	mg/L	1	
4	Fluoride	mg/L	1.5	
5	Cadmium	mg/L	0.005	
6	$CaCO_3$	mg/L	500	
7	Chloride	mg/L	600	
8	Chromium, valence 6	mg/L	0.05	
9	Manganese	mg/L	0.5	
10	Nitrate, as n	mg/L	10	
11	Nitrite, as n	mg/L	1	
12	pH	mg/L	0.05	
13	Selenium	mg/L	0.01	
14	Zinc	mg/L	15	
15	Cyanide	mg/L	0.1	
16	Sulfate	mg/L	400	
17	Metal	mg/L	0.05	
Organic chemical				
1	Aldrin and dieldrin	mg/L	0.0007	
2	Benzene	mg/L	0.01	
3	Benzo (a) pyrene	mg/L	0.00001	
4	Chloroform (total isomer)	mg/L	0.0007	
5	Chloroform	mg/L	0.03	
6	2.4-D	mg/L	0.1	
7	DDT	mg/L	0.03	
8	Detergent	mg/L	0.5	
9	1.2-dichloroethene	mg/L	0.01	
10	1.1-dicloroethene	mg/L	0.0003	
11	Heptachlor and heptachlor epoxide	mg/L	0.003	
12	Hexacholobenzene	mg/L	0.00001	
13	Gamma-hch (lindane)	mg/L	0.004	
14	Methoxychlor	mg/L	0.10	
15	Pentachlorophenol	mg/L	0.01	

(Source: Regulation of Health Minister No. 416/MEN.KES/ PER/IX/1990 about Requirements and Monitoring of Water Quality)

Table 2.2 Fresh Water Requirement (Cont')

No.	Parameter	Unit	Max. Allowable content	Note
16	Pesticide total	mg/L	0.1	
17	2.4.6-trichloropenol	mg/L	0.01	
18	$KmnO_4$	mg/L	10	
Microbiology				
1	Coliform feces	per 100 ml	0	Not pipe water
2	Total coliform	per 100 ml	0	Not pipe water
Radio active				
1	Gross alpha activity	Bg/L	0.1	
2	Gross beta activity	Bg/L	1	

(Source: Regulation of Health Minister No. 416/MEN.KES/ PER/IX/1990 about Requirements and Monitoring of Water Quality)

Note:

mg = milligram
ml = milliliter
L = Liter
Bg = Beguerel
NTU = Nepnelometrik Turbidity Units
TCU = True Color Units
Heavy metal is dissolved metal

Not all types of water can be classified either as drinking water or fresh water. In other word, one or more ways are needed to treat such particular water so that it will meet the requirement of drinking water or fresh water. This effort is conducted to serve water to customers.

In the effort of supplying water, there are several components that integrated in a system, called water supply system. A water supply system should consist of source, transmission, treatment, storage, distribution, and service area.

The concept about water supply system was described by some experts. Linsley (1992) describes that water – supply system included (1) source(s) of supply, (2) storage facilities, (3) transmission (to treatment) facilities, (4) treatment facilities, (5) transmission (from treatment) and intermediate storage

facilities, and (6) distribution facilities. Other description comes from Kodoatie (2003) where a water – supply system included (1) exploration of water resources, (2) treatment (purification, water bacteria control, water chemical composition), (3) storage, and (4)transmission (pipeline, water tank truck, and other modes), (5) distribution (pipe network system, patch system, fittings, control, valve, and pump). Furthermore, Regulation of Public Work Minister No. 18/PRT/M/2007 about Implementation of Water Supply System Development determined 4 (four) units for a water supply system as follows:

1) Water sources

   Water sources is a withdrawal and / or raw water – supply infrastructure, including intake structure water storage structure, , measuring and observation tool, pump system and or carrier infrastructure structure and its equipment.

2) Production unit

   Production unit is an infrastructure which can be used for treating raw water to become drinking water through physical, chemical and biological process, including treatment structure and its equipment's, operational equipment's, measuring and observation tools, and storage structure for drinking water.

3) Distribution unit

   Distribution unit is an infrastructure for flowing drinking water from the end point of drinking water transmission pipe until service unit.

4) Service unit.

Service unit is an infrastructure that allowing the citizen to taking drinking water from it directly, which consist of house connection, public hydrant and fire hydrant.

The above description refers to drinking water supply system. While, there are four main components of fresh water supply system as follows (http://elearning.gunadarma.ac.id/docmodul/rekayasa_lingkungan/bab2_sistem_ penye - dian_ air_bersih.pdf):

1) Raw water unit (water sources)

Table 2.3 shows the types of water sources and explanation of 5 aspects in water supply system.

Table 2.3 Explanation of five aspects of water supply system in term of water source types

No.	Source	Quality	Quantity	Continuity	Accessibility	Affordability / Price
1.	Rain water	Little bit polluted	Does not enough for public supply	Cannot be taken continuously	Can be taken at any places when rain is come	Cheap
2.	Surface water	Polluted	Sufficient	Can be taken continuously	The farthest surface water is the more difficult to access	Expensive relatively
3.	Shallow ground water	Polluted	Enough relatively	Limited because of sea water intrusion	The deepest ground water is the more difficult to access	Cheap relatively
	Deep ground water	Well relatively				Expensive relatively
4.	Spring	Well relatively	Little	Cannot be taken continuously	The farthest spring is the more difficult to access	Cheap

2) Intake

This unit is divided into two sub unit are as follows:

a. Intake

Intake is a withdrawal structure for capturing the raw water. Capacity of intake depends on the raw water discharge that will be treated.

There are five types of intake according to water withdrawal location; those are river intake, canal intake, direct intake, reservoir intake and spring intake.

b. Transmission

Transmission system is a pipe system from intake structure to the treatment structure. The equipments which exist in transmission pipe system are as follows:

- Wash out

  This equipment is used for cleaning transmission pipe from sediment inside that pipe.

- Air valve

  This equipment is used for decreasing pressure inside the pipe so that the pipe will not breakdown.

- Blow off
- Gate valve

  This equipment is used for controlling water discharge.

- Pump

3) Treatment

Water treatment process is depending on its water source quality. The better the quality of water source the simpler water treatment process and the poorer the quality of water source the more complex the water treatment. There are two types of fresh water treatment as follows:

a. Surface water treatment

The structures needed in this kind of treatment are as follows:

- Intake

  This equipment is use for tapping the water from water source.

- Structure for pre-sedimentation

  This structure functions as a place for settling discreet particle like sand, clay and other solid substance which can be settled gravitationally.

- Structure for rapid mixing

  This structure functions as a place for mixing coagulant with raw water.

- Structure for slow mixing

  This structure functions as a place for formalizing flock. This process calls flocculation.

- Structure for sedimentation

  This structure functions as a place for settling flock.

- Structure for filtration

  This structure functions as a place for filtering the unsettled dirt and as a filter for filtering microorganism.

- Unit of chemical substance

This structure functions as a place for dissolving chemical substance to treatment structure.

- Reservoir

  This structure functions as a place for water temporary storage, before the water was distributed.

b. Ground water treatment

- Aerobic ground water

  The quality of aerobic water usually fulfills the requirement, but a little bit acid. Then, treatment for increasing pH level to be neutral (7) is needed.

- Anaerobic ground water

  Usually anaerobic groundwater contains Fe, manganese ammonia and H_2S. The appropriate treatment for this kind of water is aeration. The purpose of this treatment is for binding getting O_2 into the water, removing H_2S and CH_4, and reducing CO_2 concentration.

4) Distribution

There are two types of distribution systems, those are:

a. Gravitational flow

This type is used whenever water pressure is enough to reach the most remote point of service area.

b. Pumping flow

This type is used whenever water pressure is not enough to reach the most remote point of service area. Needed equipments in fresh water distribution are as follows:

- Reservoir

  The function of reservoir is for collecting or storing fresh water which has been treated before. The other function of this equipment is for giving pressure to the water. Two types of reservoirs are as follows:

  - Ground reservoir

    This structure is for storing water under the ground.

  - Elevated reservoir

    This structure is for storing water on the ground with certain elevation, so that water pressure is enough for reaching the most remote point of service area.

- Pipe type

  In water distribution system, there are two types of pipe material. Those are PVC and galvanic pipes. Usually PVC pipe is used as branching pipe. While galvanic pipe is used as distribution pipe which directly reaches the customers

- Valve

  Valve is used controlling water flow inside the pipe and stopping the water if there is any damage.

- Water meter

  Water meter is used for measuring amount of water flow.

- Flow restrictor

  This equipment is used for limiting amount of water either for household or public hydrant, so that the distribution can be spread equally.

- Pipe accessories

  Pipe accessories that functioned as pipe connector in water distribution system are as follows:

  - Socket
  - Flense
  - Water mull and nipple
  - Gibault connector
  - Dope and plug
  - Bend
  - Tee

Water supply system should not only serve a good quality of water, but also should keep the stability of water quantity, should keep water continuity, facilitate affordability of water price and service accessibility.

A number of complaints about PDAM performance are comes from almost all customers even the head of its administrative area (Regent of Kupang District). The regent felt blush at the complaint of customers, which just “pay for the wind.”

(http://sindikasi.inilah.com/read/detail/1792758/bupati-kupang-malu-dengan-konsumen-pdam).

With the waterloss ratio of 49, 58%, PDAM Kabupaten Kupang is far from the referred standard of 20 %. (Rumiyanto, 2009, http://kupang.tribunnews.com/read/artikel/56716)

Customers in some villages are complaint about the service of PDAM Kabupaten Kupang, because the water is no longer flows on schedule. In order to fulfill the daily needs, customers should bought water from some private sellers. The customers consider this is unfair for them. They have to pay regularly on time, but PDAM does not provide consistent service in term of water distribution or water supply. (http://kupangkota.go.id/webkota/ content/view /710/66/)