

Industriewassertag

AK Industriewasserwirtschaft & GEMÜ

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German Water
Partnership

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German Water
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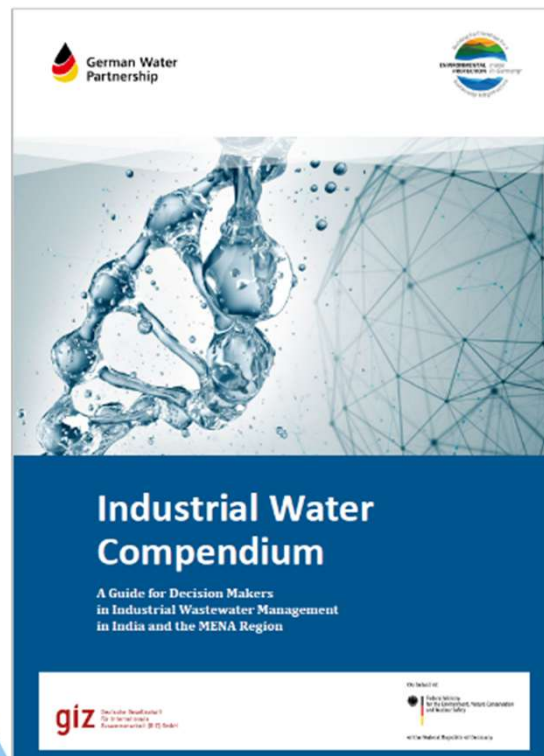
Industrial Water Compendium



On behalf of:



of the Federal Republic of Germany



1 OIL AND GAS EXTRACTION

Country-specific information

India
The Indian oil and gas industry produces approximately 24 million tonnes of crude oil and 32 million cubic metres of natural gas annually, placing India 24th among oil-producing countries¹⁾. The country includes 26 sedimentary basins with a total area of 1.8 million km², of which 1.3 million km² are located in deep-water (deeper than 200 m). A relatively large share of the oil and gas deposits is therefore located on land, making extraction correspondingly easier. The main deposits are located in Assam and off the west coast (both oil and gas), in Gujarat (oil) and off the east coast of the country (gas). To date, many of the sedimentary basins in India have been exploited to a small degree if at all, with an average well density of one well per 250 km². Especially in the west of the country, larger oil reserves (approximately 300 million tonnes) are yet to be exploited.
The country is trying to meet the increasing domestic demand for oil and gas by exploring deposits further (including unconventional oil deep-water wells). An important focus is also on

improving the yield of existing extraction facilities. Besides some private domestic and foreign investors, the Indian oil and gas sector is mainly dominated by large national companies. Among the most important are ONGC (Oil and Natural Gas Corporation), Reliance Industries and Indian Oil²⁾. Challenges involved in implementing investment projects include complex regulatory conditions and governmental price regulation of oil products³⁾.

MENA
The most important oil-producing countries in the MENA region are Saudi Arabia, Iran, Iraq, Kuwait and the United Arab Emirates. On the African continent, Egypt plays a significant role alongside Algeria and Libya (Figure 1). Egypt is the largest African oil producer, while the third-largest gas producer on the continent. It also benefits from a strategic location on the Suez Canal. Its main deposits are in the Western Desert and the Gulf of Suez. In recent years, substantial natural gas deposits have been discovered, and these are now being developed by national and international investors. One of these is the Zohr ('Siwaoui') field in the Mediterranean – the Zohr ('Siwaoui') field – which was first discovered in 2015⁴⁾. In Egypt, both national and international companies (such as Shell and BP) are involved in exploration⁵⁾.

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10 | 1. Pharmaceutical industry

via solvent recovery systems. In general, the pharmaceutical industry is facing a challenge due to the great variation in the quantity and characteristics of the individual production wastewaters involved, as well as the extreme persistence and poor biodegradability of many contaminants.^{15, 16}

Treatment processes

Biological cleaning
Wastewater treatment in the pharmaceutical industry is traditionally carried out by means of biological cleaning processes. The wastewater often contains a highly biologically active organic load; however, there are often substances in the wastewater that have poor biodegradability or can even have a toxic effect on the biological agents. This is a challenge for numerous biological cleaning processes. The biodegradability of a chemical compound depends mainly on its stereochemistry, toxicity and concentration levels. From an operational point of view, the suitability of the particular microbial strain involved, the digestion conditions and the time spent in the biological stage play an important role.¹⁶

Aerobic processes are most commonly used in the pharmaceutical industry for wastewater treatment, as they are very robust in operation. Activated sludge processes including sedimentation and long sludge retention times are often the means of choice, although membrane bioreactors are also increasingly utilized to achieve a high effluent quality. Aerobic processes have proven successful for the degradation of many active pharmaceutical ingredients (e.g. digoxigenin, naproxen, bezafibrate and metoprolol), but they have their limits, especially with nitrophenols (e.g. nifedipine, nifedipine, cefepime and colistin). Anaerobic processes are less commonly used because, on a comparative basis, they are susceptible to a number of pharmaceutically active substances and disinfectants.¹⁶

In recent decades, increasing attention has also been paid to active pharmaceutical ingredients in

wastewater. Although these substances occur in consistently low concentrations, they are difficult to remove and have a high level of environmental toxicity. The removal of these active substances is close as possible to their source (i.e., as a decentralized basis within the wastewater stream involved) serves the following goals, among others:

- Removal of substances with a toxic effect on biology
- Increasing the biodegradability of the water
- Removal of non-biodegradable contaminants

depending on the general conditions and the wastewater matrix, it may also make sense to further purify the wastewater stream following biological cleaning. In both cases, the removal of persistent active pharmaceutical ingredients is achieved by advanced physico-chemical cleaning processes. The most commonly used processes are:^{16, 17}

- Coagulation and flocculation
- Precipitation
- Adsorption
- Oxidation
- Membrane filtration

Even though, in many locations, there are still no binding limits in place for the discharge of some active pharmaceutical ingredients, advanced purification is already widespread in many pharmaceutical production plants. One reason for this is that companies operating globally often set high operational quality standards that have to be met regardless of local regulations.

The reuse of treated wastewater in the pharmaceutical industry is only considered, if at all, for non-production applications. This is because of the very stringent quality standards imposed as an operational level on the use of pure water streams for production and cleaning purposes. Discharge into the environment is also problematic due to contaminants. In contrast, there is more potential in the recovery and reuse of other raw materials, such as solvents, acids and individual active ingredients. These recovery approaches often rely on the operation of an efficient and decentralized secondary wastewater treatment system.¹⁸



Oxidation
A number of chemical compounds that have poor biodegradability and are difficult to remove from wastewater by adsorption can be successfully eliminated by oxidation processes. Oxidation products are formed from the original molecules as a result of reaction with oxygen. It is often observed that these oxidation products are more easily degradable in a subsequent biological stage than the original substances. However, it should also be noted that the resulting reaction products are not fundamentally harmless and, in some cases, may even be more toxic than the original substance.

The most frequently used oxidation process in industrial wastewater treatment is treatment with gaseous ozone. The ozone molecules react selectively with certain functional groups of the wastewater matrix but they also decompose to form hydroxyl radicals, which oxidize wastewater components less selectively and have a higher

oxidation potential. Ozone processes are widely used in the pharmaceutical industry, for example for the targeted removal of antibiotics from wastewater streams.¹⁹

As an alternative to ozonation, advanced oxidation processes are increasingly being used. These are mainly aimed at the formation of non-selectively reacting hydroxyl radicals and are intended to reduce the formation of problematic oxidation products. There is a wide range of tried-and-tested processes available, from homogeneous to heterogeneous catalyzed reactions. The catalysts used are usually transition metals, while an external energy source, such as UV radiation, can also be deployed. Common advanced oxidation processes for wastewater treatment include:^{19, 20}

- Combination of ozone and hydrogen peroxide
- Fenton process with iron salt as catalyst
- Electro-oxidation
- F₂O₂ photocatalysis (mainly at pilot scale) (1)

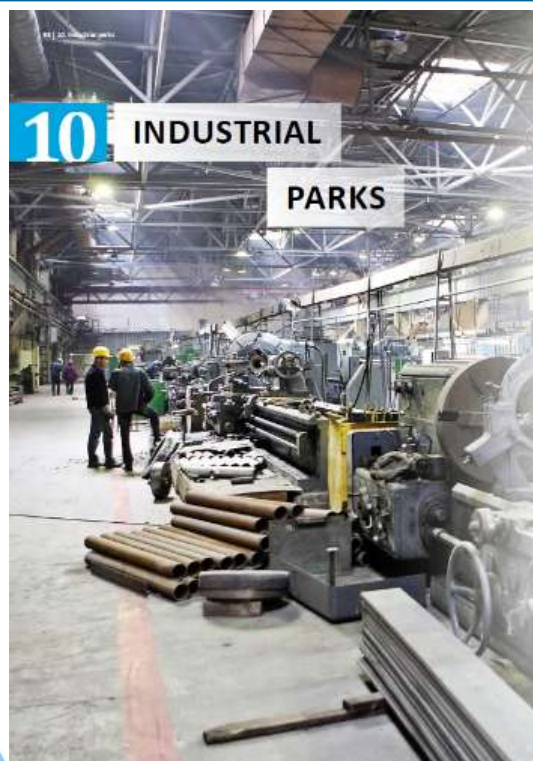
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08 | 10 Industrial parks

case study: Wastewater treatment in industrial areas in Morocco

Turnkey construction of the 'Nouaceur Industrial Zone' wastewater treatment plant in Casablanca

Background

The government of the Kingdom of Morocco has decided to upgrade the wastewater treatment facilities at the country's industrial zones to comply with the new discharge regulations. This decision takes into account the national and regional trend to build stand-alone industrial wastewater treatment plants for the purpose of raising the treated wastewater and/or discharging it into a receiving water body in an environmentally sound way. The policy pursued by the government is aimed at equipping existing industrial areas with specific wastewater treatment plants adapted to the particular industrial park involved. These plants will contribute to environmentally sound wastewater treatment while at the same time relieving the burden on the municipal drainage infrastructure.

Parameter	industrial zone	typical discharge
reaction time	10/20h	2-6h
max. volume	10/20m ³	500
max. inflow biological treatment	10/20m ³	500
BOD ₅	mg/l	400 ± 10
SS	mg/l	130 ± 10
DS	mg/l	400 ± 20
nitrate	mg/l	500 ± 10
nitrogen	mg/l	150 ± 10
phosphorus	mg/l	40 ± 2

Note: 10 Design parameters and the effluent values to be achieved for the treated wastewater of the 'Nouaceur Industrial Zone' wastewater treatment plant, Morocco

The location of the 'Nouaceur industrial zone' wastewater treatment plant project is in the Casablanca region, within the ZONE SAPEMA industrial park. More than 100 companies from a very wide range of sectors are located here, industries represented include the manufacture of gas fibre-reinforced plastic pipes, packaging production, the food industry, the manufacture of aluminium cans, battery production, large-scale handsets, metal processing, distillery production and service providers and trading companies.

The project sponsor is the Moroccan Ministry of Industry, Trade and Green and Digital Economy (MIDCE). It has entrusted the project to UVED, the company responsible for drinking water supply, sewerage, electricity distribution and public lighting in the Casablanca region. The contractor is a consortium led by PAUT Wasser- und Abwassertechnik GmbH.

Particular challenge
Industries are required to pre-treat wastewater locally; this pre-treatment can involve both mechanical and chemical processes. The client UVED first carried out a series of measurements. The parameters investigated were those shown in Table 1 along with electrical conductivity. The design parameters for the treatment plant were determined in consideration of a possible expansion and/or change in the population of the area. Furthermore, consideration was given to ensuring that peak inflows can be handled. The concept developed and implemented by the PAUT includes a buffer basin necessary for equalising peak inflows and for the intermediate storage of contaminated wastewater, in also provided for the possibility of future expansion.

Solution

The Nouaceur treatment plant is an activated sludge plant involving aerobic and simultaneous sludge stabilisation in nucleation basins. The wastewater treatment consists of mechanical pre-treatment (coarse screen upstream of the lift station, fine screen and an afloat grit and grease trap, a buffer tank to accommodate peak flows or contaminated wastewater, biological treatment by means of simultaneous denitrification and secondary sedimentation, chemical phosphorus elimination, and disinfection with sodium hypochlorite prior to discharge into the Oued Mersha. The expansion of the plant is currently under consideration. This would include a further cleaning stage involving sand filtration and UV disinfection so that water can be reused for irrigating green areas.

Sludge treatment includes mechanical dewatering of the sludge using centrifuges along with conditioning and coagulation by the addition of lime, prior to disposal at the municipal landfill site. Due to the location of the treatment plant in a densely populated area, the facilities concerned are equipped with modern odour treatment and noise reduction equipment. Table 1 lists the design parameters and the effluent values to be achieved for the treated wastewater.

Figure 1: Aeration basin under construction at the Nouaceur wastewater treatment plant in Nouaceur, Morocco



Technical measures to deal with unpredictable fluctuations

- In this context, the following points should be noted:
- The chosen treatment process, involving a buffer tank for peak inflows or for contaminated wastewater, provides a certain degree of flexibility in cases where the quantity/quality of the wastewater is difficult to predict.
- The solution provides for the installation of corrosion-resistant materials, as higher salinity levels may occur in the wastewater due to the proximity of the project site to the sea.
- Hydrocarbon measurement and pH and conductivity measurements are installed in the feed area of the treatment plant so that any unusual wastewater can be identified and directed to the buffer tank. Depending on the results of the analysis of the stored water, it can then be sent for treatment or disposed of in accordance with environmental regulations.

Benefit
Construction of the wastewater treatment plant at the Nouaceur industrial zone is currently underway. Fig. 1 shows the aeration tanks constructed.

Contribution of the technology provided
The plant installed on the site incorporates complete mechanical, biological and chemical wastewater treatment. Special attention was paid to the specific requirements of an industrial wastewater treatment plant receiving water from a very wide range of sources, e.g. high plant flexibility and safety, as well as appropriate metrological monitoring of plant operation.

Greendustrial Dialogues Ägypten 2022 und Indien 2023



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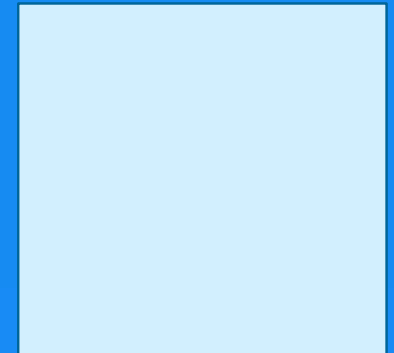


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