IIOAB JOURNAL

ARTICLE

INITIAL DILUTION OF EFFLUENT DISPOSALOF SOLAR DISTILLATION SITE TO SEA FOR MARINE ENVIRONMENT

Mehdi Nezhad Naderi*, Ehsanallah Hadipour

Department of Civil Engineering, Tonekabon Branch, Islamic Azad University, P.O. Box Tonekabon, IRAN

ABSTRACT

Initial dilution and its characteristics play important roles in designing of effluent disposal into the sea. Using of the mixing models is very common for estimating of initial dilution. In this study, the performance of the jet system has been studied for waste disposal of Kish port solar desalination site by using empirical equations. Initial dilution is related to water depth, diameter, flow rate, distance between openings, water velocity environment. After considering different environmental conditions and the most critical conditions the best initial dilution is determined. In the scenarios, the final scenario is best and the first scenario is worst case. By using of jet system as an effluent disposal system for Kish Port Solar Distillation, we have obtained with increasing effluent discharge from 0.463 m^3/s in the Khamir port to 1.2 m^3/s in Kish port, the length of main duct must be increased. The performance of the T-shaped diffuser for waste disposal is cheaper than the jet system because in it is consumed the length of duct from beach to sea.

KEY WORDS
desalination unit, Ssaltwater, Mixing zone, Initial dilution, T form Diffuser, jet system for waste disposal.

Published: 10 September 2016

***Corresponding Author**
Email:
mehdi2930@yahoo.com

INTRODUCTION

There are many areas in which they need access to fresh water and healthier facility is not possible, Therefore need for investment in research and study of different methods of desalination of saltwater feels. At first glance the use of fresh water now seems very good but when the water supply is low. However, when the volume of water extracted is high, there are financial costs of implementation issues for the supply of land, building construction, supply and installation of facilities and structures (such as intakes, pipelines and water disposal system). Another aspect of this type of desalination is destructive environmental effects of around the disposal of wastewater. Some of these effects such as increasing of salinity could be dangerous for fish and other animals in the ocean environment and that can cause the loss of them or away from the area. Another risk is damage of the plant tissue by disruption of chemical properties, salinity and temperature of seawater. Another threat to human life or living in areas near the sea is increasing of ground water resources salinity due to sea water. With regard to the above destructive effects of desalination on the marine environment and coastal areas, the designing of desalination disposal system must be carefully. In this paper we describe the marine depletions and plume jet by mixing mechanism. Then the governing equations and the expression characteristics of Kish and Khamir desalination site are paid and initial dilution by diffusers and jet system are defined.

Governing equations

When sewage is discharged into the sea then immediately mixed to environment. Initial mixing zone is done through diffusers in a radius about "100 meters and few minutes after discharging wastewater to the environment that is defined near field. The incorporation of this region is determined by intensity of mixing due to turbulence that generated by buoyancy force and momentum of the discharged jet. Processes that occur in this area include a mix of free plume, plume hitting to water surface, the horizontal distribution and additional mixing beyond of final height of plume. Near field when ends that the turbulence due to discharge is less than the effect of turbulence due to buoyancy force. For a layer that is distributed below the surface, the loss of momentum is due to stable distribution of the density profile inside the layer. Beyond the Near field, the plume of contamination moves with the acceptor environment flow and that is distributed by turbulence of this area that is defined Far field. Mixing in a Far field is quieter than near field. Finally input waste water with initial concentration is mixed in near field and far field then average pollutant concentrations will reduce to acceptable standards in coastal water. Although the concentrations of pollutants in near field may damage to marine ecosystems, But because of given the small size of the area to the sea in this area, the adverse effects of waste water discharging is not regarded. Discharging a fluid with the initial momentum from a hole or groove into a large volume of fluid is called jet. The initial velocity is caused movement of the jet and the amount of discharge from the jet is important for form of jet movement. Discharge of water from a tube into a pool is a clear example for a jet. The plume stream is similar the jet with the difference that the initial velocity is not reason of plume flow movement but reason of fluid motion is difference in the density with the recipient environment. For example, air flow caused by the fire plume is a clear example. The plume was created without any initial velocity and as a result of the density difference due to the air warming. The discharge of pollutants into the sea usually caused by a combination of jet and plume and that is rarely due to only jet or simple plume. Primarily discharge of pollutants into the sea act as jet due to the initial velocity and momentum flux and then that act the same as plume because of energy dissipation of velocity operation due to taking the distance into sea. As the motion of the tube, the behavior of pollutants can also take a layer or turbulent condition that in this state turbulence criterion is Reynolds numbers above 4000. The pollutants in the tube have density more than the sea water, and it may those sat there on the bed. Discharge of pollutants must be same as jet mode at the beginning to move to the water environment. Discharge of pollutants caused dilution by creating more

turbulence with the water environment. It is mentioned standards proposed by the U.S. Environmental Agency that discharge of pollutants process must be located in maximum radius of 200 meters from beginning of the tube [5].

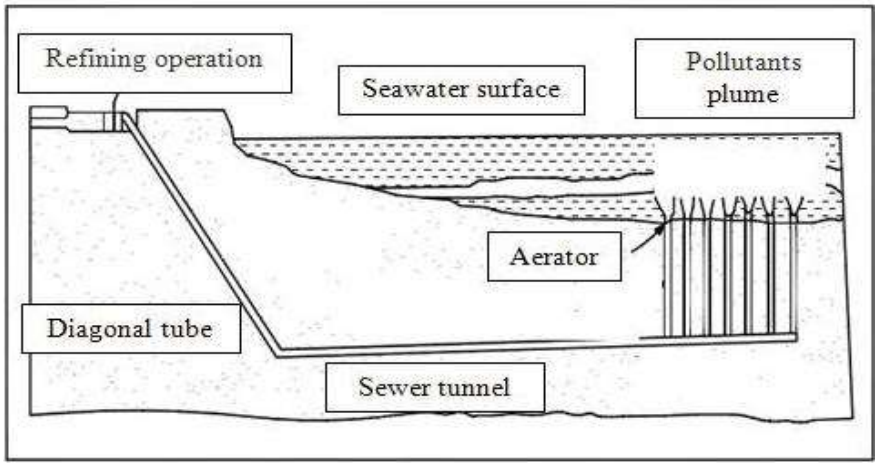

Fig. 1: A typical sewer tunnel to discharge sewage into the sea [3].

Sewage outflow from single- diffuser or multiport diffuser can be removed. Multiport diffuser in the thermal discharge shows greater rates than single-diffuser in initial dilution. A Multiport diffuser has linear structure form that includes a few branches with large ducts with spaced from each that goes out heat sewers from these ducts. In this paper sewage outflow from a T-shaped diffuser in multiport diffusers is parallel to the stream environment [1]. Gained initial dilution equation in T-shaped diffuser by using the Bernoulli equation and the momentum equation for the pressure continuity along the axis of multiport diffuser. In T shaped diffuser, the momentum loss is considered due to the surrounding environment flow in the momentum equation between the front and rear sections of the T-shaped diffuser. Then by combining the energy equation and the momentum equations, the amount of dilution in the near-depletion of T-shaped diffuser be calculated as follows:

$$\frac{S_t}{S_o} = 1 - C_d M_r \quad (1)$$

The S_t is T-shaped diffuser minimum dilution level and C_d is effective coefficient of the inertia of the flow and M_r is proportion between momentum of depletion discharge by T-shaped diffuser and the momentum of discharge by surrounding environment flow that is calculated as follows:

$$M_r = \frac{(U_a)^2 H}{(U_O)^2 D} \quad (2)$$

In this formula H is depletion depth and D is the diameter of the discharge tube, U_O is the depletion discharge rate and U_a is surrounding environment flow rate. S_o is initial dilution of the surrounding flow in inertia state that follows by [1]:

$$S_0 = \sqrt{\frac{H\cos\theta_0}{2B}} \quad (3)$$

θ_0 Is Angle between the urethra and the sea floor, usually less than 45 degrees is chosen.
[6] obtained constant coefficients of Equation with experimental data in the following way:

$$\frac{S_t}{S_o} = \frac{1}{1-[60\exp(-5{M_r}^{0.2})]M_r} \quad (4)$$

By substituting equation (3) in equation (4) we get:

$$S_t = \left[1 - \left[60\exp\left(-5{M_r}^{0.2}\right)\right]M_r\right]\sqrt{\frac{H\cos\theta_0}{2B}} \quad (5)$$

It is first necessary to define B parameter for T-shaped diffuser. This parameter, which is denoted by the letter B is the area of each hole of T-shaped diffuser to the distance between holes in the T-shaped diffuser:

$$B = \frac{A_0}{l} \quad (6)$$

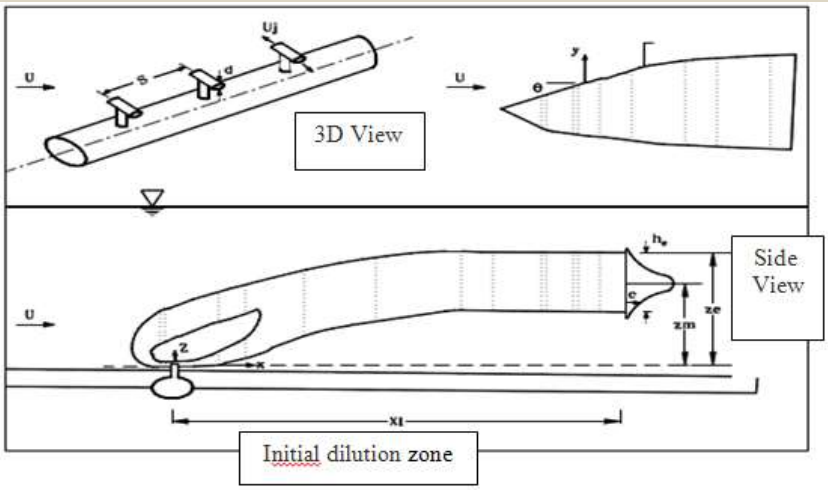

Fig. 2: Exit of effluent plume from diffuser into the sea with marine parameters [4].

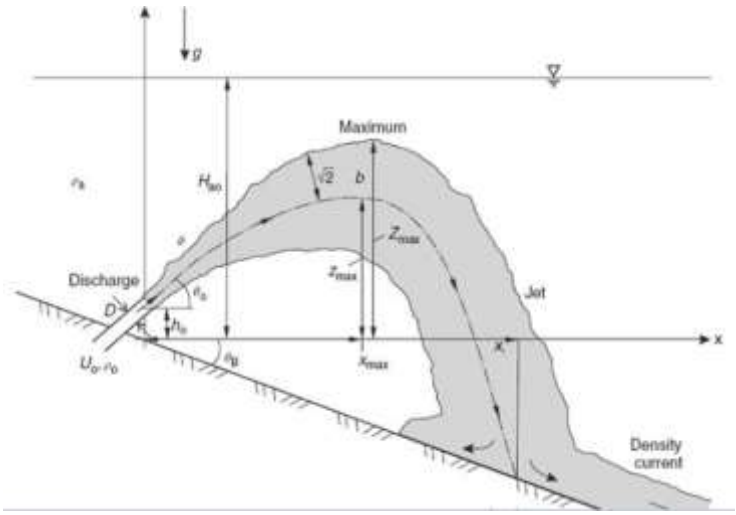

Fig. 3: Exit of effluent jet from tube into the sea with marine parameters [4]

Kish Port Solar Distillation and surrounding area

RO technology is used in Kish port solar distillationin Hormozgan province. For reasons mentioned in the introduction, one of the most important sections of the solar distillationsite is effluent disposal system. Importance of this issue is the environmental impact and economic costs. According to information received from the desalination system and the efficiency of the system the effluent characteristics are considered in [Table 1].

Calculation of the minimum dilution level of the jet system

For comparison of the effluent disposal systems in this section is investigated application of jet system in Kish Port Solar Distillation. 8 tubes are used with diameter of 20 cm at the end of one main duct. End of main duct is 2500 meters from the beach and the location of the slope fracture from 4% to 1% is 500 meters from the beach. By using of Cormix software we have obtained result of dilution and cormix by jet system in effluent disposal systems of Kish Port Solar Distillation as table4.

Table: Characteristics of effluent of Kish Port Solar Distillation

Effluent discharge	1.2 m^3/s
Effluent density	90000 mg/lit
Effluent temperature	45°C

Table 2: Characteristics of effluent of surrounding areas of Kish Port Solar Distillation

Velocity of flow	3 m/s
Wind velocity	2 m/s
environment tempreture	40°C
coefficient of Darcy Veysbakh in near the sea	0.04
coefficient of Darcy Veysbakh in depletion area	0.13
near the seaSlope in	%4
Slope in near depletion area	%1.2
Environment density	45000 mg/lit

Table 4: Result of dilution and density concentration (mg/lit) by jet system in effluent disposal systems of Kish Port Solar Distillation

Concentration mg/lit (cormix)	S(dilution)	X(distance)	Concentration mg/lit (cormix)	S(dilution)	X(distance)
6360	14.1	17.43	88000	1	0
5960	15.1	18.38	49400	1.8	0.73
5960	15.2	18.62	39600	2.3	1.67
5930	15.2	18.99	37000	2.4	2.62
5900	15.2	19.36	34000	2.6	3.58
5880	15.3	19.73	29700	3	4.53
5860	15.3	20.11	25900	3.5	5.38
5860	15.4	20.45	22300	4	6.32
5684	15.4	20.85	19200	4.7	7.26
3490	25.8	45.35	16700	5.4	8.2
2540	35.5	69.15	14700	6.1	9.13
2210	40.7	93.31	13000	6.9	10.07
2070	43.5	117.11	11700	7.7	10.93
1990	45.3	140.91	10500	8.5	11.87
1930	46.6	165.07	9540	9.4	12.81
1890	47.7	188.87	8700	10.3	13.75
1850	48.5	213.02	7970	11.3	14.96
1810	49.8	236.82	7400	12.2	15.55
1790	50.3	260.63	6850	13.1	16.49

CONCLUSION

The use of saline water resources by solar distillation is available in many areas that are an affordable way to provide drinkable water. But the site desalination plant produces a much higher salt concentration of sea water. Using of the mixing models is very common for estimating of initial dilution. In this study, the performance of the jet system has been studied for waste disposal of Kish port solar desalination site by using empirical equations. Initial dilution is related to water depth, diameter, flow rate, distance between openings, water velocity environment. After considering different environmental conditions and the most critical conditions the best initial dilution is determined. In the above scenarios the final scenario is best and the first scenario is worst case. By using of jet system as an effluent disposal system for Kish Port Solar Distillation, we have obtained thatwith increasing of effluent discharge from 0.463 m^3/s in the Khamir port to 1.2 m^3/s in Kish port, the length of main duct must be increased. The performance of the T-shaped diffuser for waste disposal is cheaper than the jet system because in it is consumed the length of duct from beach to sea.

CONFLICT OF INTEREST
There is no conflict of interest.

ACKNOWLEDGEMENTS
None

FINANCIAL DISCLOSURE
None

REFERENCES

[1] Adams EE. [1982] Dilution analysis for unidirectional diffusers, Journal of the Hydraulic Division, ASCE, 108(3), 327-342.
[2] Moshir Panahee D, Ghaheri, M, Ranaee, F. [2010]. Waste disposal site location and desalination Port paste", fourth Environmental Engineering Conference, Tehran, Tehran University, Iran.
[3] Nezhad Naderi M, Hessami Kermani M, Barani G. [2013] Form of waste water discharge in Khamir port solar distillation for environmental management by the empirical equations. Advances in Applied Science Research, 4(4):76-80.
[4] Takdastan OR. Hajizadeh N, Jafarzadeh N. [2006]. Discharge of sewage into the sea is a good option for the disposal of sewage in coastal areas, Seventh International Conference on Coasts, Ports and Marine Structures, Ports and Shipping Organization, Tehran, Iran.
[5] US Environmental protection agency- USEPA. [1994]. Dilution models for effluent discharge. Office of research and development Washington DC EPA/600/R-94/086.
[6] Won Seo II, Kim HS. Yu D Kim DS. [2001]. Performance of Tee diffusers in shallow water with cross flow. J of Hydr Eng., 34:53-61.