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Design RO desalination plants and sewerage for Al-Safwa and Al-Qatif cities

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ABSTRACT

The increase in the population, the industrial and commercial activities, and the heavy farming, are factors that increase the water demand on the earth. Climate changes and limited or decreased water availability (i.e. rainfall, groundwater) force all the intervenient to search for other water resources alternatives. This aim is a global trend and one goal of Saudi vision 2030. Desalination is one of the best solutions, especially in Saudi Arabia which has coastal beaches on both the Arabian Gulf and the Red Sea.
The aim of our project is designing the desalination plant to service Al-Safwa and Al-Qatif cities. These cities overlooking the Arabian Gulf in the eastern region of KSA, about 500 km from Riyadh. Water supply to this area is carried out by transmission pipelines from the water desalination plant in Al-Khobar, with a length of about 250 km. By designing and implementing this station, the burden on the water station in Al-Khobar city will be reduced, as well as avoiding operating problems and saving maintenance costs for transmission pipelines.
First literature review about the current situation of desalination in world, regional and KSA is presented. Also, technologies of desalination are described and finally Reverse Osmosis (RO) system is chosen due to its advantages. RO desalination plant contains several stages, pre-treatment, RO system, and finally post-treatment units. Design procedure is conducted by using Excel solver.
The desalination plant will serve about two million person until 2052 with around average flow rate 600 thousand cubic meter per day. The pre-treatment stage consists of intake, conduit, low-lift pump station, grit chamber, and granular filter. Composite membranes is used in RO system.
Also we will work to plan and deign the sewerage to serve Al-Safwa city, First we have to planning first before to design to know our boundaries then we will make the design , and our design will involve see the diameter of each pipe , the velocity that move through the pipe , the slope for each pipe , and then after design each of this correctly the wastewater will go from the main collector to the main pump station and then the main pump station will take it and through it the Wastewater treatment plant to make the treatment and recycle the water and to help the environment

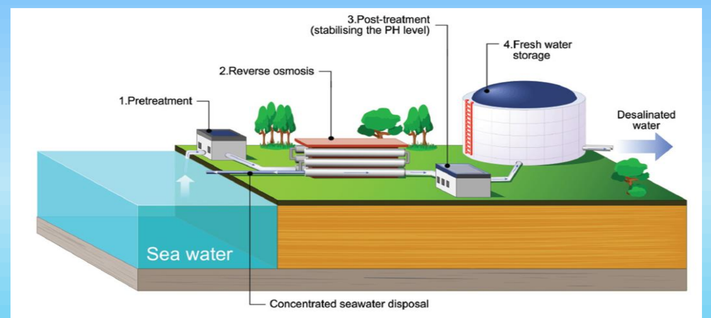
PROBLEM STATEMENT

Because the water is limited in our country , no river , lakes , and the rainfall is variation with time and quantity , so there is no sources of water .
From the Figure below there is a yellow line which is delivered water from Al-Khobar to Al-Safwa which that will make the cost huge , so we want to build our plant near to Al-Safwa and our plant will serve Al-Qatif also.

OBJECTIVES

- Understand the Desalination process.
- Choose the location of desalination plant depends on the intake.
- Study the current situation of desalination.
- Study the alternative layout of desalination plant.
- Get the information for the current population ,consumption ,area will be served.
- Design the Desalination plant (RO system).
- Planning the network.
- Design the network

METHODOLOGY



SOFTWARES

First one is Microsoft excel to find our result and diameter of each pipe .
The second software is IMSDesign is to find our membrane type of RO.

Microsoft Excel

IMSDesign

RESULT

By using Microsoft excel we get our result of pretreatment unit :

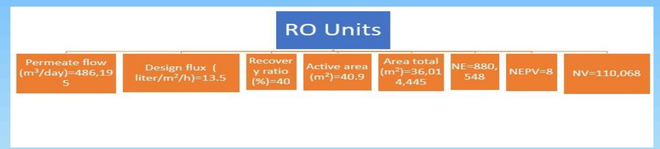
By using IMSDesign we get our membrane type :

Nitto — HYDRANAUTICS Nitto Group Company

Membrane Element	SWC6 MAX	
Performance:		
Permeate Flow:	**Low Pressure:** 6,600 gpd (25 m^3/d)	**High Flow:** 13,200 gpd (50 m3/d)
Salt Rejection:	99.6% (99.4 % min)	99.8% (99.7% min)
Applied Pressure:	600 psi (4.1 MPa)	800 psi (5.4 MPa)
Type		
Configuration:	Spiral Wound	
Membrane Polymer:	Composite Polyamide	
Membrane Active Area:	440 ft^2 (40.9m^2)	
Application Data*		
Maximum Applied Pressure:	1200 psig (8.27 MPa)	
Maximum Chlorine Concentration:	< 0.1 PPM	
Maximum Operating Temperature:	113 °F (45 °C)	
pH Range, Continuous (Cleaning):	2-11 (1-13)*	
Maximum Feedwater Turbidity:	1.0 NTU	
Maximum Feedwater SDI (15 mins):	5.0	
Maximum Feed Flow:	75 GPM (17.0 m^3/h)	
Minimum Ratio of Concentrate to Permeate Flow for any Element:	5:1	
Maximum Pressure Drop for Each Element:	15 psi	

* The limitations shown here are for general use. For specific projects, operating at more conservative values may ensure the best performance and longest life of the membrane. See Hydranautics Technical Bulletins for more detail on operation limits, cleaning pH, and cleaning temperatures.

By using Microsoft excel get the result of RO units



By using Microsoft excel get The result for the left main collector

Section name	Length (m)	Qmax(m3/s)	Qfull(m3/s)	Vfull	Area(m2)	Diameter (m)	Vfullact	Slope	Qmin	Qmin/Qfull
1L	74	0.00306586	0.002766273	0.95020905	0.031415927	0.2	0.08805	0.004	0.001758046	0.635528671
2L	452	0.018726605	0.016896693	0.95020905	0.031415927	0.2	0.53784	0.004	0.010738333	0.635528671
3L	2225	0.092182955	0.083175092	0.95020905	0.096211275	0.35	0.8645	0.00282	0.052860156	0.635528671
4L	6377	0.264202563	0.238385422	0.95020905	0.282743339	0.6	0.84312	0.0013	0.151500771	0.635528671
5L	9000	0.372874874	0.408898864	0.88230104	0.502654825	0.8	0.81348	0.00082	0.213816361	0.522907692
6L	10128	0.419608525	0.460147521	0.88230104	0.636172512	0.9	0.72331	0.00056	0.240614679	0.522907692
7L	14886	0.616735042	0.676318721	0.88230104	0.785398163	1	0.86112	0.00068	0.353652262	0.522907692
8L	25678	1.063853446	1.166633892	0.88230104	1.327322896	1.3	0.87894	0.0005	0.610041836	0.522907692
9L	35712	1.4795675	1.622510692	0.88230104	2.010619298	1.6	0.80697	0.00032	0.848423322	0.522907692
10L	37757	1.564292957	1.7154216	0.88230104	2.010619298	1.6	0.85318	0.00036	0.89700715	0.522907692

By using Microsoft excel get the result for the right main collector

Section name	Length (m)	Qmax(m3/s)	Qfull(m3/s)	Vfull	Area(m2)	Diameter (m)	Vfullact	Slope	Qmin	Qmin/Qfull
1R	91	0.00377018	0.003401768	0.950209046	0.03141593	0.2	0.108281633	0.004	0.00216	0.635532867
2R	724	0.02999571	0.027064614	0.950209046	0.03141593	0.2	0.861493431	0.00592	0.0172	0.635532867
3R	3100	0.12843468	0.115884398	0.950209046	0.12566371	0.4	0.922178742	0.00268	0.07365	0.635532867
4R	4616	0.19124338	0.172555608	0.950209046	0.19634954	0.5	0.878818493	0.0018	0.10966	0.635532867
5R	7712	0.31951234	0.350380893	0.882301041	0.50265482	0.8	0.697060639	0.0006	0.18322	0.52290769
6R	14250	0.59038522	0.647423201	0.882301041	0.78539816	1	0.824324822	0.00063	0.33854	0.52290769
7R	18315	0.75880037	0.832109188	0.882301041	0.95033178	1.1	0.875598615	0.00062	0.43512	0.52290769
8R	22216	0.92042091	1.009344129	0.882301041	1.13097336	1.2	0.892456152	0.00058	0.52779	0.52290769
9R	30264	1.25385391	1.37499058	0.882301041	1.5393804	1.4	0.893210398	0.00047	0.71899	0.52290769
10R	31731	1.31463251	1.441641094	0.882301041	1.76714587	1.5	0.815801978	0.00036	0.75385	0.52290769
Section name	Length (m)	Qmax(m3/s)	Qfull(m3/s)	Vfull	Area(m2)	Diameter (m)	Vfullact	Slope	Qmin	Qmin/Qfull
END POINT	69848	2.89384047	3.173418649	0.882301041	3.80132711	2.2	0.834818619	0.00022	1.65941	0.52290769

Dnew(m)	Dnew(m)	Anew(m2)	Vfull new	slope
1.56736093	1.5	1.76714587	1.79579	0.001629695

CONCLUSION

After we design the pretreatment and RO units , and get our information about the pipes on the main collector we seen that :
Pretreatment units have 5 units we need to design it and must be good , because it will remove any particles that will occur a damage in RO system .
RO system will remove the salinity from water.
Planning and design sewerage : After we plan our study area we design the sewerage and get the diameter of the pipes on our study area .

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