CASE STUDY

BioPetroClean (BPC) – Cost effective Bioremediation solutions for oil-polluted water

Introduction

The following case study discusses the installation of BioPetroClean's (BPC) Automatic Chemostat Treatment (ACT) at the Eilat-Ashkelon Pipeline Company (EAPC), following a successful pilot project in 2007. Using a fully-automated biological skid-mount system, BPC was able treat drainage and ballast water on-site. BPC provided a cost effective solution, utilizing existing infrastructure, giving EAPC the ability to improve and control the quality of their waste water.

Background

EAPC serves as a land bridge for transporting crude oil between the Red Sea and the Mediterranean, and provides long term storage and crude oil blending. The company produces waste water from storage tanks, feeder pipes from tankers, and runoff rainwater. EAPC's awareness of environmental issues was heightened by the site's proximity to a water desalination facility, a nature reserve, and a densely populated civilian area.

The company's former method of drainage and ballast water treatment was based on the use of a gravitational oil separator, following which the inadequately treated water was released into permeation lagoons in close proximity to the shoreline. The treatment flow rate was 5m^3/hour and contained a 4% salinity level. EAPC was having difficulties in adhering to the required environmental standards, and was strongly criticized by members of industry, as well as civilians, for polluting the waters surrounding the terminal.

> *"We searched for a solution that was not only cost-effective and uncomplicated, but one that would also improve the [water] quality for the surrounding environment and residential areas."*
>
> - Izik Levi, Port Manager and Operations Head at EAPC

Consequently, EAPC sought a cost-effective solution that would bring its waste water to the highest standards, using less chemicals and electricity.

BPC's Solution: Analyze – Customize – Solve

The BPC solution is implemented using a three phased approach. Feasibility testing and extensive analysis were performed on water samples from the EAPC site at BPC's laboratory. Based on the results of the analysis, BPC installed a pilot system which operated for a period of 6 weeks, incorporating specific environmental elements and ground conditions. Following the successful pilot test, BPC installed a full scale permanent solution at the EAPC site.

Phase 1: Lab Analysis – 3 Stage Process

Automatic **C**hemostat **T**reatment (ACT) was performed on EAPC's water samples by applying a tailored bacterial cocktail to remove all hydrocarbons. The cocktail is comprised of a unique mixture of naturally-occurring bacteria that feed on petroleum hydrocarbons and other organic compounds. In order to ensure optimal bio-degradation of the contaminated water, this cocktail is then combined with a proprietary nutrient-mix.

For the purpose of identifying the optimal bacteria and treatment conditions, a selection of flask treatments were performed under simulated conditions, utilizing bacteria from BPC's "bacterial bank". Continuous flow experiments were then conducted in order to determine the optimal treatment process. The results were presented in a detailed report that included comparison values of all measured parameters and associated treatment protocols.

The three stages of the lab analysis are described below:

Stage 1: Analysis – A series of laboratory tests (which included bacterial concentration, TOC, TPH, COD, phenol, UV scan, salinity, etc.) were performed to identify the contaminating materials.

Stage 2: Flask-Mode Experiments – The purpose of this stage was to identify the optimal treatment conditions for the site-specific case. Based on results of the previous stage various bacteria were selected from the water samples, and BPC conducted a variety of batch-mode treatments under differing conditions.

Stage 3: Continuous flow treatment – In the continuous flow stage the aeration, flow, and other parameters necessary for installing the ACT system were examined. The optimum conditions identified during batch mode testing formed the basis for the continuous flow treatment.

Results of the lab analysis, conducted for both batch (flask) and continuous modes of operation are presented in Table 1 below. As shown in the table, contamination levels were reduced to acceptable standards, including significantly lower levels of TPH, TOC, and turbidity.

BPC Lab Analysis of EAPC Wastewater: Before and After Treatment

Parameters (ppm)	Unit	Before Treatment	Flask Mode	Continuous flow	Discharge Requirements		
					Maximum value	Minimal value	Average Value
Flow	%		**Flask**	**10**			
TPH	ppm	11.97	1.3	0.5	5		3
TOC	ppm	382	76	34	100		50
TSS	ppm	640	106	32	75		50
Turbidity	NTU	360	142	15.13	50		30
pH		7.6	8.5	8.4	9.5	6	9
Sulfide	ppm	147	NM	0.022	0.5		0.2
Phenol					0.15		0.1
phosphate*		1		2.1			
Ammonia*		8		5.1			

Phase 2: Pilot Installation

Following the completion of the laboratory analysis BPC proceeded with an onsite pilot installation, incorporating all of the specific environmental elements and ground conditions. The pilot also allowed the client to experience the ACT technology first hand. During the pilot installation, the BPC solution underwent extensive evaluations by EAPC's finance, engineering, and environmental personnel.

Results of the pilot installation are presented in Table 2 below.

Parameters (ppm)	Before Treatment	After Treatment	Discharge Requirements
TPH	25 – 75	1-2	3
BOD	300-1500	20-30	30
TOC	400-1000	25-50	50
TSS	10 – 100	2-15	50
Turbidity	200-1000	2-7	30
pH	7-9	7-9	6.5<pH<9
Detergents	1-5	1-2	3
Sulfide	50-200	<0.1	0.2
Phenol	5	<0.02	0.1
Cresol	1	<0.02	0.15
Benzene	0.5	<0.05	0.1
Xylene	0.5	<0.05	0.1
Toluene	0.5	<0.05	0.15

Table 2: Pilot Results

Contamination levels were reduced to within government discharge requirements or better. TPH with excess levels at 25-75 ppm, was reduced to 1-2ppm. Turbidity was reduced from 200-1000 to 7 NTU, while TOC was brought down from 400-1000 to 25-50 ppm. Furthermore, BTEX was reduced to below the detection level of the sensors.

Following BPC's successful treatment, the purified water could be released into the sea with the full authorization of the local environmental protection authority.

Total Petroleum Hydrocarbons (TPH) Flow Results

The pilot installation clearly demonstrated BPC's ability to provide a stable bio-remediation process inside the bio-reactor by overcoming the fluctuations in the TPH concentrations. The continuous flow both before and after treatment, as shown in Figure 1 below, illustrate that despite significant fluctuations in the TPH inlet quality, the outlet was kept below 3 ppm. The retention time of the bioreactor was 5 hours (20% of volume) at all times.

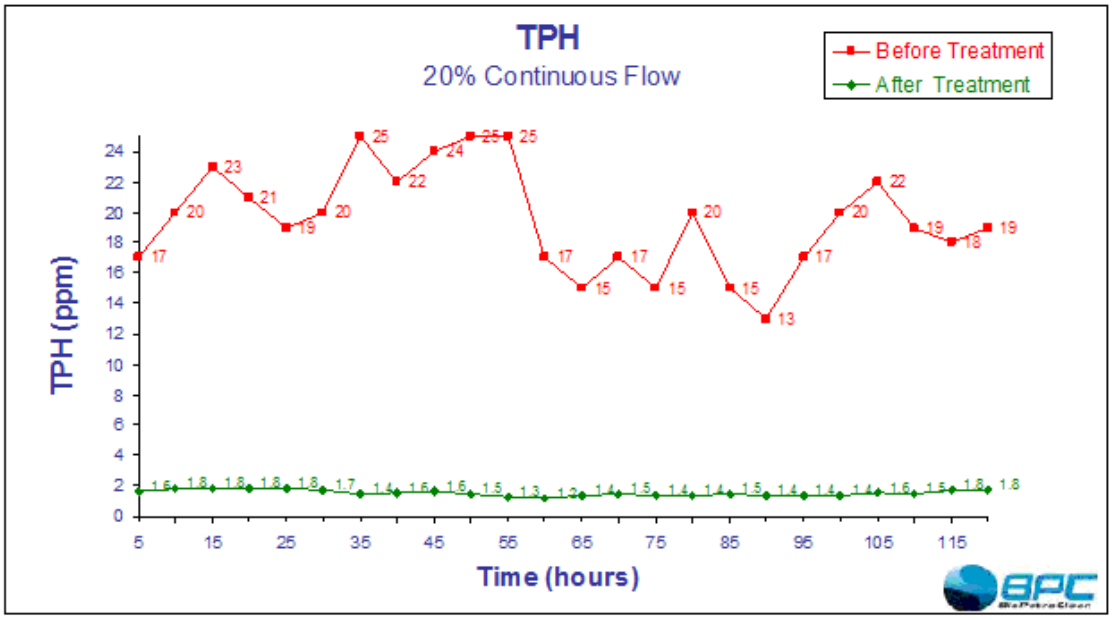

Figure 1: Low & Stable TPH Flow

Following the client's complete satisfaction with the results of the pilot, BPC proceeded with the design of the full scale system for permanent installation at the EAPC site.

Phase 3: Full-Scale Solution

With all of the components for the full scale solution in place, BPC's bio-reactor was installed at the EAPC site. BPC's system seamlessly integrated with existing infrastructure. As shown in the figure below, BPC's ACT bio-reactor integrated with EAPC's available tanks and separators. EAPC's gravitational separation method fed directly into the BPC bio-reactor for efficient and rapid processing.

Figure 2: BPC - Integrates with Existing Infrastructure

The BPC system is fully automated, maintaining complete stabilization at all times. Any change in parameters such as temperature and pH are immediately detected by the bio-reactor's sensors. This information is communicated to the control system which immediately makes necessary adjustments. Reports and system logs are generated automatically and the system can also alert support personnel via SMS.

The figure to the right illustrates the automated control system.

Figure 3: Automated Control System

Conclusion:

BPC provided a cost effective solution to EAPC for the rapid and efficient treatment of their waste water output. Using a three phased approach of laboratory analysis, pilot installation, and a full scale solution, BPC successfully demonstrated its ability to produce sludge free purified water for rapid release into the environment with no harmful effects.

Due to the low concentration of bacterial cells used in the process, no aggregates were formed. Each bacterium increases the surface area available for the process thereby enabling biodegradation at a much higher level of efficiency. As illustrated in the figure below, the output from BPC's full scale solution is sludge-free purified water that can be immediately released into the environment.

Figure 4: Pre- and Post-Treatment

BPC's solution offers several key benefits:

- The system can be easily installed and rapidly integrated into any existing infrastructure.
- BPC's treatment delivers the lowest hydrocarbon content with no sludge by-product.
- BPC requires a low upfront capital investment and minimal operational and maintenance costs.
- BPC's treated water meets the most demanding regulatory standards across the globe.

With several of its key technologies and elements patented, the ACT technology transforms the treatment of waste water into a significantly more efficient, economical and environmentally friendly process. It can be applied across a wide range of sites from

refineries and oil terminals to drilling sites, marine ports, side streams water, reservoirs and more. BPC's system is fully operational and under evaluation in several sites around the world.

For further information please visit our website at www.biopetroclean.com

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