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Design of Drinking Water Treatment Plant for Mekelle City

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Abstract

Safe and clean drinking water has major role for human health. The water quality can describe according to their physicochemical and biological characteristics and permissible limits have been fixed by international organization. The aim of study is to design and development drinking water treatment plant according to public health safety. The treatment plant was designed has been used the combination of reverse osmosis and ultrafiltration for purification of Mekelle City's drinking water. Totally there are 13 unit operations used for design and the plant is designed to be used for the next 15 years. The design has been done with by using intelligen super pro designer version of 9.0, The results shows that total dissolved solid was decreased 119.2 mg/L and arsenic 0.0041 mg/L, which is meet the standard of drinking water.The engineering aspects of material balance, energy balance and cost estimation has also been discussed.

Keywords: Biological; Contaminates; Drinking; Pollutants; Treatment

1 Introduction

Groundwater is water located beneath the earth's surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs at springs and seeps, and can form oases or wetlands [1]. Groundwater is accumulated in layers of bedrock and soil where the mix forms a geologic unit, an aquifer, in to which wells are sunk and which supply the municipal water system. It is difficult to purify once tainted, since poisons can lodge in geologic shelves, which can infect the unpolluted water batches [2]. Freshwater covers only 3 percent of the earth's surface and much of it lies frozen in the Antarctic and Greenland polar ice [3].Water quality is a term used to describe the chemical, physical, and biological characteristics of water, generally in terms of suitability for a particular - or designated - use. It is a function of the geology of the watershed.

Impurities in water can be determined by water analysis. Water analysis is used to classify, prescribe treatment, control treatment and purification processes and maintain public supplies of water of an appropriate standard of organic quality, clarity and palatability. There are different methods used today to analyze water quality, such as AAS which is used to know the concentration of heavy metals. The analysis of raw water enables the choice of the process for water purification. Analysis at the various stages of treatment allows monitoring the effectiveness of the treatment process, and the analysis of purified water ensures the correct degree of purification, as per required standards, is obtained [4].

Common water sources for municipal water supplies are deep wells, shallow wells, rivers, natural lakes, and reservoirs. Depending on the quality of the raw water, the extent of pollution and the regulations for safeguarding of public health, drinking water is treated by various methods before it reaches the consumer. Well supplies normally yield cool, uncontaminated water of uniform quality that is easily processed for municipal use. Processing may be required to remove dissolved gases and undesirable minerals. The simplest treatment is disinfection and fluoridation. Deep well supplies may be chlorinated to provide residual protection against potential contamination in the water distribution system. In the case of shallow wells not under the direct influence of surface water, chlorination serves to disinfect the groundwater and provide residual protection. Fluoride is added to reduce the incidence of dental caries [2]. Dissolved iron and manganese in well water oxidize when they come in contact with air, forming tiny rust particles that discolor the water. These can be removed by oxidizing the iron and manganese with chlorine or potassium permanganate, and removing the precipitates by filtration. Excessive hardness is commonly removed by precipitation softening. Lime and, if necessary, soda ash are mixed with well water, and

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settle-able precipitate is removed. Carbon dioxide is applied to stabilize the water prior to final filtration. Aeration is a common first step in the treatment of most ground waters to strip out dissolved gases and add oxygen [4]. Disinfectant is the last treatment applied to water [5].

Ethiopia is one of the member countries that adopted the millennium development declaration with its main objective of poverty reduction [6]. This includes prioritizing accessibility to improved water supply. Prior research has revealed that access to clean water, sanitation and hygiene are the significant elements for poverty alleviation [7]. In 2001, the Government of Ethiopia adopted a water and sanitation strategy that called for more decentralized decision-making; promoting the involvement of all stakeholders, including the private sector, and integrating activities relating to water supply, sanitation and hygiene [4].According to a report from MWSS on January 2014 there are 37, 298 customersusing individually 49 lit/capital/day on average out of the total 18,000m^3/day, which is equivalent to 750 m^3/h,supply by the municipalityfrom the total 22 bore holes currently functioning. Earlier this year the office had planned to supply 40,160 m^3 on daily basis, which is equivalent to 1673.4m^3/h, to fulfill the daily demand which is 160lit/capital/day hence satisfying the 342,200 people currently living in the City according to the office. We can see that not only there is a problem of quality supply of water but also there is a huge gap in the supply-demand of water in the City.Being one of the cities of Ethiopia, Mekelle, is also expected to have the required sanitation and hygiene of water for its population. According to an analysis made by Gebrekidan, M and Samuel, Z; Concentration of Heavy Metals in Drinking Water from Urban Areas of the Tigray Region, Northern Ethiopia, and by the MWSS, the groundwater of Mekelle City has found to be of high concentration of TDS (may reach up to 1288 mg/L) [8] Though the recommended amount of TDS is 500mg/L [9] and above average concentration of many heavy metals like Arsenic and cadmium.The Feed water composition shows that the raw water was rich in sulphate, chloride and calcium and highly furring [10].High levels of TDS may be objectionable to consumers and could have impacts for those who need to limit their daily salt intake e.g. severely hypertensive, diabetic, and renal dialysis patients [11]. And also it is found to be with a high concentration of heavy metals and slightly saline [12].

The aim of drinking water treatment plant should be to provide accordingly susceptible standards of service, to gain customer satisfaction, delivering to customer 'water that is both aesthetically pleasing and to meet public health safety requirements [9]. Unfortunately still there is no any technology employed to solve this problem that is they use only chlorine which is used for disinfection purpose while the problem is in need of beyond disinfection. So it was planned to work to fill this gap; to design a cost effective and modernized technology or plant to eliminate this problem.The goal of this study was to show how to improve access to quality water of Mekelle City, located 777 kilometers of the capital [13], by designing a suitable drinking water treatment plant after assessing current service and treatment of the ground water of the City. The general objective was to develop and construct a plant that will treat the ground water of the City.

2 Material and Methods

2.1 Material

The drinking water sample was collected from borehole at four different locations Mekelle City. It was preserved in 18^{o}C until used. The initial physicochemical parameters are shown in Table. 1.

2.2 Methods

The methodology that was used in this project needed assessment which includes the analysis of data collected from municipal and national offices; a review of relevant documents, a synthesis of informal interviews conducted with stakeholders, and data collected through questionnaire. Members from the MWSS were consulted for information regarding the state of water and sanitation in Mekelle City. The design of the treatment plant was carried out by using intelligent super pro design and ROSA. For the treatment of drinking water reverse osmosis. Reverse osmosis in conjunction with ultrafilteration in the design of the plant as a main method of treatment of the drinking water. The complete setup after design with super pro is shown in Fig.1.

As it is clearly shown in the figure below, super predesigned treatment plant, we mainly used RO and ultrafiltration as a main method for the treatment and purification of the City's drinking water. The specification of the major equipment is given in table 11, shown below. Reservoir however, should be designed to keep the water fresh and to prevent the carry-over of sediment [14]. In our design first the feed water which was pumped using centrifugal pump from the ground water was forced to enter to the ultrafiltration through the Mixer of three inputs (including recycles from the two RO) at a flow rate of 763.999m^3/h, a flow rate that is being used by MWSS considering the total supply and customers demand. Virtually all pumps used to lift water more than a few meters are centrifugal pump [15].The ultrafiltration was designed with a recovery rate of 95%, rejection coefficient of 0.0009, and pore size of 0.45 microns. Most of the water is then passed through the RO into the Degasification unit by recycling one-fourth of its content back to the first Mixer. Around 50 m3/h of water is sent to the waste water treatment section through the second mixing unit. The RO, main separation unit, has a recovery rate of 99%, Membrane Area of 30 m^2 (maximum area=80 m^2), and pore size of 0.45 microns. We used ROSA to get the optimum recovery and rejection percentage. The Degasification unit is mainly designed to remove the gaseous component of the feed water (dissolved O_2 and N_2) and oxidize Fe and Mn so as to from a precipitate. After removal of these Dissolved gases the water is stored in a tank with a capacity of 50 m^3.

For the second section of the design, waste water treatment section, the Mixer begins with mixing two inputs, one from the Ultrafiltration and another input by the addition of $CaSO_4$ (16 kg/h) and water for settlement purpose.

Table 1: Physicochemical parameters of four different location of Mekelle city

Sources of sample	**Bore hore FPW-10**	**Borehole Laci (Elala)**	**Borehole Chinferes**	**Bore hole Dandera**	WHO Standard (MPL)
Physical parameters					
Appearance	Clear	Clear	Clear	Clear	Clear
Color	Clear	Clear	Clear	Clear	Clear
Odor	Non-objectionable	Non-objectionable	Non-objectionable	Non-objectionable	Non-objectionable
Taste	Non-objectionable	Non-objectionable	Non-objectionable	Non-objectionable	Non-objectionable
Chemical Parameters					
Dissolved Oxygen (DO)	5	6.4	5.3	4.2	6 mg/L
Total Iron (mg/L Fe)	0.96	0.3	0.54	0.4	0.3 mg/L
Copper (mg/L Cu)	1.92	7.74	0.31	0.8	1.5 mg/L
Chromium (mg/L Cr)	0.002	0.015	0.06	0.025	0.05mg/L
Manganese (mg/L Mn)	0.3	67.6	0.3	0.03	0.5mg/L
Ca hard(mg/l) as $CaCO_3$)	400	1200	360	420	200mg/L
Total Hardness as $CaCO_3$	620	1600	400	720	300mg/L
Nitrate (mg/L NO_3)	0.8	0.6	0.3	3	50mg/L
Nitrite (mg/L NO_2)	1	1.2	2	1.4	3mg/L
Bacteriological Parameters					
Total Coli form	Nil	Total Coli form	Nil	Total Coli form	Nil
Fecal Coli form	Nil	Fecal Coli form	Nil	Fecal Coli form	Nil

This treatment involves various unit operations such as clarification, centrifugation, GM filtration, a second RO, and another storage unit for the wastes. The basic principle behind this treatment section is sedimentation of these waste product by addition of $CaSO_4$ so as the heavy particle with remain at the bottom of these unit operations and the light particle, water part, will recycle to the main treatment section. According to author Gebrekidan and Samuel, 2010 in Mekelle city some other heavy metal was detected those are mention in Table 2.

Table 2. Heavy metal available in Mekelle city drinking water (Gebrekidan and Samuel, 2010)

S.No	**Heavy metals**	**Quality (mg/L)**	**Permissible limit (mg/L)**
1	Arsenic(As)	330-460	10
2	Cadmium(Cd)	14-21	5
3	Chromium(Cr)	131-158	100
4	Iron(Fe)	97-919	300
5	Lead(Pb)	69-106	15
6	Conductivity(μS/Cm)	1172-2130	250
7	TDS(mg/L)	698-1288	500
8	Turbidity(NTU)	0.504-27.42	0.5-1

2.3 Analytical method

Physicochemical parameter can be analysis with reference of standard book. Temperature, conductivity, total dissolved solids and salinity of the samples were measured at the sampling sites using Jenway 4150, portable conductivity meter. pH was also recorded at the sampling sites using Hach, HQ11d Portable pH Meter. Turbidity of the samples was measured at aquatic chemistry laboratory of Mekelle University using Hach, 2100Q Turbidimeter. Heavy metals (As, Cd, Co, Cu, Cr, Fe, Mn, Ni, Pb and Zn) analysis was done at analytical laboratory of Ezana Mining Development P.L.C. using AA240FC, Varian instruments, Fast Sequential AAS Australia with instrument working condition. Analytical grade chemicals (HNO3, Sigma chemicals, Australia and standard heavy metal solutions, Varian instruments, Australia) after preserving at 4 ^{o}C for short period of time. For biological testing the sample was taken in test tube. After we sterilize all flasks, test tubes, and Petri plates required in hot air oven were used Ethylene Methylene Blue (EMB) Agar for the growth E.coli and

Violet Red Bile (VRB) agar for the growth of total coliform. The sample was incubated in media. By doing this it was able to identify the specific types of microorganisms found in petri plates. The result obtained from experiments was compared with WHO drinking water biological parameters standards.

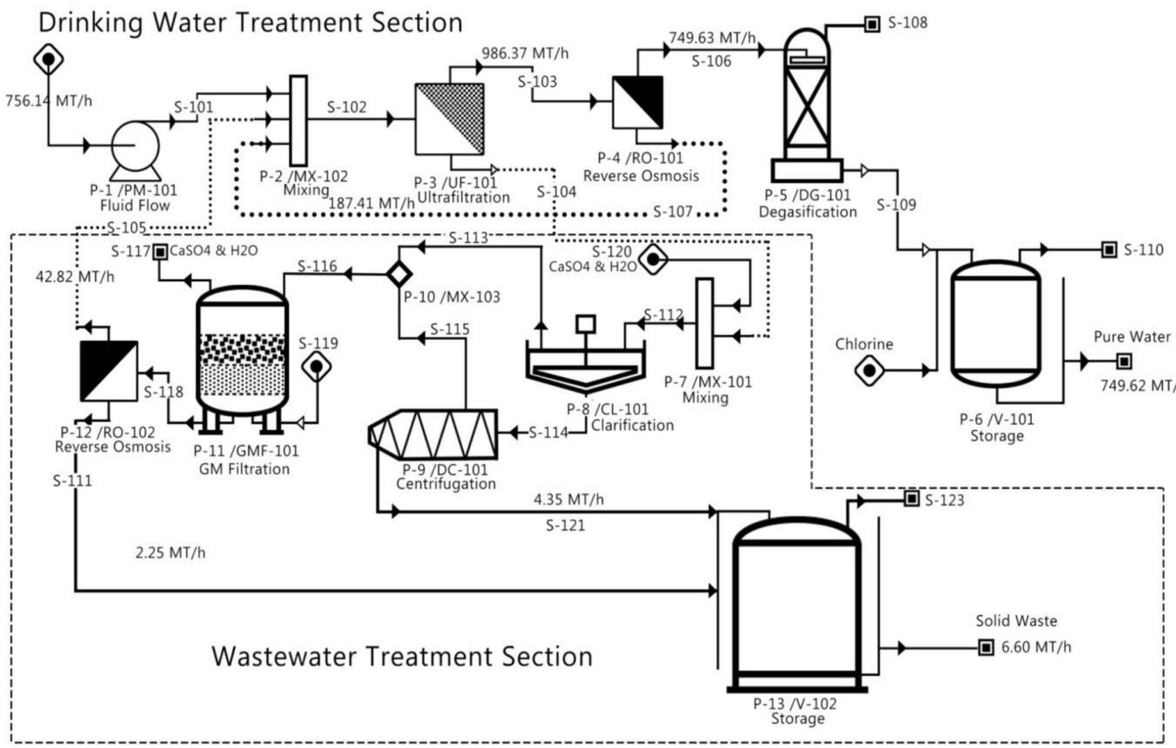

Fig.1: Drinking water treatment plant layout for Mekelle City

3 Results and Discussion

3.1 Selection of Membrane

In the designing the Drinking Water Treatment plant using reverse osmosis systems that uses intermittent energy sources, it is very important to design a RO system that could operate under broad operational window. The main thresholds of the operational window include the maximum feed pressure (determined by the membrane mechanical resistance); maximum constituents chemical flow rate (should not be exceeded to avoid membrane deterioration); minimum constituents chemical flow rate (should be maintained to avoid precipitation and consequent membrane fouling); and maximum product concentration (if the applied pressure is less than a determined value, the permeate concentration will be too high). Using chemical characteristics of water of the study area, and varying the values of variables of operational window thresholds, it was run the model several times. According to the results of the analysis, at 25°C, the maximum allowable pressure, maximum chemical constituents flow rate, minimum feed flow rate, and minimum pressure of our design are about 50 bar, 780m^3/h, 700m^3/h, and 30 bar, respectively.

Membrane performance was measured in terms of membrane rejection (R) and permeates water flux (J_w). Rejection is a measure of solute separation by the membrane and is defined as:

$$R = [\, 1 - C_p/C_f \,] \times 100 \qquad (1)$$

Where C_p and $C_f$are the solute concentrations in the permeate and feed streams, respectively. Using ROSA, we have performed several RO design options capable of producing 750 m^3/h. After performing several design alternatives, our preferred design is a two stage with three membrane elements in each stage. The membrane has a recovery rate of 99%, membrane area of 30m^2, and pore size of 0.45 microns. The type of membrane used in this analysis is SW30HRLE-400. The optimization of membrane is shown in Fig.

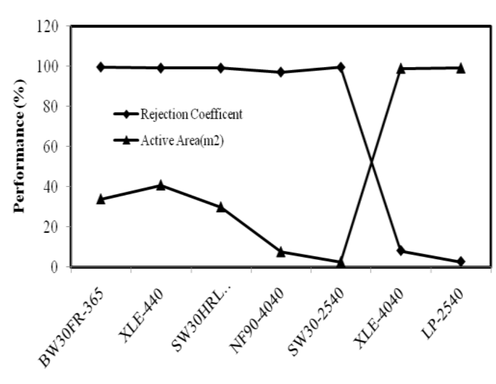

Fig.2 Optimization of membrane system

3.2 Power Requirement

The power requirement for the treatment of drinking water is shown in Fig. In reverse osmosis treatment systems, energy is a major consideration. Power consumption by the system which includes power for drinking water pumping, high pressure pumping, booster, and chemical treatment could be calculated using equation (2) [16].

$$P_{wn}= Q_n (P_{rn}/E_n) \quad (2)$$

Where,

Pw_n(kW) = Power consumed by feed, low and high pressure, booster and chemical water treatment pumps,

Qn(m_3/s) = Rates of feed water, fresh water production, boosted water,

Pr_n(kPa) = Feed pressure, boosted pressure, rejection pressure

En (Net efficiency of feed pump) = Ep (pump efficiency) * En (motor efficiency) for high pressure pump (booster) and energy recovery turbine.

From the result it is clear that energy requirement increase with increase in feed flow rate. At optimum pressure 50bar and flow rate 780m^3/h it show 5.5KW/h power consumption, According to [16] the low pressure pump consumes the highest energy, and the rest constitutes about 20% of the lowerpressure pump. The power required for the system's lower pressure pump, at 10m^3/h feed water flow rate, 45bar pressure, and 0.85 pump efficiency, is about14.71kW. An additional 2.94kW will be needed for booster, feed water, chemical treatment andother pumps, which is about 20% of the lowerpressure power requirement. Thus, the total power requiredfor the RO system design is equivalent to author.

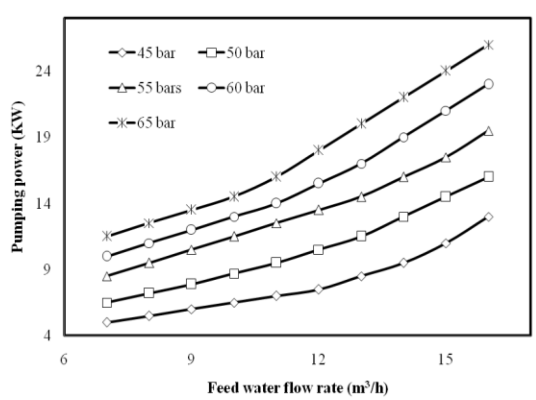

Fig.3: Pumping power requirement for RO system

3.3 Biological Test

The bacterial reduction study is shown in Fig. 4 (a) and Fig (b). The results show that at the end of culture there was no sign of microorganism found in all of these samples. From these four results it canbe possible to conclude that the drinking water of Mekelle City is free of both E.coli and total coliform. Hence the researchers decided to add 1.5 mg/L of 70% strength chlorine to it in order to avoid the formation of any related microbial life in the storage and distribution system. This might be due to drinking water usually undergo dramatic changes in distribution systems and this may made the distribution systems no longer considered as inert systems supplying drinking water to large areas [9]. In this study distribution systems are considered as biological and chemical reactors that interact with the transported water, in that water quality changes with time and space [17].

3.4 Effect on physicochemical parameters

The initial feed concentration and outlet concentration of physicochemical parameters and heavy metal on RO system is shown in Table3. From the Table 3, it is clear that by using the RO purifier system, the concentrations can be decrease upto acceptable international standards. For instance, the TDS was lowered to a value of 119.2mg/L from 1288 mg/L which is an excellent water quality for drinking according to many international organization and countries classification of drinking water including the WHO. This means a huge increase in the aesthetic value of the water, while decreasing the amount of substances consumed while drinking water. The Arsenic value was decreased from a value of 0. 44938 mg/L to 0.0041mg/L.Arsenic (As) is a potential risk to consumers because it has the potential to cause hyperkeratosis and skin cancer in human beings.The concentration of As in the water distributed in Mekelle City ranged between 395 and 460 µg/L. Implementation of this design would decrease the concentration of As to 0.004108.The concentration of Lead in Mekelle City's distributed water ranged from 80 to 583 µg/L, which way beyond the safety standards set by WHO (10 µg/L), and USEPA (15 µg/L). This means that diseases and/or disorders related to lead consumption have the potential to happen. This project managed to decrease the concentration of Lead to 5.29 µg/L. The other element which were causing stains and affecting the taste of beverages is Fe having a concentration of 97-919 µg/L, while the MPL of WHO is 300 µg/L. After we designed the treatment plant we were able to decrease this high concentration of Fe into insignificance amount, 0.2613 µg/L.

3.5 Mass balance of treatment plant

For drinking water practice, the water itself is the defined system, which the mass balance is constructed. Based on practical considerations, it is fairly easy to determine the mass of compounds in the water taking a water sample. Furthermore, only final water from the treatment plant enters the drinking water network and it is only drinking water that is consumed at the tap. Influences on the system, mostly elements attached to, lying on or are part of the wall of the main network pipes (such as biofilms, sediment and the pipe material) should not be included. Incase particles are suspended in the water; this might be as well called suspended in the bulk phase, assuming that most of the particles are present in the water [18]. The next two tables show the overall and component material balance.

Assume data for material balance:

Annual Operating Time	7,920.00h
Unit Production Ref. Rate	6,514,205.76m^3 (STP)
Operating Days per Year	330.00

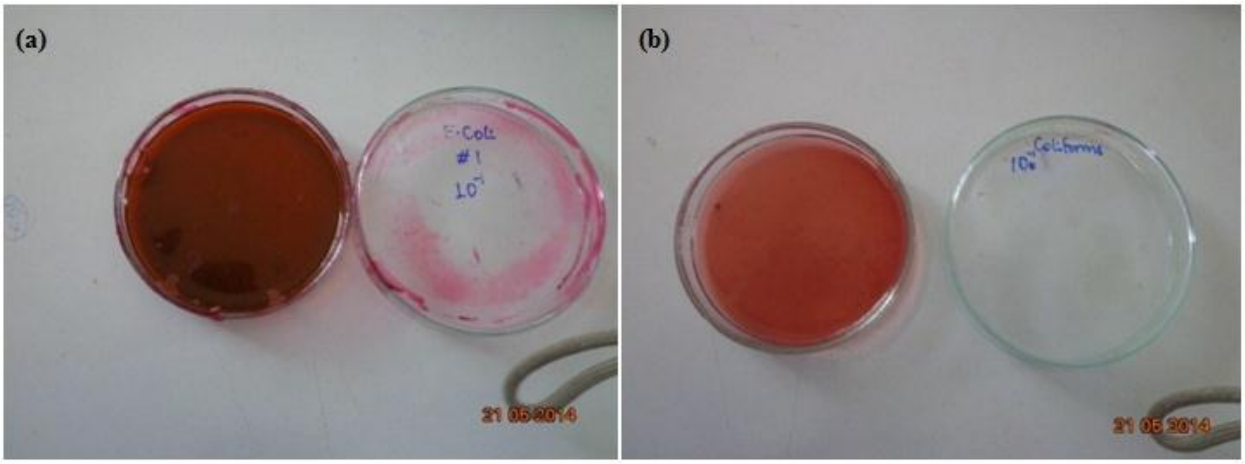

Fig.4 Cultured Sample from drinking water (a) E.Coli (b) Coliforms

Table 3: Inlet and outlet concentration in drinking water treatment system

S.No	Components	Concentration(mg/L) (IN)	Concentration(mg/L) (OUT)
1.	As	0.44938	0.004108
2.	Cd	0.02052	0.0010480
3.	Cl	0.00000	3.972606
4.	Co	0.02931	0.014972
5.	Cr	0.15435	0.078850
6.	Cu	2.63763	1.347332
7.	Fe	0.89779	0.2613
8.	Mn	0.08597	0.043917
9.	Pb	0.10355	0.0052900
10.	Ni	0.04005	0.020461
11.	Zn	0.56954	0.290948
12.	$CaCO_3$	1172.30263	68.729266
13.	$CaSO_4$	0.00000	0.589473
14.	Oxygen	6.25228	0.000632
15.	Nitrogen	1.95384	0.000197
16.	TDS	1288	119.144900
17.	Total hardness	1563.07018	141.308492
18.	Water	985711.86475	993359.187931

Table 4: Bulk Materials (Entire process)

No	Material	Kg/yr.	Kg/h	Kg/m^3(STP) MP
1.	As	2,719	0.343	0.000
2.	$CaCO_3$	7,093,453	895.638	1.198
3.	Cd	124	0.016	0.000
4.	Co	177	0.022	0.000
5.	Cr	934	0.118	0.000
6.	Cu	15,960	2.015	0.003
7.	Fe	5,432	0.686	0.001
8.	Mn	520	0.066	0.000
9.	Ni	242	0.031	0.000
10.	Nitrogen	11,822	1.493	0.002
11.	Oxygen	37,832	4.777	0.006
12.	Pb	627	0.079	0.000
13.	TDS	7,613,640	961.318	1.286
14.	Total Hardness	9,457,938	1,194.184	1.597
15.	Water	5,965,096,745	753,168.781	1,007.225
16.	Zn	3,446	0.435	0.001
17.	Chlorine	23,760	3.000	0.004
18.	$CaSO_4$	132,000	16.667	0.022
19.	Total	5,989,497,376	756,249.669	1,011.345

Table 5: Overall components balance (kg/yr.)

S.No	Component	IN	OUT	IN-OUT
1.	As	2,719	2,719	0
2.	$CaCO_3$	7,093,453	7,093,453	0
3.	$CaSO_4$	132,000	132,046	46
4.	Cd	124	124	0
5.	Chlorine	23,760	23,760	0
6.	Co	177	177	0
7.	Cr	934	934	0
8.	Cu	15,960	15,960	0
9.	Fe	5,432	5,432	0
10.	Mn	520	520	0
11.	Ni	242	242	0
12.	Nitrogen	11,822	11,822	0
13.	Oxygen	37,832	37,832	0
14.	Pb	627	627	0
15.	TDS	7,613,640	7,613,640	0
16.	Total hardness	9,457,938	9,457,938	0
17.	Water	5,965,096,748	5,964,294,219	802,529
18.	Zn	3,446	3,446	0
19	TOTAL	5,989,497,376	5,988,694,801	802,575

3.6 Energy balance

1. Total Heat Transfer Agent Demand

Heat Transfer Agent	kg/yr.	kg/h	kg/m^3(STP) MP
Steam	2087149.94	263.53	0.35
Steam (High P)	0.00	0.00	0.00
Cooling Water	536695699.95	67764.61	90.62
Chilled Water	0.00	0.00	0.00

2 Total Power Demand

Power Type	kW-h/yr.	kW-h/h	kW-h/m^3(STP) MP
Std Power	103947055.58	13124.63	17.55
TOTAL	**103947055.58**	**13124.63**	**17.55**

3.7 Cost Estimation

1 Executive Summary (2014 prices)

Total Capital Investment	2,328,718.9$$
Capital Investment Charged to This Project	2,328,718.9$$
Revenues	1,042,272.9216 $/yr.
Cost Basis Annual Rate	6,514,205.76m^3/yr.
Unit Production Revenue	0.160 $/m^3 (STP) MP
Payback Time	2.3 yr.

2 Fixed Capital Estimate Summary (2014 prices in $)

A. Total Plant Direct Cost (TPDC) (physical cost)

1.	Equipment Purchase Cost (for the 13 unit operations)	395,870
2.	Installation	193,810
3.	Process Piping	138,555
4.	Instrumentation	158,350
5.	Insulation	11,875
6.	Electrical	39, 585
7.	Buildings	178,140
8.	Yard Improvement	59,380
9.	Auxiliary Facilities	158,350
	TPDC	**1,333,915**

B. Total Plant Indirect Cost (TPIC)

10.	Engineering	333,480
11.	Construction	466,870
	TPIC	**800,350**

C. Total Plant Cost (TPC = TPDC+TPIC)

TPC	**2,134,265**

D. Contractor's Fee & Contingency (CFC)

12.	Contractor's Fee	53,357.5
13.	Contingency	10,526.4
	CFC = 12+13	**63,883.9**

E. Direct Fixed Capital Cost (DFC = TPC+CFC)

DFC	**2,198,148.9**

1 Labor Cost

Labor Type	Unit Cost	Annual Amount (h)	Annual Cost ($)	%
Operator	**($/h)**	97,869	32,199	100.00
TOTAL	**0.329.00**	**97,869**	**32,199**	**100.00**
12.	Contractor's Fee			53,357.5
13.	Contingency			10,526.4
	CFC = 12+13			**63,883.9**

2 Materials Cost

Bulk Material	Unit Cost ($/h)	Annual Amount (h)	Annual Cost ($)	%
Chlorine	0.300	23,760 kg	7,128	9.75
$CaSO_4$	0.500	132,000 kg	66,000	90.25
TOTAL			**73,128**	**100.00**

3 Profitability Analysis (2014 prices)

A	Direct Fixed Capital	2,198,148.9
B	Working Capital	7,850 $
C	Startup Cost	122,720 $
D	. Up-Front R&D	0 $
E	Up-Front Royalties	0 $
F	Total Investment (A+B+C+D+E)	2,328,718.9$
G	Investment Charged to This Project	2,328,718.9$

4 Revenue/Savings Rates

Pure water (Main Revenue)	753.959 m^3/h = 6,514,205.76m^3 (STP) /yr.
Pure water (Main Revenue)	0.16 $/$m^3$ (STP)
Total Revenues/Savings	**1,042,272.9216 $/yr.**

4 Conclusions

It is concluding that after design of the treatment plant almost all of the concentration of the heavy metals and the amount of the physicochemical parameters were decreased to lower values which are acceptable by many international standards including by the WHO. By this work an attempted has been carried out to highlight importance of treatment plant for Mekelle City. The result shows that after treating the ground water using the designed treatment plant; it is suitable for drinking purpose. It is recommending to MSWW (Mekelle City Water Supply and Service) to implement this plant in order to avoid the current problem which may be a cause for many diseases and get customers satisfaction.

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