MSWT-01 (MOBILE SURFACE WATER TREATMENT) PROTOTYPE, AN ALTERNATIVE FOR DISASTER MITIGATION

Gamawan Ananto[1], Albertus B.Setiawan[1], Darman MZ[1]
[1] Manufacture Engineering Dept, Bandung State Polytechnic for Manufacturing,
Jl. Kanayakan 21 Bandung 40135, INDONESIA
Email: gamawan@polman-bandung.ac.id

Abstrak

Clean water lacking is a problem that occurred in places where flood disaster happened frequently. Some solutions that already initiated to provide clean water might be not that efficient due to disaster location infrastructure and other constraints. Developing mobile water treatment could be an alternative favor. The equipment is designed for raw water source in flood area, basically made for 1m^3 per hour or 100-150 man requirements. This water treatment design adopted from existing technologies and related literatures. Though using common processes, the important thing is how to make such modular process put in compact design elegantly and will be equipped with mobile feature and electric generator due to make easier in operational and moving the unit to reach disaster sub locations where it's needed. Through prototype level experiment trials, the machine is proved to produce clean water that suitable for sanitation and cooking/drinking purposes although using contaminated water input source. Since the technologies are possibly not special, the important thing is then how to combine such methods, implementing for people needs, and developing network with disaster mitigation management stake holder for wider arrangement. The machine could be also treated as an investment that will be used from time to time when needed.

Keywords*: water treatment, raw water source, capacity.*

Introduction

For particular places in Indonesia flood disaster happened frequently and caused problem in clean water lacking due to its sources contaminating. Since water is such human basic needs, water procuring and managing became a very vital issue. All parties, people and Government, always look for all possible solution from time to time in many ways to provide such clean water, especially for places that had potential flood disaster in rainy season. In locations where no water source, clean water are supplied from other place using trucks for transportation and distribution, whereas in other areas that have improper water source condition people are treating their water sporadically in very small capacity level, or arranging some company CSR by social foundations to collect branded standard water machines. It could be considered to ask how efficient these actions are, due to some factors. Using big trucks may constrained by disaster location infrastructure. Provide imported equipments that available in the market, although are capable to produce better quality output or guaranteed result but has the costly consequence with very specific or limited implementation, and usually initiated by project based approach.

Clean water and drinking water quality standard is defined, such as in SNI 01-3553-2006 Badan Standardisasi Nasional as a reference in treating surface and ground water. In some cases there are still obstacles to reach such quality standard either caused by high turbidity or iron/ manganese contamination, or organic/ ammonium/ undissolved compound content. Unfortunately that in some conditions people are pushed in using their water for sanitation only, whereas for cooking and drinking are unsolved.

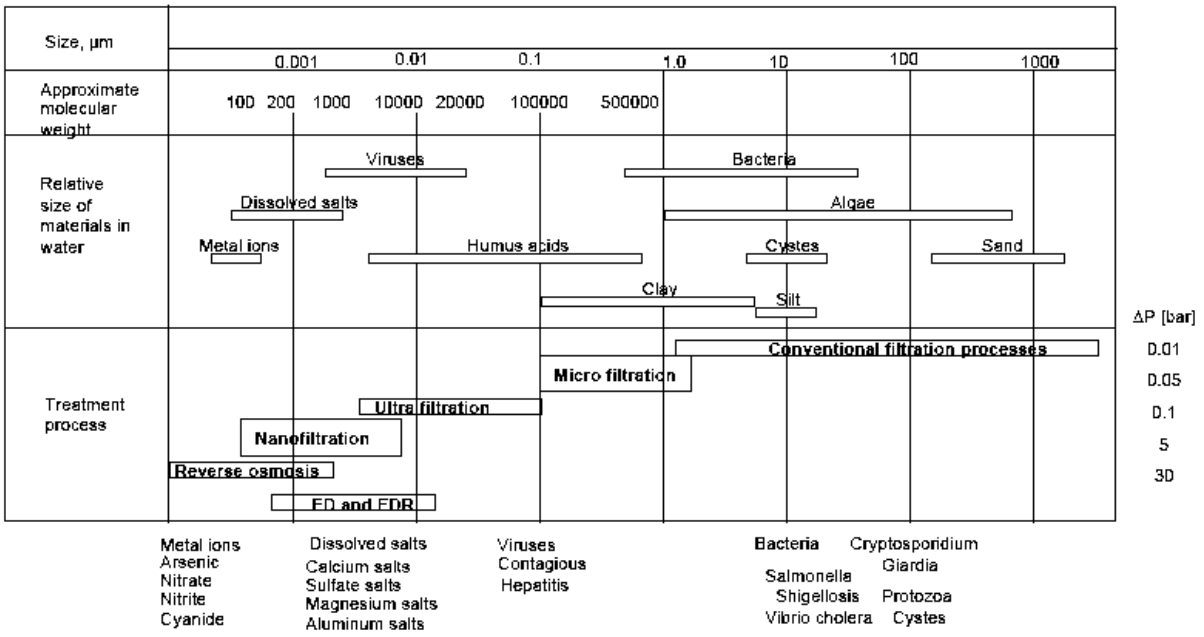
Above mentioned problems are inspiring to develop water treatment that could be an alternative favor. It innovates a prototype water treatment system that might use available raw water such as river or flood water at disaster location, in order to provide clean water demand easier for the people. Following factors should be considered in such idea development:

a). Technology that will be choosed
b). System capacity (in m^3 per hour) that possible to produce
c). Mobile mechanism system in order to make easy for moveable in operation
d). Energy (electric) source for the system

Methodology

Treating water as people do for their need could implement common technologies, whether in simple method or high technology. Source water with low turbidity level for instance, might use rapid sand filtration or slow sand

filtration, the easy and simple methods that do not need any high skill**.** Other ways that more sophisticated are possible to handle more complicated water source input. A few water treatment technologies in **Figure-1** (*Heijman S.G.J, CT4471, Nanofiltration and Reverse Osmosis, 2007, p2*) shows that conventional filtration process may handle undissolved compound content up to around 1µm dimension, whereas the most extreme such as seawater or brackish with salts content has to use RO (reverse osmosis) membran.



(*Heijman S.G.J, CT4471, Nanofiltration and Reverse Osmosis, 2007*)

Fig.1: Water treatment process technology level

The study to develop water treatment (WT) equipment refers to previous researches, which technology level will be used. It has to be designed for river or surface raw water source in flood area, and basically made for limited community, it is $1m^3$ per hour or 18-20 m^3 per day capacity, which is equal with approximately 100-150 man requirements. This number is considered for temporarily operation, it then has to be made easier in operation due to limited weight and easily move the unit to different places. Therefore this water treatment design is adopted from several existing technologies, related literatures and combined with necessary modification, considering as well with appropriated with local parts availability due to maintenance aspect. Above mentioned 'water treatment process technology level' and exploring/ searching information resulted that the basic processes in treating water generally seem still in common ways: coagulation, flocculation, filtration and disinfection. The technologies are possibly not special, thus the important thing is how to combine such methods and implement for people needs, and make such modular process put in compact design elegantly.

One of WT technologies that could be adopted is WWT (well water treatment) and RWT (river water treatment) machine that manufactured by IWET a.s, Czech Republic. IWET produced the minimal capacity of WWT for $1m^3$ per hour (WWT-01) whereas RWT for $5m^3$ per hour (RWT-05). This RWT-05 is designed for surface water source such as river or lake, and could be adopted for flood water with some necessary improvement. The disadvantage is that physically it has big dimension (L-W-H of 2x3x1.8 in meter) that might give rise to obstacle in mobile operation due to its total weight and infrastructure access width. In the other hand, the WWT-01 has appropriated dimension (1x2x1.8 in meter) but its capability is only for well water sources. Combining the mechanical and electrical parameters of RWT-05 and WWT-01 could be a good reference for developing "new sub varian' called MSWT-01 (Mobile Surface Water Treatment) prototype for disaster mitigation.

The following pictures show the block diagram of WWT-01 (**Figure-2)** and RWT-05 (**Figure-3**). From such figures the following components in both IWET products could be explained:

a). Hydrocylone : removal of most solid suspended substances with part size larger than 0,2 mm.
b). Static Mixer : intended for spontanious mixing different chemical solutions.
c). Retention Tanks : precipitate iron and manganese through oxidation reaction.
d). Sand Filter/ Active Carbon Filter Chamber : ensures water filtration from undissolved substances.
e). Dosing Pump : dose chemical solution with automatic dosage measure.
f). Sieve Filter, Automatic Self Cleaning: eliminates all undissolved substances > 100µ
g). Turbo Mixer : for effective mixing and homogenization of dosed flocculants with crude water.
h). Flocculations Chamber : for optimum drain of cores created during coagulation and condensation

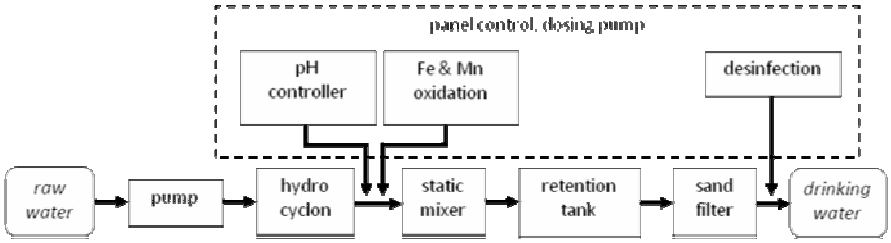


Fig. 2: WWT-01 Block Diagram

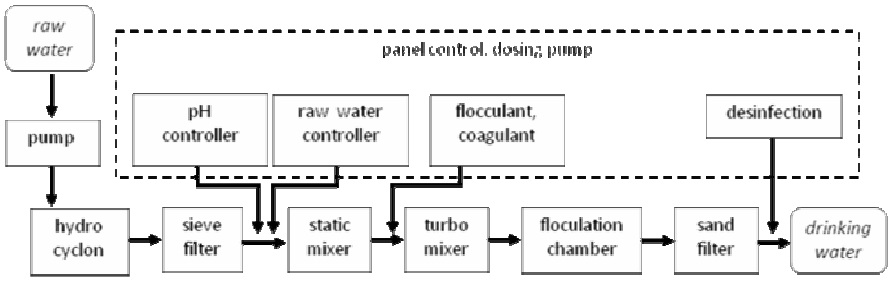


Fig. 3: RWT-05 Block Diagram

The differences between these two kind of machines are that WWT-01 uses retention tank for oxidation reaction, whereas RWT-05 equipped with sieve filter due to potential raw water higher turbidity, turbo mixer and flocculation chamber that needed for flocculation and coagulation process that not necessary in WWT. These components are used for processing surface water source since it might has moiré than 10,0 NTU (Nephelometric Turbidity Units) of maximum 5 NTU that recommended by quality standard for clean water.

Discussion

Due to the similarity, the RWT basic/ general system & components could be easily adopted into WWT (hydro cyclone, dosing pump, static mixer and sand/ carbon filter). The striking differences are flocculation chamber, sieve filter and turbo mixer in RWT that can't be found in WWT. The study is just simplified its system that flocculation chamber and turbo mixer, which are relatively expensive, won't be used in MSWT-01, as a part of cost reduction aim.

The study still has to prove experimentally that the only necessary additional component could be sieve filter, although, since its unavailability in local market, other type of screen filter will be used, without automatic self cleaning capability. Regarding the replacement of turbo mixer and flocculation chamber, implementing the sedimentation tank could be considered in order to make the sand filter performance longer, as shown in **Figure-4**.

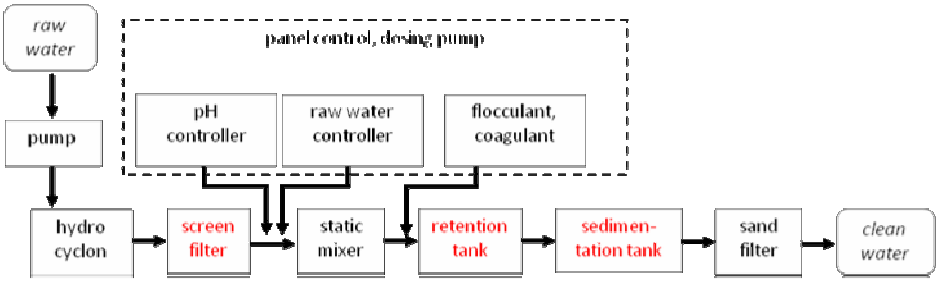


Fig. 4: MSWT-01 for Disaster Mitigation Block Diagram

Figure-5 shows all components for MSWT-01. Considering the poor quality of input raw water at flood disaster location, implementing the disinfection process is more elegant, although the output clean water as default will not be used for drinking purpose. UV lamp is shown on Figures-04, but as described, other alternatives for disinfection system could be choosed such as Ultra Filtration, adding NaClO etc.

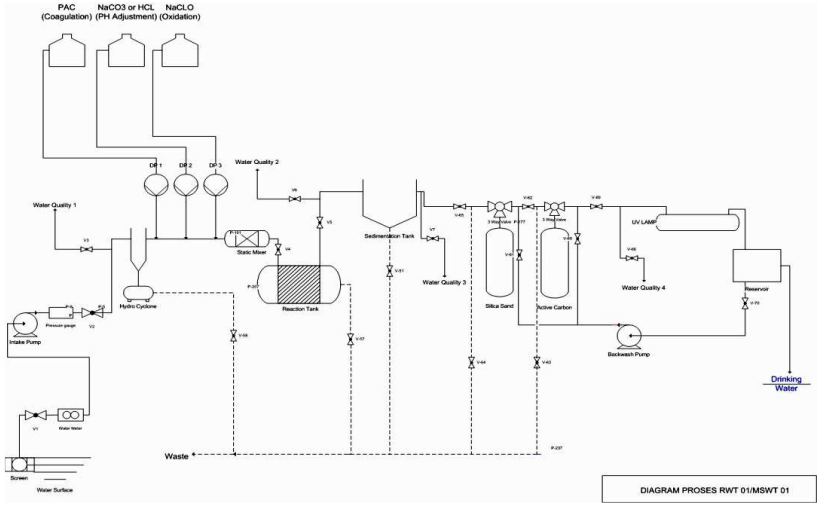


Fig. 5: MSWT-01 Components with UV lamp disinfection system

The MSWT-01 trial from 4 raw water samples mentioned that the samples from several places had different condition or content, and might be in extreme differences. **Table-01** shows several essential parameters only of not so terrible samples. The experiment should be done for more samples that have extreme turbidity for instance, in order to attempt with the real condition in flood area.

Table-1: Sample results from 4 different places

Parameter	Unit	Std. max spec.	Sample-1		Sample-2		Sample-3		Sample-4	
			Source	Result	Source	Result	Source	Result	Source	Result
Color	TCU	15	< 5	0.5	< 5	0.65	6.9	2	14.6	6
Turbidity	NTU	5	0.28	0.2	3.17	0.35	37	1.2	57.7	2
Fe content	mg/L	0.3	< 0.1	0.1	0.69	0.23	0.15	0.1	0.49	0.2
Mn content	mg/L	0.4	< 0.03	0.03	0.02	0.02	< 0.01	0.01	0.65	0.3
Hardness)*	mg/L	500	64	60	32	32	46.5	45	114	111.7

)* $CaCO_3$ content

In necessary condition, a location that has flood water source with a high turbidity for instance, sedimentation tank could be added to the system. For such case, this sedimentation tank just mounted easily to the main unit as mentioned in **Figure-6**, thus the unit is designed for replacable.

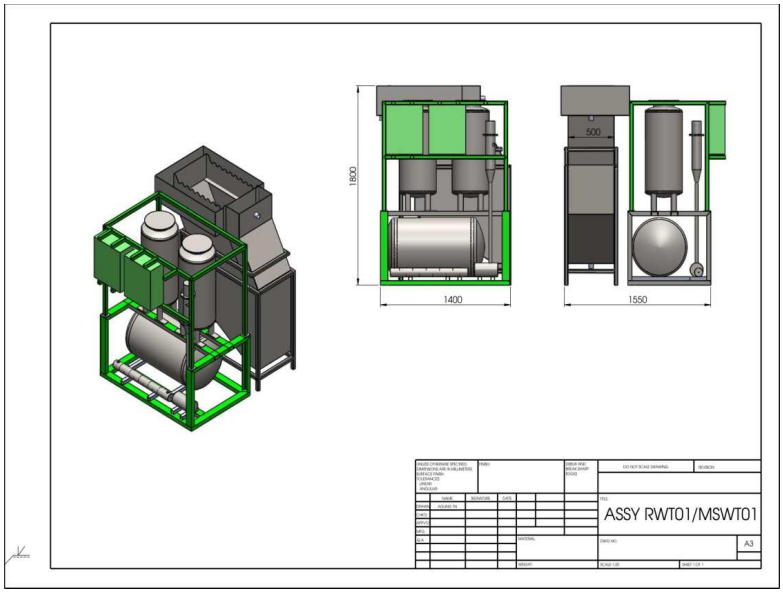


Fig. 6: MSWT-01with Sedimentation Tank mounted

Summary

MSWT-01 (Mobile Surface Water Treatment) Prototype for Disaster Mitigation is designed for river or surface raw water source in flood area, made for $1m^3$ per hour or 18-20 m^3 per day capacity, which is equal with 100-150 man requirements. Adopted and combined from RWT-05/ river water treatment with $5m^3$ per hour capacity, WWT-01/ well water treatment $1m^3$ per hour from IWET a.s (Czech Republic) and several references, is capable to produce clean water that suitable for sanitation and cooking/ drinking purposes although using contaminated water input that taken from improper or dirty sources. It is proved through number of experiment trials at prototype level. More samples that reprecent real disaster condition are needed to develop in next stages. For necessary condition, it could be added with sedimentation tank and disinfection system. All of this could be more efficient than older ways and also contributing in energy saving for general issue.

Next step is that this MSWT will be equipped with mobile feature and electric generator in order to make easier in operational and moving to reach disaster sub locations or sub sectors where it's needed, thus clean water demand could be provided in nearly any condition. Moreover, since the technologies are possibly not special, then the important thing is how to combine such methods, implementing for people needs, and developing network with disaster mitigation management stake holder for wider arrangement. From each stake holder entitiy point of view, the machine could be also treated as an investment that will be used from time to time when needed.

References

Ananto, Gamawan, (2010), "Smallest Unit Water Treatment opportunity from entrepreneurship point of view", Thesis. Bandung: MM Universitas Padjadjaran.

Heijman, S.G.J, (2007), "CT4471, Nanofiltration and Reverse Osmosis", TU Delft, pp 2.

Mohammad Arifur Rahman, Shamim Ahsan, Satoshi Kaneco, et.all, (2005), "Waste water treatment with multilayer media of waste and natural indigenous materials", Journal of Environmental Management, 74, Issue 2:107-110, downloaded Dec 2009.

Website Pemerintah Kota Singkawang, Kalimantan Barat, (2009), downloaded October 2010.

Website PDAM Kota Bandung, (http://pambdg.co.id), downloaded March 2010.

Ziv-El, Michael C & Rittmann Bruce, "Water quality assessment of ground-water treated with a membrane bio-film reactor", AWWA Journal Article.cfm-3.htm, item number = 52401, downloaded December 2009

Badan Standardisasi Nasional. (2006). "Air Minum Dalam Kemasan", SNI 01-3553-2006.

IWET, pt. (2007). "Well Water Treatment/ WWT-01 Manual Book", Tasikmalaya, IWET.

IWET, pt. (2007). "River Water Treat-ment/ RWT-05 Manual Book", Tasikmalaya: IWET.

Kementrian Pekerjaan Umum, Dirjen Cipta Karya, downloaded January 2010. <http://ciptakarya.pu.go.id>.

Len Boselovic and Mc Clatchy.(2009). "Carbon wins contract for Phoenix water treatment", ProQuest document ID1923254051. Washington: Calgon - Tribune Business News Dec 17, 2009. downloaded December 2009.

Philadelphia Water Department, PWD, (2009), "General Information, Literature". <http://www.phila.gov/water/>. downloaded 2011.

Daryono, SSi, MSi, (2010), "Mitigasi Bencana Banjir", Program Doktor Ilmu Geografi UGM.

Sekretariat Badan Koordinasi Nasional Penanggulangan Bencana dan Penanganan Pengungsi (BAKORNAS PBP) (2002), JAKARTA, "Arahan Kebijakan Mitigasi Bencana Perkotaan di Indonesia"

Badan Koordinasi Nasional Penanggulangan Bencana (BAKORNAS PB), "Pedoman Penanggulangan Bencana Banjir Tahun 2007/2008", Pelaksana Harian BAKORNAS PB, Jakarta.