Valuation of Petroleum Industry Impact on the Hydric System of Some Regions in Albania

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Abstract : - **Operation of oil and gas drilling industry in Albania dates back in the '30s of the previous century. The oil and gas fields explored up to now are situated in the South and Western part of Albania and include the regions of Fieri, Kuçova, Mallakastra, Vlora, Lushnja and Delvina. The area of crude oil drilling and its treatment, before the product passes to the refining stage, is percolated by a huge hydric system, composed mainly of the Semani, Gjanica and Vjosa Rivers, as well as by plenty of small seasonal streams that together discharge their waters in the Adriatic Sea. Approximately 4850 oil wells and 330 gas wells are exploited for a long time from the oilfields.**
In the period of 1929 - 2009 the overall amount of crude oil produced is 52.45 million tons. Beyond the economic positive impact in the national economy, the oil industry development is accompanied by a negative environmental impact related to soil, water and air of the regions were they operate.
This study analyzes and gives evidences to the current pollution level of the hydric system and its geography. It elaborates the main factors leading to such a situation and gives alternatives related to re-establishing of a qualitative environment. It offers some proposals to the treatment of solid wastes and wastewaters that are accumulated from oil industry activity from the past periods by making use of new clean technologies serving for a better future.

Key words: crude oil, oilfield, oil well, hydric system, environmental pollution

I. INTRODUCTION

The crude oil extraction, pretreatment and transport employs a considerable technical infrastructure in Albania. Actually the crude oil extraction industry is operated by Albpetrol Ltd. 100% stock share is owned by the state and two other companies, namely Bankers Petroleum Ltd and Stream Oil & Gas Ltd. Part of that infrastructure are six regions of the crude oil production, one center of the crude oil transportation, one center of gas extraction, 107 groups of the crude oil and six decanting stations. [1], [2]

The Oil Refining Industry is situated close to the oilfields. It is presented by 4 refining plants, with overall capacity of approx 2.5 million tons per year^{-1} of crude oil. [3], [4] Since 1993, two refining plants, in Kuçova and Cërriku, have interrupted their processing activity, while two other refining plants, of Fieri and Ballshi's Deep Refining Plant are currently under operation.

The infrastructure of the crude oil drilling and processing industry has generated continuously high rates of pollution to the environment. The environmental pollution is present in air, liquid and solid wastes as well as noises. Continuous misappropriate of the technology cause even artificial earthquakes.

The hydric network is extended into the regions of the oil extraction and processing industry. It includes the Gjanica River, Devoll River and Seman River. The Oil Industry Wastewaters (OIWW), as well as the urban wastewater, affect the hydric system especially those of the Gjanica River. [1], [2], [5], [6], [7]

The aim of this study is to assess the environmental contamination to the hydric network of the entire region, in focus the main tributaries: Semani with its effluents: Devolli, Osumi, Gjanica; Vjosa, and artificial channels: Rroskovec – Hoxhara and Marinza (Figure 1).

II. MATERIALS AND METHODS

The current situation related to the pollution levels in the hydric system is due to the oil industry activity, through the evaluation of main pollutants present in the surface waters and accompanying waters. The assessment on the environmental pollution is achieved through the study of biological indicators. The methods used are those recommended to the National Standards (SSH), adapted according to the International Standards: EN, ISO, ASTM.[8], [9], [10]

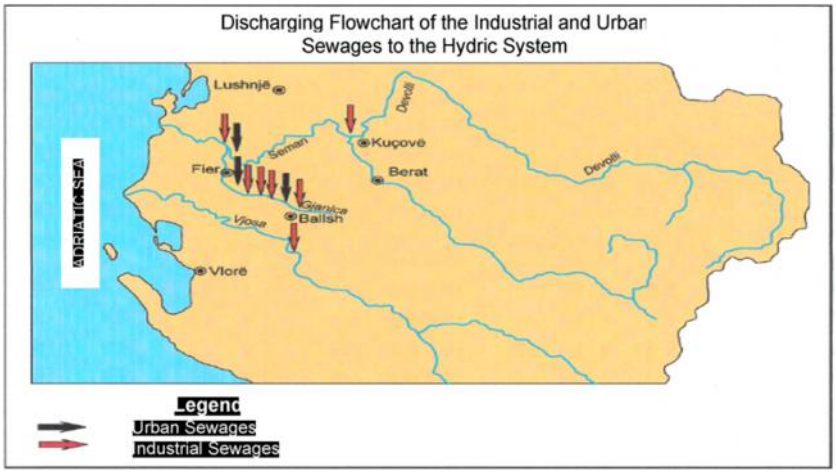

Figure 1: Discharging scheme of the industrial and urban wastewater in the hydric system of the Oil Industry Regions [1], [6], [7]

III. RESULTS AND DISCUSSION

Based on our study results of the water samples, on the geography of the hydric network where oil industry operates, on the literature; [10], [11], [12], [13] and data provided on the biological monitoring, a number of conclusion are drawn.

Assessment on the environmental pollution from OIWW is evaluated through the scientific assessment of the studies conducted during the last decade. This industry has continuously emitted to the hydric system both solid wastes and industrial wastewater. The information is contained in Table 1, Chart and Figures from the hot spot sites aiming to present the situation of biodiversity.

Discharges in surface waters from the oil drilling and refining industry are mainly constituted of the liquid phase. [1], [2], [6], [7], [14]

In that aspect the OIWW are constituted of the crude oil discharged in the vicinity of the oil well, or other technological devices. This contribution is depended on the season, where during the winter the effluent easily reaches main rivers. The OIWW origin is mainly of the decanting plants, technological wastewaters (OITWW) from refining plants in Fieri and Ballshi.

The crude oil manipulation and main hot-spot pollution sites to the surface waters may be present in different stages of the oil production from the oil well to the refining plant (Figure 2).

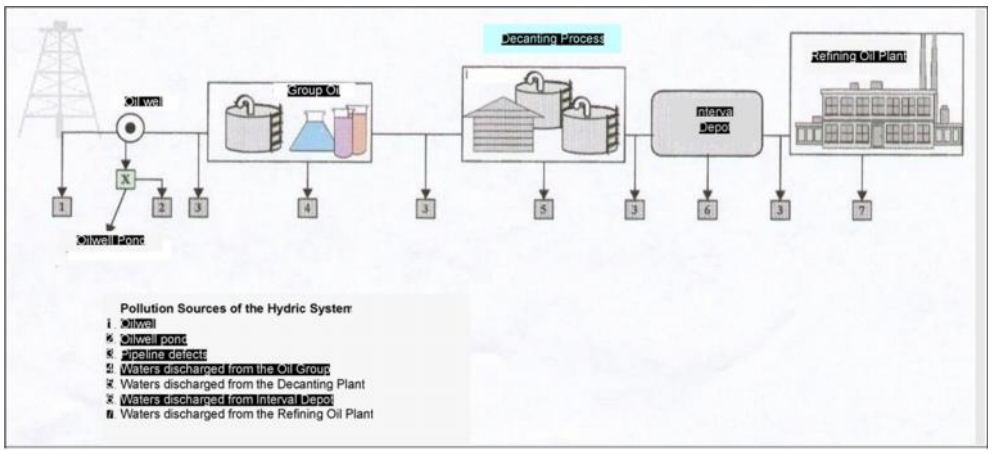

Figure 2: Flowchart of the crude oil manipulation from oil well to refining plant and main hot- spot pollution sites to the surface waters[7]

From the data collected, the decanting plants are main contributors to the pollution on surface waters, due to the high amounts of waters that accompany the crude oil. The decanting plants are situated in Marinza, Sheqishta, Visoka, Gorishti, Kashi, Usoja and Kuçova, while the most problematic sites on the environmental pollution are the hydric systems on the above mentioned areas.

Decanting plant	**pH**	**H_2S**	**Phenols**	**NH_4^+**	**COD**	**Crude oil**
Marinza – Sheqishta	6.8-8.5	110-221	0.85-9.15	17-50	1210-3020	22-190
Visoka	6.55	6.15	46	3.65	750	500
Norms	**6-9**	**1**	**1**	**5**	**150**	**40**

Table 1: Wastewaters discharged by the decanting plants [1], [2], [5], [6], [7] (m^3/year)

In the oilfields administered by the Albpetrol Ltd. the quantity of the OIWW produced varies to 50% of the total drilled fluid. The overall amount produced by the decanting plants is calculated to 1.54 million m^3 $year^{-1}$.
Regarding the chemical composition of the OIWW, the analysis show that they are constituted mainly by chemicals, as phenols, chlorides, ammoniac, sulfates, sulfides, salts, tension-active compounds and others. Due to the continuous exposure, a number of oxidation reactions take place in the water medium by diminishing the dissolved oxygen (O_2) the levels. Data on the chemicals present in OIWW are presented in the table 2

Nr.	Decanting plants	Polluted waters	Hydric system affected
1	Marinza	291 000	Adriatic Sea
2	Sheqishta	139 600	Adriatic Sea
3	Visoka	162 500	Gjanica
4	Kashi	400 500	Vjosa
5	Gorishti	135 400	Vjosa
6	Usoja	400 750	Gjanica
7	Kuçova	6 600	Devolli

Table 2: The discharged wastewaters to the decanting plants according to oilfields (in mg l^{-1})

The results show that effluent plants have high levels of contaminants, bypassing the norms. Actually the technology does not involve processes to eliminate these pollutants, such as: H_2S, phenols, crude oil etc. The wastewaters discharged by the decanting plant of the Patos – Marinza Oilfield pass to the hydric system.
The Table 3 contains the results of the study on the Rroskovec-Hoxhara Oilfield. [1], [2], [5], [6], [7]

Nr	Sample site	pH	NH_4^+	Phenols	COD	Crude oil
1	Belina bridge	7	8.8	0.75	89.8	3.2
2	Mbrostari bridge	7.5-8	4.3	0.64	98.8	1.6
3	Hoxhara bridge	7.5	1.5	0.35	86.7	1.4
4	500 m before river delta to the sea	7.5	0.1	0.32	72.1	1.2
5	River delta in the Adriatic sea	8-8.5	0	0.25	-	0.8
	Allowed levels	6-9	3	0.5	150	10

Table 3: Wastewater indicators from the Roskovec-Hoxharë Collector (*mg* l^{-1})

Another contributor in the pollution is the refining industry. The Oil Refining Plant of Ballshi discharges liquid wastes directly to the Gjanica River. The quantity of the wastewaters discharged in this site reach levels of: 420 m^3 $hour^{-1}$of water-crude oil mixtures and oil by-products; 45 m^3hour^{-1} of sodium waters and oil by-products; 26 m^3 $hour^{-1}$ of acidic waters with sulfur content; 370 m^3 $hour^{-1}$ The processing waters; and 75 m^3 $hour^{-1}$, waters to other end-point processes. Actually the wastewater treatment plant close to the Refining Plant of Ballshi is not under full operation as the biological treatment section is not yet installed. Monitoring of the industrial wastewater before the treatment process and after their discharge to the Gjanica River is given in Table 4. [1], [2], [5],

Analyzed Parameters	Unit	Mixture of the crude oil-water	Basic water	Acidic water	Desalting	Discharges in the Gjanica river
pH	-	7.5	9.9	8.9	8.5	7.9
BOD_5	mg l^{-1}	>50000	8500	6700	5400	700
Solid suspensions	mg l^{-1}	676	<30	<30	<30	200
Crude oil and lubricants	mg l^{-1}	>10000	250	160	656	3000
Phenols	mg l^{-1}	8.3	2.3	36	600	13.3 – 42.4
Sulfides	mg l^{-1}	-	5.3	3	5.4	6.1
Total Nitrogen	mg l^{-1}	-	56	336	308	-
Chromium	mg l^{-1}	<0.1	<0.1	<0.1	<0.1	<0.1
Lead	mg l^{-1}	<0.1	<0.1	<0.1	-	<0.1
Sulphur	mg l^{-1}		-	-	-	240
Chloride	mg l^{-1}		-	-	-	42.3 - 177

Table 4 Technological wastewaters to the refining Plant, Ballshi discharged to Gjanica River. Despite the environmental problems presented in the study, need to be mentioned not all the hydric system where Oil Industry operates is not heavily affected. The following chart presents the main contributors to the hydric systems' pollution as well as the contamination level of the network. [1], [6], [7]

Environmental Monitoring of the Gjanica River

The experimental study was focused on the Gjanica River being the most critical point, where oil industry directly impacts the hydric system (Figure 3). In its water body, of 41 km, from Ballshi to the Semani river, all the wastewater discharges happen. In regular distances from the River there are present technological waste water discharges, negatively changing the quality of water, hence the fauna and flora of the Gjanica River. Two main decanting plants – that of Visoka and Ballshi - release approximately 560 000 m^3 $year^{-1}$ to the Gjanica River. Actually this river is the most polluted one in Albania.

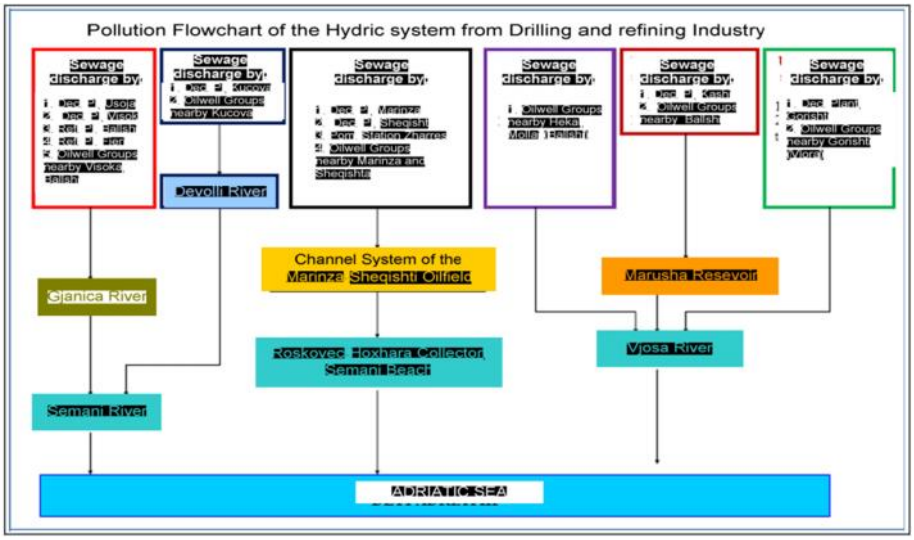

Figure 3: Pollution Flowchart of the Hydric system from Drilling and Refining Industry

Wastewaters of the technological process of Deep Oil Refining Plant of Ballshi and the Refining Plant of Fieri as well as wastewater from decanting plants of Usoja and Visoka, calculated to be 0.55 million m^3 $year^{-1}$ and other urban wastewaters are discharged in this river.
It is evaluated that 13000 -18000 m^3/month technological wastewaters with presence of hydrocarbon residues and industrial lubricants are discharged in the river, giving the Gjanica River the status of the most polluted river, by impacting the flora and fauna, with no use for irrigation of arable lands and use to livestock. [1], [2], [5], [6], [7], [14]
Effluents from the Ballshi refining plant enhance the hydrocarbon levels to the rivers as well as to other chemicals such as: nitrates, ammoniac and phenols to level above that the norms.
The results on the water samples from the Gjanica River are given in the following Table 5; 6 and Figure 4; 5.

Physic-chemical parameters	Before the refining plant, Ballshi	Usojë - Visoka Segment	Visoke – Industrial center, Fieri Segment	After the industrial center Fieri	Semani river (point maximum to the Gjanica river	Norms *(mg l^{-1})*
p	6.	6.8	6.	7.	7	6-
Nitrites	-	0.33	0.3	0.3	0.1	0.06
Nitrates	-	3.3	4.	29.	8	1
Ammonium	No present	8.3	1	110.7	26.	6
Iro	-	0.73	0.2	0.2	0.095	3.
Phosphates	-	1.18	1.4	1.	0.8	2
Phenols	No present	3.64	3.	2.2	0.6	0.
Suspensions	52	108	9	86.	3	5
CO	5	150	15	55	19	15
BOD_5	4	58	54.	102.5	47.	5
H_2	No present	-	2.	2.9	0.6	1
BETEX	No present	1.25	0.0	0.5	-	0.05
Crude oil	No present	243	36	53.	6.7	1
Reeks	No present	oily	Oily	Unacceptable	No normal	No

Table 5: Physic-chemical parameters of the Gjanica river waters *(mg l^{-1})*

Compound	Minimal values	Maximal value	Mean values	Norms (BB/IFC)
Benzene	0.11	1.39	0.75	0.05
Toluene	0.26	2.4	1.33	0.05
Ethylbenzene	0.04	0.31	0.175	0.05
p-Ksilene	0.038	0.22	0.129	0.05
m-Ksilene	0.092	0.61	0.351	0.05
o-Ksilene	0.09	0.59	0.34	0.05

Table 6: Benzene derivatives content to Gjanica River waters (mg l^{-1})

These results give evidence to high level of contamination; fold in the National Norms as well as in International norms. It is most present during the season of functioning of the Refining plants and decanting plants.

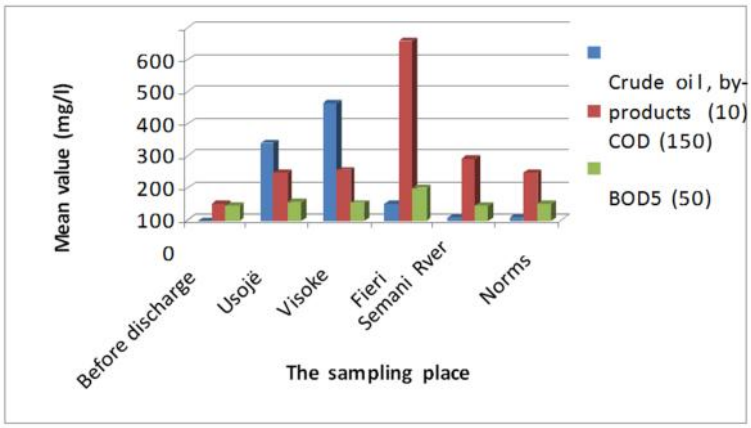

Figure 4: The content of the crud oil, by-products, COD and BDO_5 according by sampling site in Gjanica River.

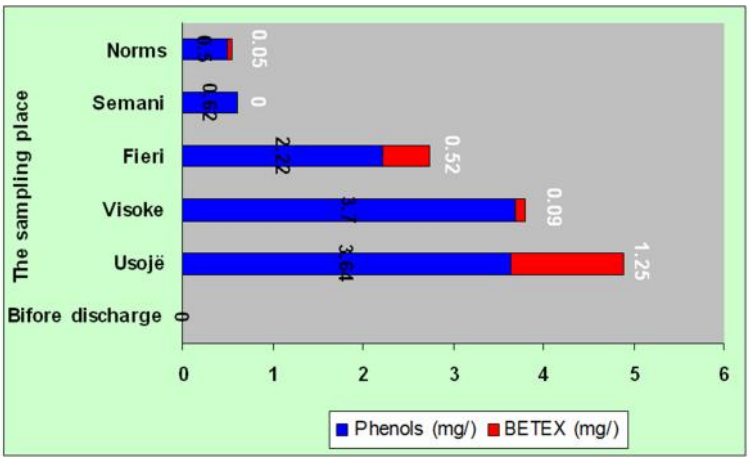

Figure 5: The content of the Phenols and BETEX according to results of the sampling site in Gjanica River (mg l^{-1})

Referring to the COD and BOD (Table 5) mean values of 264 mg l^{-1} and 65.5 mg l^{-1}, there is no possibility of the presence of living beings in the Gjanica River status.

Presence of the crude oil residues and its by products in the water reach high values of 166.6 mg l^{-1}, maximum values of 363 mg l^{-1} and minimum values of 6.75 mg l^{-1} (to the lowest point in the Semani River point).

The presence of the benzene and its derivates to the Gjanica River (Table 6) maximal values reach to 1.39 mg l^{-1} benzene and 2.4 mg l^{-1} toluene. Regarding other derivates their values are lower.

As conclusion we can say that the quality of Gjanica river waters is highly polluted with high values above the norms. [2]

Contamination sources to the Semani River

Two main tributaries of the Semani River are Devolli and Osumi. Hence, the contamination of these tributaries will be exported to the Semani River. Main sources of the contamination to this river are waters of the Sheqishta and Marinza oilfields, which reach some thousand m^3 $month^{-1}$. Another contributor to the contamination of the Semani River is Gjanica, as already previously discussed.

Contamination origin of the Vjosa River waters:

The main sources of pollution to the Vjosa River belong to the Oilfields of the Vlora, Mallakastra and Fieri districts. Currently, these oilfields produce crude oil with presence of 50-70 % water. This river ends up in getting discharges of technological waters from the decanting plants of Gorishti, Kashi and Cakrani Oilfield. [6]

Underground waters of the Albanian Oilfields:

Marinza and Sheqishta oilfields possess a great potential of pollution for the hydric system, due to their high amounts of water produced, 430 000 m^3 $year^{-1}$. This situation is due to the amortized drilling technology and transport.

Subterranean waters are discharged to the open environment, streams and channels. It is evident the presence of the H_2S and hydrocarbons is dissolved to the surface waters.

Finally the surface waters polluted by crude oil and other by-products are collected to the Roskovec-Hoxhara collector, and later end up to the Adriatic Sea. [6]

IV. CONCLUSIONS

The study of the environmental impact from the oil industry activity in Albania will positively contribute to the stakeholder to built strategies for the environmental protection in the future.

Currently the oil industry developing is not accompanied by the environmental management strategies and proper state structures

Hydric system, in these regions, is seriously polluted, which will have a prolonged impact to the fauna and flora in the future.

High amounts of untreated technological effluents have directly impacted to the flora and fauna.

All the body of the Gjanica River must be considered as a Dead River, by directly impacting the agriculture and other economical activities.

The soils' fertility is continuously deteriorated.

Air, water and soil pollution, have directly affected the human health, involving not only the oil industry staff, but also the inhabitants of the regions.

The environment-related legislation is adapted to the EU acquits due to the Albania's accession process to EU.

Despite the long time of the 'Capitalism System' the oil industry haven't changed the methods of environmental management.

It is evident that there is a lack of investments in the technology renovation and in implementation of environmentally-friendly technologies.

Also, there is a lack of a gas, liquid and solid wastes treatment project in the oil industry domain.

RECOMMENDATIONS

To minimize the environmental pollution originating from the oil industry activity, we recommend:

Construction of treatment sites and plants of liquid and solid wastes of oil industry origin.

Investments in renovation and implementation of environmentally-friendly technologies.

Amendment of national standards on gas emissions.

Enforcement of measures on offenders violating the law on environmental pollution.

Some alternatives to improve current environmental situation:

It is imperative to reconstruct the treatment plant close to the Refining Plant in Ballshi.

Another treatment plant for technological wastes needs to be constructed close to the Refining Plant of Fieri.

There is a need for direct treatment of the subterranean waters with limestone.

Another proposal is returning of the subterranean waters to their layers, which will diminish the negative impact to the environment.

Biological treatment of the waters and soils contaminated by the activity of the Oil Industry.The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression, “One of us (R. B. G.) thanks . . .” Instead, try “R. B. G. thanks”. Put sponsor acknowledgments in the unnum-bered footnote on the first page.

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