UNDERWATER CONTAMINATION BY PETROLEUM EXPLOITATION AND DISPOSAL METHODS OF HAZARDOUS SUBSTANCES AT DRILLING

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In a modern world there is a problem of underground water contamination, which can be classified as storage tanks and petroleum exploitation, septic systems, uncontrolled hazardous waste, landfills, chemicals and road salts, atmospheric contaminants. In our article we consider underground water contamination caused by petroleum exploitation. Nationally, the U.S. Environmental Protection Agency (EPA) has fixed that there have been over 400,000 confirmed releases of petroleum-based fuels from leaking underground storage tanks. Gasoline, oil, road salts and chemicals which get into the groundwater cause contamination and it becomes often unsafe for human use. One interesting property of gasoline is that it is less dense than water, and so it tends to float on top of the water table[1].

It is important to note that old oil, gas, and water wells serve as conduits for contamination of the aquifers being improperly drilled or cased, or when the casing has been corroded. Also, improperly completed and abandoned water wells allow direct accessing from the surface to groundwater for contaminants such as pesticides, or they may facilitate the pipeline blending of groundwater from one aquifer to another. Additionally, they can be hazards to humans and livestock. [2] Nowadays, many of the older fields produce small amounts of oil and gas but enormous amounts of brine. Brine refers to saline ground waters, usually high in total dissolved solids (normally 50,000 ppm chloride), which are associated with oil and gas below ground. When drilling, huge volumes of brine are produced and then pumped to the surface. The particular produced brine is one of the principal pollutants of the aquifers. Many wells may yield a small amount of brine at the beginning of the process, and it may be increased during the time. Other wells yield large quantities of saline water initially. Wells usually produce more brine as the time passed.

Initially, shallow unlined surface disposal pits were constructed and salt water was pumped directly into them for evaporation (Figure 1).

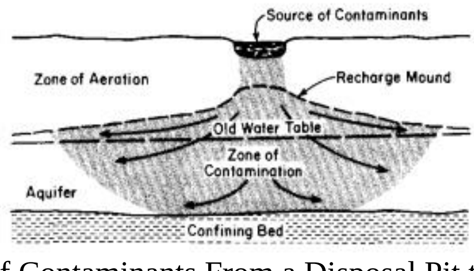

Figure 1 – Percolation of Contaminants From a Disposal Pit to a Water-Table Aquifer (U.S. Environmental Agency, 1977; After Deutsch, M., 1963)

Later, some of these pits were lined to reduce the possibility of brine seepage to ground water. Originally, salts were thought to disappear in the atmosphere. However, it was later found that only fresh-water vapors were evaporated and salts and minerals remained. There is another method of brine disposal with the advent of the no-pit order. Then brines were disposed in special injection wells constructed specifically for that purpose or reinjected into producing zones during water-flooding operations. These wells are very expensive and occasionally several operators will join together in constructing a disposal well. If the well is located at a distance from a producing lease, the brine must be trucked. During this time, there are dangers of accidental spills and/or midnight dumping incidents. Table 1 presents the lists of typical compositions of an oil field brine. In addition to the elements listed above, there are other potential ground-water contaminants which are inherent in oil and gas exploration and development activities. They include oil and gas, drilling fluids, chemicals used in wells, other additives, and corrosion inhibitors. Various additive chemicals such as barium sulfate are found in drilling fluids. Numerous acids are used in fracturing producing zonos to improve permeability, e.g. hydrochloric, nitric, sulfuric, hydrofluoric, formic, and acetic. Corrosive inhibitors also contain arsenic compounds. Certain oils contain mercury in concentrations exceeding the recommended SElt standards for drinking water. All of the above constituents have the potential to contaminate ground water when spilled on the surface, leaked to ground water or moved into fresh-water aquifers via interaquifer exchange[3].

The most serious problem of contamination is hydraulic fracturing, which is a method of intensifying the work of oil and gas wells and increases the intake capacity of injection wells. The method consists of creating high-conductive cracks in the target reservoir for the inflow of produced fluid (gas, water, condensate, oil or a mixture)on the bottom of the well. This finding is based on numerous documented instances of contamination in the drinking water wells of homes near hydrofracking drill sites, including the famous video of a homeowner igniting the water pouring from a tap with high concentration of dissolved natural gas. So-called “fracking fluid”, being hazardous water laced with a range of toxic chemicals, including known carcinogens, and sand, is injected down the well under high pressure. This fluid then spreads out along the horizontal bore and fractures the shale, releasing the trapped natural gas or oil. The resulting mixture is then returned to the surface via the vertical shaft. The gas or oil is separated, leaving millions of gallons of contaminated water for each well.

Table 1

Range of Constituents Found in a Typical Oil Field Brine, in ppm

Element	Range, ppm		
Sodium	12000	to	150000
Potassium	30	to	4000
Lithium	1	to	50
Rubidium	0,1	to	7
Cesium	0,01	to	3
Calcium	1000	to	120000
Magnesium	500	to	25000
Strontium	5	to	5000
Barium	0	to	1000
Chloride	20000	to	250000
Bromine	50	to	5000
Iodine 1	to	300	

Disposal methods of hazardous substances at drilling: mechanical, physico-chemical, microbiologic, agronomical. In conclusion, the problems of underground water contamination were considered and the disposal methods of hazardous substances, e.g. brine disposal into gullies and streams, brine evaporation pits, then special injection wells construction were analyzed and described.

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ENVIRONMENTAL RESPONSIBILITIES OF SAKHALIN ENERGY IN OFFSHORE FIELD DEVELOPMENT AND EXPLORATION

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Today, many onshore fields being depleted, the offshore petroleum projects are intensively implemented. Among most well-known projects are Sakhalin-1 (implemented by Exxon Neftegas Limited) and Sakhalin-2 (Sakhalin Energy).

The topicality of this paper is undisputable as environmental impact of petroleum production is among the crucial issues faced by oil and gas industry today. Sakhalin Energy implements its project with due regard for environmental sensitivities and the company itself is considered to be working on one of the most eco-friendly projects in Russia of the current time. Therefore, the experience of Sakhalin Energy in this sphere can be regarded as a model. The fundamental environmental strategies of the company being overviewed and analyzed, it is possible to identify the key factors providing mitigation of the negative environmental impacts.

In 2014, Sakhalin Energy was ranked second in the Russian Federation's first Environmental Responsibility Rating of Oil and Gas Companies. The company was recognized as the winner in two categories of the rating out of three: environmental management and information disclosure/transparency. The rating was launched by the World Wildlife Fund (WWF) of the Russian Federation and CREON Energy, the provider of advisory services to the fuel and energy industries, with the participation of the National Rating Agency [3]. The rating is aimed at promoting the efficient use of hydrocarbon resources, environmental protection, and socially responsible business administration. In total, 19 companies with leading positions in terms of the oil and natural gas production volume (over 1.5 million tonnes per year) took part in the Rating.

Sakhalin Energy exercises industrial environmental control of its assets to ensure the compliance with legislation on environmental protection, to observe established environmental regulations, and to provide the rational use of natural resources and fulfilment of the plans for minimizing the environmental impact [2].