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**Research Article**

# Environmental Considerations of Wastewater Discharge from Solar Distillation Site to Sea

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## ABSTRACT:

Initial dilution and its characteristics play important roles in designing of effluent disposal into the sea. Using the mixing model is very common for estimation of initial dilution. In this study the application of jet system has been addressed for waste disposal of Kish Port solar desalination site by using empirical equations. Initial dilution is related to water depth, diameter, flow rate, the distance between theopening outlets and velocity of the sea water. As the results of this paper, the critical and the best initial dilution were determined with regard to different environmental conditions. For comparison of the effluent disposal systems is investigated application of jet system in Kishport solar distillation with system of waste disposal of Khamirport solar distillation. 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.

**Keywords:** desalination unit, saltwater, Mixing zone, Initial dilution, T form Diffuser, jet system for waste disposal.

## 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 Khamirde salination 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 thatgenerated 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 beyondof 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 thatis defined Far field.Primarily discharge of pollutants into the sea act as jet due to the initial velocity and momentum flux and thenthat act the same as plume because of energy dissipation of velocity operation due to taking the distance into sea. Jet is the draining a fluid from a hole or groove to the large volume of fluid (with initial momentum).As the motion of the tube, the behaviour 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 (US Environmental protection agency- USEPA, 1994).

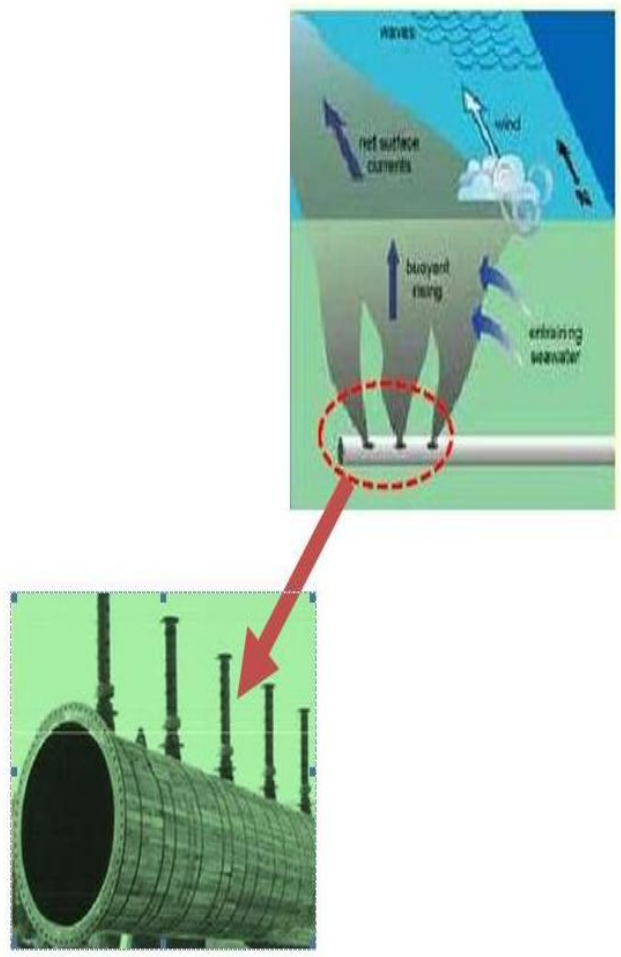


**Figure 3 -** exit of effluent jet from tube into the sea (NezhadNaderiet al, 2013)

**Kish Port SolarDistillation and surrounding area**

RO technology is used in Kish port solar distillation in Hormozgan province. For reasons mentioned in the introduction, one of the most important sections of the solar distillation site 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 SolarDistillation.8 tubesare 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 cormixby jet systemineffluent disposal systems of Kish Port SolarDistillation as table4.

**Table 1.** Characteristics of effluent of Kish Port SolarDistillation

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

**Table2.** Characteristics of effluent of surrounding areas of Kish Port SolarDistillation

| | |
|---|---|
| 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 |

**Table3.** Characteristics of effluent of surrounding areas of Kish Port SolarDistillation

| | |
|---|---|
| Diameter of tubes | 20cm |
| Number of tube | 8 |

**Table4.** Result of dilution and density concentration (mg/lit)by jet systemin 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 |

With regard to the duct diameter is 40 cm and the distance between holes is considered to be evacuated 12 m and B values according to formula (6) is 0.010467.Then the values of H (in Table 7)

and the velocity of water in the fourth column of Table 8 and ($M_r$) is calculated. Also $\theta_0$ is considered 45 degrees. Finally $S_t$ obtains for the outlined scenarios.

**Table5.**Characteristics of effluent of Khamir Port Solar Distillation(NezhadNaderiet al, 2013)

| | |
|---|---|
| effluent discharge | 0.463 $m^3$/s |
| Effluent density | 90000 mg/lit |
| Effluent temperature | 25°C |

**Table6.** Characteristics of effluent of surrounding areas of Khamir Port SolarDistillation(NezhadNaderiet al, 2013)

| | |
|---|---|
| Velocity of flow | 0.5 to 3 m/s |
| Wind velocity | 0 to 2 m/s |
| environment tempreture | 25°C |
| coefficient of Darcy Veysbakh in near the sea | 0.018 |
| coefficient of Darcy Veysbakh in depletion area | 0.2 |
| near the seaSlope in | 2.5% |
| Slope in near depletion area | 0.6% |
| Environment density | 30000 mg/lit |

**Table7.** Characteristics of effluent of surrounding areas of Khamir Port Solar Distillation (Nezhad Naderiet al, 2013)

| | |
|---|---|
| Diameter of diffusers | 40cm |
| Number of diffusers | 3 |
| Distance between diffusers | 12m |
| Distance of first diffuser from sea | 826m |
| Distance of second diffuser from sea | 838m |
| Distance of third diffuser from sea | 850m |
| Height of diffusers from bottom of sea | 1.2m |

**Table8.** Scenarios of Form of Waste Water Dischargein Khamir Port Solar Distillation (NezhadNaderiet al, 2013)

| | distance of depletion area to beach (m) | Velocity of wind (m/s) | Velocity of water (m/s) | depletion depth (m) |
|---|---|---|---|---|
| The first scenario | 1000 | 0 | 1 | 9.8 |
| The second scenario | 1000 | 0 | 2 | 9.8 |
| The third scenario | 1000 | 0 | 3 | 9.8 |
| The fourth scenario | 500 | 0 | 0.5 | 6.8 |
| Scenario V | 500 | 0 | 1 | 6.8 |
| Scenario VI | 700 | 0 | 0.7 | 8 |
| Scenario Seven | 700 | 0 | 1 | 8 |
| Eight scenario | 850 | 0 | 0.5 | 8.8 |

**Table 9.** Result of Scenarios of Form of Waste Water Dischargein Khamir Port Solar Distillation (Nezhad Naderi et al, 2013)

| | $S_0$ | $M_r$ | $S_t$ |
|---|---|---|---|
| The first scenario | 18.19405 | 16.1964 | 15.3265 |
| The second scenario | 18.19405 | 64.7865 | 17.4883 |
| The third scenario | 18.19405 | 145.7703 | 17.985 |
| The fourth scenario | 15.155 | 2.8152 | 9.693 |
| Scenario V | 15.155 | 11.232 | 12.088 |
| Scenario VI | 16.4384 | 9.25524 | 12.7084 |
| Scenario Seven | 16.4384 | 13.221 | 13.4458 |
| Eight scenarios | 24.382 | 1.469 | 16.164 |

## 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 SolarDistillation, 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.

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