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Zafarjon Jabbarov
National University of Uzbekistan, zafarjonjabbarov@gmail.com

Tokhtasin Abdrakhmanov
National University of Uzbekistan, soilecology@yandex.ru

Shavkat Akhmedov
National University of Uzbekistan, axmedovshavkat@mail.ru

Urol Nomozov
National University of Uzbekistan, urolnomozov@mail.ru

Muqaddas Abdurahmonova
National University of Uzbekistan, muqaddasabduraxmonova@gmail.com

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CHANGE IN THE PHYSICAL AND CHEMICAL PROPERTIES OF OIL-CONTAMINATED SOIL IN THE STEPPE ZONE

Jabbarov Z.[1], Abdrakhmanov T.[1], Akhmedov Sh.[1], Nomozov U.[1], Abdurahmonova M.[1]
[1]*National University of Uzbekistan, Tashkent, Uzbekistan*
e-mail: zafarjonjabbarov@gmail.com, soilecology@yandex.ru, axmedovshavkat@mail.ru, urolnomozov@mail.ru, muqaddasabduraxmonova@gmail.com

Abstract

Today, around the world as a result of the activities of industrial enterprises, mining, their use, as well as other anthropogenic factors, there is a chemical pollution of the soil cover, a change in soil properties and fertility. Pollution of soils of various types leads to the formation of problems such as soil degradation, a decrease in the qualitative and quantitative level of fertility, as well as other problems associated with the ecosystem. Today, the urgent task is to create remediation measures for soils contaminated to varying degrees with oil and oil products, corresponding to the climatic conditions of the territory. Actual problems are studying the state of pollution by sources, for reclamation of soils contaminated with oil and oil products in the desert zone, their difference, determining the physicochemical, agrochemical, microbiological, biological properties of soils, separation of factors, algorithms, stages of restoration, the choice of measures taking into account the properties of soils and the nature of pollution, periods of reclamation processes, development of primary indicators and factors of soil fertility restoration, analysis of the temporary state of contaminated soils, the creation of cartograms for predicting the future state of soil pollution, the appointment of measures for the rational use of land resources based on the data obtained.

Keywords: soil, oil, pollution, desert zone, ecosystem, heavy metals, enzymes.

Introduction

In order to activate Bioremediation process was used worms, and improving fiscal structure of soil activated Bioremediation process faster cite1. Recommended to use cyanobacteria in the development of bioremediation methods for oil contaminated soils [2] and some scientists have admitted that transgenic plants, microorganisms and ramnolipid biosurfactants [3]. By the results of contamination morphological signs, physical, chemical, biological and geotechnical structures of soils damaged,, including the PH environment, cation ($Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}$) and anions ($CO_3^{2-}, HCO^{3-}, CI^{-}, SO_4^{2}$) and the number of bio organisms varied [4].

In northern Nigeria, the biochemical and physical properties of soils contaminated with diesel fuel and gasoline have been studied, soil acidic properties, organic carbon, nitrogen, heavy metals, and sediment increased against background. In particular, increased against the background cadmium 0.25 mg / kg, iron 6311 mg / kg. and lead to 1.67 mg/ kg. Soil microorganisms in not contaminated soils, 4.6×109 cells / g. and 4.0×106 cells / g., contaminated soils 1.3×109 cells / g. and 3.0×106 cells / g. [5]. In India, cadmium, copper, iron, spirit and lead have increased as a result of contamination with oil and gasoline, and nutrient elements have also changed [6].

Soil microorganisms have been subjected to drastic changes due to oil and oil products pollution [7], Increasing the amount of gum substances in the soil has accelerated the self-cleaning process [8]. Oil pollution changes the physical, chemical properties of the soil, moisture and nutritional elements that play an important role in productivity [9]. Low concentrations of diesel fuel (5 ml / 100 g of soil), increased hydrocarbon-containing microorganisms, soil breathing rate, nitrofixation and denitrification. Increasing of concentration (30 ml / 100 g soil) effected to all indicators decreasing of microorganisms and biological activity have slowed down [10].

Various quantities of oil have a negative impact on the physical and chemical properties of forest and black soil (acidity, total carbon dioxide, nitrogen regime), soil breathing, enzyme activity, mineralization of nitrogen compounds, physical, microbiological properties and its fertility (Polyanskova et al., 2015), oil contamination affected negatively to supply plants with nitrogen and deterioration of nitrogen regime [11].

Various concentrations of oil influenced to soil by increasing and decreasing ureaza, catalase, polyphenoloxidase, invertase, degidrogenase, and peroxidase enzymes [12], [13]. Various concentrations of diesel fuel have a negative effect on the activity of urease, dehydrogenase and phosphatase enzymes in the soil [14]. Some scientists have studied the biological activity of soils contaminated with oil through high-frequency radiation and have undergone various changes in the activity of the enzymes [15]. In the study of the very strongly polluted soil properties used in the Ukrainian agricultural sector, they studied the changes in vegetative development of plants, along with the physical and chemical properties, nitrogen balance, and water regime change [16, 17].

1 Material and methods

The study areas are situated in two regions of Uzbekistan, Kashkadarya and Surkhandarya, there are five soil types chosen for our researches. The main soils of study areas are sandy soils and they spread around of pollution sources "Kukdumalak", "Zevarda", "Khovdak" and "Kakaydy" oil fields. These soils form in the sandy areas that stabilized with plant species. Study objects in Surkhandarya region oil field "Amudarya" (Termez district), "Kakaydy" and "Khovdak" oil fields (Djarkurgan district), in Kashkadarya region "Kukdumalak" oil field (Mirishkor district), Shurtan oilgas (Guzor district) with soil types sandy desert, grey-brown, takyr, meadow-saz soils were investigated. Humus spots in some cases reach 25-30 cm with amount of 0.2-0.5% (without oil pollution), groundwater lie more than 5 meters.

The laboratory work was done at Czech University of Life Sciences Prague by the

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support of Erasmus Mundus CASIA Project and at National University of Uzbekistan, Department of Soil Science. Soil organic content was determined by Tyurin modification method, the cation content was done by Aqua regia method. Soil sampling was as following: the distances from "Kukdumalak" oil field 1, 3, 6, 9, 13 and 16 km accordingly with PK-10-1; PK-10-4; PK-10-6; PK-10-9; PK-10-12 and PK-10-14; in the same distance from "Khodvak" oil field samples were named PX-10-2; PX-10-5; PX-10-7; PX-10-10; PX-10-13 and PX-10-15 respectively. Samples were named according to oil field name, so that "PK"-Profile Kukdumalak, "PX"-Profile Khovdak.

2 Results and discussion

Pollution of soils with oil, oil products, and pollution with other oil-bearing properties, including some heavy metals, exceeds the RECU. Heavy metals and their quantity depend on the chemical composition of the oil and oil extracts from the subsoil.

Oil industry activity Pb, Cu, Ni, Zn, Mn, oil burning are the man-caused source of heavy metals such as As, Pb, Cd. Cd, Ni, Pb and As heavy metals in the soil have a decelerating effect on oxidation-reduction reactions in the soil, biological activity and productivity. Oil spills on the Earth are distributed across landscapes, where migrations are accumulated in the form of elliu- lional landscape, transelvi- vial landscape, eluvium-accumulative landscape, accumulative landscapes, and oil migrations spread in this sequence. The amount of oil in the soil and the heavy metals contained in the soil activate or slow down the growth of plants, mono-aromatic hydrocarbons are quickly and efficiently bound to the soil hard phase and peat, and the mineral part of the soil is the least absorbed.

The amount of heavy metals in the soil is explained by the chemical composition of the oil and minerals in the oil-bearing layers, and partly by the parent genes. It also depends on the duration of contamination, so their size varies considerably from one region to another (Figure 1).

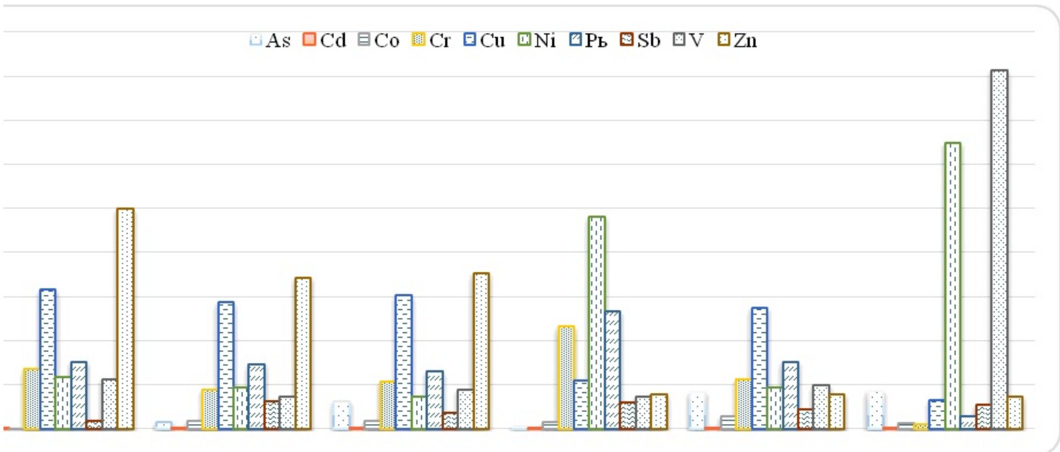

Figure 1. Pollution of heavy soils in the desert zone

Ground metals in the soil are as follows: As - 2.0, Cd - 0.05, So - 5.0, Cr - 200, Cu - 55, Ni - 85, Pb - 32, Sb - 4.5, V - 150, Zn - 100 mg / kg.

If we compare the results, As and Cd have increased in all soils, so only in KKD cuttings, the remaining KC, KSO, KT, KM, KX cross-border regions do not exceed RECUU. Cr, Ni, Pb, V, Zn are not higher than the RECU value at any soil crossings. Cu was higher in the CSC, CT, CVC, and the lowest values were found in the CF, CX, and KM cuttings. The amount of Sb in all cuttings, except for the CC cut, was higher than the RECU (Table 7).

The highest levels of heavy metals are as follows: As KKd-3,37; Cd KX-9,4; So PP-1.04 increased, Cr, Ni, Pb, W, Zn did not exceed RECHU, CU KK-1,15; Sb increased by 2.79 times. This analysis analyzes the total amount of heavy metals, and the analysis of contamination sources, distance and soil layers is as follows.

The difference pollution desert oil field, which is the main source of pollution for the region and a case study from the oil and gas industry. According to these sources, two different sources of pollution, including oil field Recht index increased by 0-5 cm of the soil, the amount of heavy metals. Less than 5 to 20 cm. a similar situation was observed. The reduction of heavy metals to reduce the two-sided nature, the oil center distance away from the Land and soil layers from top to bottom descending toward the state.

The oil and gas industry is a source of heavy metals contamination level of pollution in regions I, II and IV, the third source of pollution in the region, which is less compared to the first decrease and then increase, while the soil layers above, like the source of the oil field downward direction.

The soil cover is transformed into oil and oil products in a variety of ways, with the soil being adapted to climatic conditions. There are three basic mechanisms of oil transformation in the soil:

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Table 1

Contamination by heavy metals and other substances due to oil and oil products, for example, in the case of dark brown (PK) and sandy desert (PX) soil, mg / kg

Soil samples	As	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	S	Sb	V	Zn
PK-10-0,8	5,89	0,16	4,36	27,05	63,72	18721,07	541,75	23,04	30,81	944,21	3,54	22,41	100,0
PK-10-2	5,89	0,16	0,83	21,63	29,24	16,55	0,14	0,44	1,92	6,41	3,54	0,83	4,96
PK-10-10	5,89	0,16	4,03	22,15	28,24	14563,59	408,03	16,31	24,17	760,09	14,62	17,30	62,75
PK-10-14	5,89	0,16	4,94	22,02	29,07	14884,62	418,15	16,62	24,40	734,77	3,54	16,90	62,85
PK-10-18	5,89	0,16	6,09	28,62	41,91	19536,72	555,83	23,35	30,74	969,85	24,35	22,08	85,09
PK-10-20	5,89	0,16	7,02	26,08	47,79	18925,63	551,99	21,64	30,68	953,80	15,22	21,01	86,91
PX-10-0,8	17,66	0,47	2,50	1,90	12,71	49,65	0,42	1,33	5,75	19,23	10,62	2,49	14,88
PX-10-2	15,02	0,33	4,61	27,19	58,27	17800,03	511,05	21,52	32,40	909,16	12,17	21,08	85,34
PX-10-10	10,23	0,28	4,42	23,85	59,87	16359,26	456,61	18,85	27,17	784,38	3,54	20,25	76,51
PX-10-14	6,20	0,18	4,48	25,47	62,44	17474,24	503,16	21,18	30,45	858,13	15,19	21,01	77,32

Physicochemical degradation, in which the C12-16 hydrocarbons are first destroyed. In these changes, microflora is exposed to intoxication, with a decrease in toxic effects, the amount of paraffin oxidizing bacteria increases dramatically.

Microbiological transformation of oil hydrocarbons. The n-alkanes (C_{17-30}) and the oxidation of simple aromatic hydrocarbons will be involved. Oil concentration decreases to 90%, paraffin structure decreases, polyethylene chains increase. The oxidation of aromatic compounds begins.

At this stage, oil-resistant high molecular connections remain, microbiological effects also weaken, oil residues remain. The oil transformation in the soil can be divided into the following three steps:

The first phase lasts from several months to 1.5 years, with physical and chemical decomposition and the beginning of microbiological processes.

The second phase lasts for 3-4 years, where microbiological processes take place.

In Phase III, the structure of the oil contains high molecular compounds and the breakdown of 5-6 atoms with polycyclic structure hydrocarbons.

Of course, these processes take place at varying degrees according to the nature of pollution and soil type. On the soil, the following processes are observed in the soil. At the beginning of soil pollution, oil and oil products are subjected to photochemical, chemical, microorganisms disintegration, flushing, vegetation absorption, adsorption to soil colloids. As a result, the concentration of oil and oil products on the soil surface decreases, which is observed due to soil mechanical composition, pollution level, temperature and chemical composition of oil. All types of soils have been subjected to pollution, whereas the overall porosity has been reduced in the soil genetic layers, from the top to the bottom. Such a change in soil is the result of strong consolidation of oil and oil products and soil. Statistical and correlation of the soil content of oil concentrations was studied, and as a result, increased correlation with volume of oil concentration increased.

The physical properties of the soil under the influence of oil and oil products increased significantly in size, ie the volume of oil and oil products increased and the overall porosity decreased. On contaminated soils, the size of the gravel has generally increased from the top to the bottom, whereas in all the studied desert soils the volume in the upper layers of the soil layer is significantly higher, with a general low porosity (Table 2). This bonding was investigated by the concentrations of oils 2, 8, 14 and 29 g/kg, resulting in an increase in oil concentration in the weight ratio. The correlation coefficient is equal to 0.99 ha, and R-squared = 96.0%. The hydrocarbons of the same concentration affected the total porosity of the soil depending on the mass of the soil.

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Table 2

Change of general physical properties of soils of the desert zone polluted with oil and petroleum products

Soils	Depth, cm Specific	Weight, g/ cm^3	Volume Height, g/ cm^3	General Permeability, %
PKD	0–5	2,72	1,15	57,20
	5–20	2,7	1,12	58,00
	20–55	2,7	1,09	59,60
PSO	0–5	2,61	1,42	45,59
	5–20	2,61	1,34	48,66
	20–557	2,6	1,31	49,62
PT	0–5	2,73	1,48	45,15
	5–20	2,72	1,41	48,80
	20–55	2,72	1,37	49,63
PM	0–5	2,69	1,47	45,35
	5–20	2,68	1,41	47,39
	20–55	2,68	1,34	50,00
PK	0–5	2,7	1,48	45,19
	5–20	2,7	1,40	48,52
	20–55	2,69	1,32	49,39
PX	0–5	2,64	1,45	45,58
	5–20	2,63	1,43	45,46
	20–55	2,63	1,39	47,56

As a result, with the increase in the concentration of oil, the total porosity of the soil has decreased, which is due to the massive increase in mass and deterioration of soil physical properties. The greatest indica- tion was on the KK soil and in the picture above, the overall porosity to the KX soils, where the level of pollution was naturally increased.

The change in the overall physical properties of the soil has been systemically increased due to the high level of pollution with oil and petroleum products. The rate of absorption of oil and oil in soils is also varied, and the determination of this feature of the desert zone soil is also determined by the mechanics of the rate of swallowing.

According to the results, at the same time, soil with different mechanical content has been found to absorb oil and oil in various quantities, ie the heavier mechanical content of soils with relatively light mechanical content, relatively low oil and oil productivity, moderately sandy soils.

If we analyze the types of soil, KK, the lowermost oil absorption rate of 542.3 ml in 48 hours. KShO the lowermost 453,8 ml., KM 430,7 ml., KT cut the lowermost 482.3 ml., CCC, the lowermost 441.7 ml , 553.8 ml in the KX cut. equal to The speed of swallowing oil and oil products depends on many factors, even on seasons. The second half of the spring, the full months of the summer and the first half of autumn, the rate of swallowing is higher than in the remaining months.

The study of soil evaporation of petroleum and petroleum products index and the level of foreign scientists (Kokoris N.G., Okolelova determined on the basis of the testimony of AA, Golovanchikov Amankul, 2012) (Table 3). Plane Sbug. - Organic carbon content evaporated from the soil surface, %; Sorg. - Organic carbon content remaining in the soil after test (evaporation), %; Sdd - expression ratio represents % units. Oil and petroleum products in the soil to evaporate indicator of contamination of soil composition, temperature, time, vary depending on the chemical composition of the oil. In the case of a new contamination evaporation is highly observed. As a result of evaporation of petroleum hydrocarbons in the soil of heavy fractions of hydrocarbons in the soil, and it takes a lot of time for reclamation technology.

Table 3

Degree of hydrocarbon grass soil degradation (%)

Indicators	**Duration of the experiment (day)**				
	2	4	6	8	10
PKD					
C_{org}	0,94±0,02	0,81±0,021	0,70±0,020	0,59±0,014	0,46±0,012
C_{st}	0,40±0,01	0,31±0,006	0,25±0,006	0,23±0,005	0,21±0,004
S_{kont}	57,4±1,21	61,7±1,41	64,2±1,62	57,6±1,19	54,3±1,001
PSO					
C_{org}	0,84±0,019	0,76±0,019	0,67±0,018	0,56±0,015	0,42±0,012
C_{st}	0,59±0,012	0,47±0,011	0,39±0,009	0,37±0,009	0,33±0,007
S_{kont}	29,7±0,74	38,15±1,11	41,7±1,21	33,9±0,84	21,42±0,54
PK					
C_{org}	0,72±0,015	0,64±0,017	0,51±0,013	0,48±0,012	0,38±0,008
C_{st}	0,57±0,011	0,49±0,010	0,42±0,009	0,40±0,010	0,33±0,006
S_{kont}	20,3±0,45	23,4±0,53	17,6±0,41	16,6±0,25	13,15±0,025
PM					
C_{org}	0,67±0,015	0,60±0,015	0,53±0,012	0,45±0,014	0,34±0,005
C_{st}	0,42±0,012	0,35±0,05	0,29±0,05	0,28±0,05	0,24±0,02
S_{kont}	37,3±1,01	41,6±1,01	45,2±1,14	37,7±1,00	29,0±0,71
PT					
C_{org}	0,59±0,013	0,51±0,014	0,46±0,012	0,40±0,011	0,34±0,012
C_{st}	0,43±0,010	0,35±0,06	0,30±0,05	0,28±0,012	0,25±0,05
S_{kont}	27,1±0,81	31,3±0,90	34,7±0,92	30,0±0,87	26,4±0,64
PX					
C_{org}	0,68±0,012	0,42±0,010	0,37±0,04	0,35±0,010	0,30±0,012
C_{st}	0,39±0,011	0,27±0,011	0,25±0,01	0,15±0,004	0,19±0,012
S_{kont}	57,3±1,25	64,2±1,33	67,2±1,35	57,1±1,12	36,6±1,001

As a result, the level of oil hydrocarbon moisture content has varied depending on the mechanical composition of the soil. The highest figure Khovd oil fields around the sandy desert soils, and 6 days after the evaporation rate of 67.2%, the highest Kokdumalak around the oil field, light brown loamy mechanical composition fighting around the oil field, 64.2%, Uchkyzyl medium loam soil irrigated Battle brown soils scattered around 45.2% of the oil field, North Oqnazar heavy loamy mechanical composition of irrigated meadow alluvial soils around 41.7%, Kokdumalak oil field wearing heavy loamy mechanical composition soils, 34.7% and Low around UDE figure Muborakneftgaz widespread heavy loamy mechanical components of the bald-meadow soils irrigated by 23.4%.

As it is evident, light soil mechanics have more than crushed oil and oil products relative to medium and heavy mechanical components.Deep knowledge of changes in the mechanical composition of desert soils under oil and oil products plays an important role in the development of recycling technology. Changes in the mechanical structure of the soil due to oil and oil products are mainly 1-0.25 mm. particles, partly 0.25-0.1 mm. the particles in the particles were flat and the other particles were subjected to irregular changes gray soils are lightweight rubber with mechanical content of 0-5 cm. and 5-20 cm. 1-0.25 mm in layers. and 0.25-0.1 mm. the particles have increased relative to the substrate, the degree of contamination is weak and average, and the growth of these particles is not high.

Irrigated meadow-alluvial soils have heavy mechanical properties and 1-0.25 mm above. the particles were reduced in the contamination layer with very little difference, with a decrease in the level of downstream pollution, with a relatively small difference of 0.25-0.1 particles, increased in the contaminated layer and downwardly. Similar mechanical and mechanical properties have changed in the subsequent soil types. Irrigated grassy soils are heavyweight mechanical rubber with 1-0,25 and 0,25-0,1 mm above the contaminated top layer. the particles are relatively high, with the reduction of pollution decreasing and the remaining layers have the same uniformity. The irrigated clay gray soils are moderate to moderate, with an impact of oil and oil products contamination of 1-0,25 and 0,25-0,1 mm. the amount of particles increased and the decrease in contamination was observed.

A similar situation exists on the following soils, however, because the concentration of oil in the sandy desert soils is very high, 1-0,25 and 0,25-0,1 mm. particles have increased dramatically (Figures 7 and 8). For oil stickiness there is a combination of fine particles in the soil, growth of large particles, as well as the formation of the structure, but it is temporarily returning to recovery after recultivation. 1-0,25 and 0,25-0,1 mm. the increase in the particles is clearly seen in the picture above, since the contamination layer is larger than all other ground cross sections, with an increase in these particles up to 75 cm. to the layers. 0,25, significant for soil fertility as a result of pollution with oil and petroleum products; 0.5; 1; 2; 3; 5; 7; 10 mm. the proportion of aggregates has changed dramatically. The following is an analysis of irrigated meadow-alluvial soils.

The result is 0.25 mm in the background (5.07%). aggregates have not changed in 5% contamination of oil, gasoline and paraffins, while oil pollution by 15% is 0.01%, diesel oil is reduced to 0.035%, kerosene is reduced to 0.094% and gasoline is not affected.

0.5 mm. aggregates are 15.37% in the background, up to 5.05% under oil, up to 3.03% under engine oil, and 1.02% in kerosene. Significantly reduced by 0.25 and 0.5 mm. 1-3 mm at the expense of aggregates. Aggregates increased dramatically, including 1 mm. aggregates were 19.14% in background, 34.15% under engine oil, 33.56% in kerosene, 2 mm. aggregates were 11.52% in the background, 17.36% for oil and 20.44% in engine oil. The effect of gasoline is low in all aggregates. Enlargement of aggregate aggregates in the order of increase of petrolcorocinum engine oil.

Due to the fact that oil and petroleum products are organic substances, resistance and quantity of aggregate aggregates have changed, in particular, 1-5 mm. The microcirculation of the size of the microcirculation increased significantly in comparison with soil types and levels of pollution compared to microgregs of other sizes. Including 1-5 mm. the quantity of water-resistant aggregates was analyzed for pollution levels.

Changes in the amount of water-resistant micro-registers have a statutory shift, with agglomerates aggravated by increased oil and oil products.The increase in water-resistant aggregates in soils was explained by the viscosity of oil and oil products, especially in heavy-duty oil samples, and water-resistant aggregates also depend on the soil's soil composition and showed a relatively high level of irrigated, heavier mechanical content. When evaluated according to the scale recommended by M.Umarov and J.Ikramov, the amount of aggregate water resistant aggregates has been reduced to moderate and strongly contaminated with oil and oil products, from poorly structured to poorly structured and slightly structured to average structural state. There was no change in weak pollution, and macroagregates produced a very strong contamination. However, the increase in water-resistant aggregates is temporary, and this is not the case after recultivation. Thus, the structural status of oil and oil products is negligible in terms of farming.

3 Conclusion

1. The southern region of Uzbekistan contaminated with oil and oil products in desert soils is the main pollutant sources oil and gas industry. Contamination degree decresing fare in distance from oil deposits, increasing then decreasing in the oil and gas industry systems, and by the soil layers in both sources, from top to bottom flat decline was observed. In the occurrence and spread of pollution, technical defects and fatalities in oilfields, high temperature oil and gas industry and speed of the wind were the key factors. Pollution status is higher in I, II, III oil fields, in II, III, and IV oil and gas industry regions.

2. As a result of contamination with oil and oil products, soil poluted with heavy metals (AS, Cd, Cu, Sb, Cr, Pb, Ni, V) in diferent levels. In particular, near the oilfild mainly with Cd, Ni, Cu, Sb, V and near oil-gas industry with Cr, Pb and Ni contamnated.

3. In all explored soils the amount of carbon increased in accordance pollution level with oil and oil products, this carbon is anthropogenic carbon (Sant.) and does not have a correlation with soil humus and insignificant for soil fertility.

4. Depending on concentration (5-15%) of oil and oil products significantly affecting to aggregates quantity (0.25; 0.5; 1; 2; 3; 5; 7; 10 mm), including 0.25 mm. aggregates amount reducing, 2-3 mm. aggregates quantity increasing.

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