Optimizing the wastewater treatment method for industrial use: a case study of Bandar Abbas city

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Introduction

Iran is situated within the arid belt of the world. Climatic shifts attributable to global warming over the past few decades, as well as the indiscriminate utilization of available water resources, have put Iran at a high risk of experiencing severe water shortages (Zarepour Moshizi et al. 2022). According to recent surveys, the impacts of climate change and drought have been more pronounced in south of Iran, than in other regions of the country (Mansouri Daneshvar et al. 2019). As a result, the management of water consumption and the use of wastewater in industries have become imperative, particularly in these areas (Charkhestani et al. 2016). Discharging wastewater from urban and industrial activities leads to the destruction of biological environments and ecological changes. Consequently, the reuse of water, an old practice but a novel approach, has become the focus of all governmental and non-governmental. Therefore, to preserve water reserves and promote the development of industry and agriculture, it is necessary to utilize the full potential of sewage effluents in accordance with all environmental standards, particularly given the impact of drought and water scarcity on water resources in the Bandar Abbas city (located south of Iran) in recent years. This study aims to examine the feasibility of using Bandar Abbas wastewater treatment effluents in the industries located to the west of the city. Three different methods of wastewater treatment and reuse have been assessed in this study, and the optimal option has been selected based on technical, environmental, economic, and operational considerations.

Material and Method

The proposed supplementary treatment unit will be situated within the Bandar Abbas wastewater treatment plant. It is noteworthy that the treatment plant was designed to handle a flow rate of 64 thousand cubic meters per day. However, the current flow rate of incoming wastewater to the plant has exceeded its capacity, with 100 thousand cubic meters per day, leading to the discharge of untreated wastewater into the sea. As such, the primary aim of this project is to reuse wastewater and prevent environmental pollution. Based on the investigations carried out, three different options have been suggested for the additional treatment of Bandar Abbas wastewater. These options are outlined as follows:

- Option 1: This method involves chemical precipitation, double layer filtration, ozonation, activated carbon, ultrafiltration, filter cartridge, reverse osmosis, and final purification.
- Option 2: This method includes chemical precipitation, double layer filtration, ultrafiltration, advanced oxidation, filter cartridge, reverse osmosis, and final purification.
- Option 3: This method involves chemical precipitation, double layer filtration, advanced oxidation, ultrafiltration, filter cartridge, reverse osmosis, and final purification.

Result and Discussion

Based on the information provided, it appears that all three options have several stages of treatment including chemical precipitation, double-layer filtration, and reverse osmosis. However, the main difference lies in the additional treatment steps such as ozonation and activated carbon in option 1, advanced oxidation in option 2, and dissolved air flotation in option 3. Option 1 has a comprehensive treatment plan that includes ozonation and activated carbon to remove the remaining organic matter. However, the high-dose chlorine injection may raise environmental concerns. Option 2 has a similar treatment process to option 1 but with the addition of advanced oxidation to remove organic matter, reducing the amount of ozone needed for the ozonation process. It also includes a UV disinfection system to reduce microbial burden. Option 3 has the most complex treatment plan with dissolved air flotation added to the chemical precipitation process, followed by advanced oxidation and ultrafiltration. This may result in higher costs and greater technical challenges. In terms of economic factors, option 2 may be the most cost-effective due to the reduced ozone usage and simpler treatment process. However, the advanced oxidation unit and UV disinfection system may add to the capital and operational costs. From an environmental perspective, option 2 may also be preferable as it reduces the amount of ozone required for treatment, reducing the potential for harmful by-products. From a technical perspective, option 1 may be the most reliable as it includes multiple treatment stages to ensure high-quality effluent, but the high-dose chlorine injection may pose technical challenges. Therefore, based on the given information, option 2 may be the most favourable choice, as it offers a good balance between economic, environmental, and technical factors.

The economic and technical advantages of the third option for the additional treatment of Bandar Abbas wastewater treatment plant are highlighted in the evaluation matrix (Tables 1 and 2). The low initial investment cost and the low cost of treating each cubic meter of wastewater make this option economically favourable. Additionally, the less energy consumption compared to the first option is a technical advantage that can reduce operational costs over time. Moreover, the ease of operation of the system due to the units considered for desalination water pre-treatment is another significant technical advantage of the third option. The speed and ease of system implementation according to the type of units considered can also reduce the downtime of the plant during the construction phase. Another technical advantage of the third option is less water wastage due to the absence of active carbon filters, which can result in lower operational costs. Overall, the third option offers a balanced approach, making it the best option for the additional treatment of Bandar Abbas wastewater treatment plant.

Table 1- Economical evaluation matrix of different options.

Alternative	**Treatment cost per cubic meter**		**Initial investment cost**		**Operation cost**		**Total**
A1	73	7.3 10	68.8	8.6 8	72	9 8	213.8
A2	100	10 10	80	10 8	80	10 8	260
A3	100	10 10	80	10 8	80	10 8	260

Table 2- Technical and operational *evaluation matrix of different options.*

Alternative	**The amount of energy consumption**		**Ease of use**		**Speed and ease of implementation**		**Executive records and operation inside the country**		**The amount of water wastage**		**Ensuring the quality of outgoing water**		**Total**
A1	80	10 8	63	7 9	49	7 7	63	9 7	54	9 6	56	7 8	365
A2	61.6	7.7 8	72	8 9	70	10 7	42	6 7	60	10 6	64	8 8	369.6
A3	61.6	7.7 8	81	9 9	70	10 7	42	6 7	60	10 6	72	9 8	389.6

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