Research Article

Assessment of produced water from oil and gas field Gujar Khan, Punjab, Pakistan

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Abstract

This study was conducted to analyze the physiochemical and heavy metal concentrations in produced water of Missa Kaswal Oil field Gujar khan, Punjab, Pakistan. Produced water samples were collected from various locations points and analyzed for various parameters by using standard operation procedures. According to Pakistan Environmental Protection Agency, pH, temperature was noted with in permissible limit, total dissolved solids, chlorides, fluorides and oil and grease concentrations were found very high. The concentration of chloride and oil and grease were found several times higher as compared to Pak-EPA. Heavy metals results of the research samples are compared with Pakistan Environmental Protection Agency. From the results it was found that nickel (Ni), lead (Pb), manganese (Mn), zinc (Zn) and arsenic (As0 were within the permissible limits while chromium (Cr) concentration was observed in produced water above the permissible limits. So overall study concluded that wastewater which is released from oil and gas sector is highly polluted. So, it is strongly recommended that Pakistan Environmental Protection Agency should regular check and monitor that wastewater before releasing into the environment.

Keywords: Produced water, physicochemical characteristic, Heavy metals, Pak-EPA

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Introduction

Reservoir rocks are the constant pedigree of water and petroleum hydrocarbons, both gases in liquid sates. Subsurface rocks are largely equipped with fluids like oil, water and gas and amalgamation of them in their pores. Provocation reduces due to uprooting of gas and oil to increase the oil recovery; further external water is added into the reservoir. As gas and oil mass production continues, there comes a time when formation of waters reaches in a condition to production well, hydrocarbons and water mixed with water and comes with their production [1]. The emersed

water is collectively called as “formation water” or “connate water”. When reservoir forms, this water is brought to the upper surface besides other fluids it termed as “produce water”. So therefore, categorized as oil field produced water, their characteristic is depending upon the source [2]. Toxic metals like chromium (Cr), copper (Cu), lead (Pb), cadmium (Cd), zinc (Zn), nickel (Ni) is mostly released from industries and municipal sewage systems which highly contaminated the external environment [3, 4] Different industries including metal finishing, electroplating, metallurgical work, chemical manufacturing exploration, tanning, and other production process releasing wastewater consist of heavy metals having high environmental problems due to their toxicity even at low concentrations. Wastewater which is released in the oil and gas sector consists of heavy metals (Cd, Cr, Cu, Pb, Ni, and Zn) and their concentration depends upon the on-well’s age and formation of geology [3, 5]. Several studies were conducted on produced water throughout the world on toxicity effects of this water on surrounding environment including soil, ground water, crops and on vegetation [6, 7, 8, 9]. It is estimated that globally wastewater generated from oil sectors is around 250 million barrels per day compared with around 80 million barrels per day of oil. Comparatively water to oil ratio is 3:1 water cut is seventy percent. This world water cut has risen, a decade ago and continues to rise [6, 10]. Produced water characteristics are variable, owing to changes in the operational conditions, chemicals used in process facilities and on the nature of the producing. Composition of wastewater obtained from different sources can be changed but by qualitatively like oil and/or gas production [11]. So, this production consists of oil & grease, salts like sodium chloride, magnesium chloride, calcium chloride and potassium chloride which highly pollute the external environment, depleting biodiversity and deforestation [12]. Therefore, the present study was conducted to analyze the physiochemical and heavy metal concentrations in produced water of Missa Kaswal oil field, Punjab, Pakistan [1].

Methodology

Gujar khan is a city located in Rawalpindi district and Missa Kaswal is a small village in Gujar khan, Punjab, Pakistan. There is an oil field known as Missa Kaswal Oil Field operated by Oil and Gas Development Company Limited (OGDCL). This oil field was discovered by OGDCL in June 1991 and regular production was started from December 1992. Latitude and Longitude of Missa Kaswal are 33°11’55.94” and 73°20’32.53” respectively.

Result and Discussion

Composite produced water samples were collected from Missa Kaswal Oil and Gas Field from various locations including produced water tank-1, produced water tank-2, produced water tank-3, produced water tank-4 and produced water tank-5.

Samples results were analyzed for physicochemical analysis. It was found that pH ranged 6.76-7.44 compared with Pak-EPA, all the results were found within permissible limits.

pH plays an important role in the survival of aquatic organisms because most of the metabolic activities of the organism depend on pH. In produced water research samples, temperature and conductivity values were found 26.7-27.2 °C, 232-917 µS/cm respectively and compared with Pak-EPA, all the results were found with in permissible limits. conductivity values were found high, but their permissible limits are not defined by Pak-EPA [13]. For determining the water quality conductivity is also a significant factor.

Table 1: Shows the results of physiochemical properties of produced water of Missa Kaswal oil field.

Sample Locations	pH	Temp (°C)	Conductivity (µS/cm)	Concentration mg/l			
				TDS	Chloride	Fluoride	Oil and grease
Produced water tank 1	7.27	26.9	232	1100	1595	6.2	220
Produced water tank 2	7.44	26.7	321	1861	8862	5.3	203
Produced water tank 3	7.23	26.9	546	2199	9217	6.5	170
Produced water tank 4	7	27.2	748	3102	1843	7.8	180
Produced water 5	6.76	26.7	917	5546	9217	20	185
Pak-EPA	10-Jun	-	-	3500	1000		10
Min	6.76	26.7	232	1100	1595	5.3	170
Max	7.44	27.2	917	5546	9217	20	220
Pak-EPA	9-Jun	40	ND[a]	3500	1000	20	10

a=not defined

If there are many ions in water, it will conduct electrical current which is directly proportional to the dissolved ions. Other factors including total dissolved solids, organic compounds, and temperature also play an important role in increasing or decreasing electrical conductivity. In research samples, the rest of the parameters including TDS values were 1100-5546 mg/l, Cl were 1595-9217 mg/l, F were 5.3 20, oil and grease were 170-220 mg/l as shown in Table 1. These results were compared with Pak-EPA and found that TDS, Cl, oil, and grease were found in all samples above the permissible limit except F which were found within permissible limit. Its high amount makes it acidic, brackish, and salty. Its high value favors anions and cations, as TDS values have direct relation with most ions.

Samples results were analyzed for heavy metals concentrations in the same research samples, it was found that Cr were ranged 1.13-1.26 mg/l, Ni 0.03-0.1 mg/l, Pb were 0.04-0.3 mg/l, Mn were 0.62-0.75 mg/l, Zn were 1.7-2.5 mg/l and as were 0.05-0.2 mg/l, these results were compared with Pak-EPA. All the research samples were with in permissible limit except Cr results which were found in all samples above the permissible limit, as shown in Table 2.

Table 2: Results of heavy metals concentrations produced water samples.

Sample Locations	Concentration (mg/l)					
	Cr	Ni	Pb	Mn	Zn	As
Produced water tank 1	1.17	0.09	0.04	0.75	2.5	0.025
Produced water tank 2	1.13	0.1	0.05	0.62	2.1	0.05
Produced water tank 3	1.26	0.03	0.16	0.74	2	0.2
Produced water tank 4	1.2	0.05	0.3	0.67	1.7	0.2
Produced water 5	1.24	0.08	0.15	0.66	1.8	0.2
Minimum	1.13	0.03	0.04	0.62	1.7	0.05
Maximum	1.26	0.1	0.3	0.75	2.5	0.2
Pak-EPA	1	1	0.5	1.5	5	1

The wastewater which consists of series of heavy metals including Cr, Cd, Mn, Ni, Cu, Fe and Pb are releasing by oil and gas sectors into surrounding environment can be added in agricultural soil or in aquatic ecosystem to toxic level [6, 14]. It became more toxic even in small level for organism when it accumulated in living organism and food chain [15]. Wastewater which is released from industrial activities are used for irrigation are highly contributor to surface soil pollution, some of the toxic heavy metals like Cr, Cd, Pb and Mn [16]. This not only pollutes the soil but also impacts on food quality [15, 17] and effects some plants [15]. Further these accumulated heavy metals in soil disturbed the balancing of biochemical process. In plants growth different activities take place like organic matter degradation, assimilation, and nitrogen fixation [18] also harmfully affected by Cr, Cd, Pb, Mn, Ni, and other heavy metals in soil [19, 20].

Conclusion

Present study which was to analyze the physiochemical and heavy concentrations in produced water of Missa Kaswal Oil field Gujar khan, Punjab, Pakistan. Produced water samples were collected from various locations points and analyzed for various parameters by using standard operation procedures. All the results which were obtained were analyzed and compared with standard. In the oil and gas sector treatment plants are working so effectively that to treat the water in such a way that it becomes within a permissible limit. Therefor most of the water is highly contaminated. So, the concerned authority should regularly check and monitor the water before releasing it into the environment.

Authors' contributions

Methodology, Conceptualization; Hira Mumtaz (Mumtaz. H), Formal analysis; Iqra Fayyaz (Fayyaz.I), Writing - original draft preparation; Fateha Khan (Khan.F); Writing, review and editing Syeda Hijab Zehra (Zehra.S.H). Supervision, Dr. Said Akbar Khan (Khan. S.A). All authors have read and granted to the published this version of manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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