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# ESSENTIAL CONTROL TO ENVIRONMENTAL REGULATIONS FOR OIL AND GAS INDUSTRY: SPOTLIGHT ON DRILLING PROCESSES IN LEBANON

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## 1. INTRODUCTION

Recently practice towards environmental safety has quickly changed especially in the past 20 years, thus it was called the "decade of the environment" (Longwell *et al.*, 1992). All drilling companies and drilling fluid manufacturers are pushing forward their processes or activities from a sustainability perspective. In this perspective, approaching the environmental legislation of drilling waste disposal has many environmental and economic benefits. The US Environmental Protection Agency (EPA) explains "pollution prevention" as efforts to reduce or prevent pollution at the source through cost-effective changes in production, operation, and raw material use. Usually, drilling fluid residues and drill cuttings from these activities have been assumed as drilling wastes and treated accordingly (Jensen *et al.*, 2004). They commonly consist of a complex mixture of drilling muds, chemicals, and formation material. Mud exists under different type, composition, and usage (Abou Alfa *et al*., 2019). Some types of mud include chemical materials that can damage the reservoir formation and the bottom-hole therefore they must be treated.

There are four major groups of waste: completion fluids, workover/stimulation fluids, tanks bottom/oily sludge and dehydration/sweetening waste. More precisely, in the drilling process, waste is divided into primary and associated waste. Primary waste, such as produced water and chemicals, influences the environment through the drill cuttings and the drilling fluid used to lift the cuttings from the well. Moreover, it can also occur due to air emissions from power engines (Matanovic *et al*., 2003). The associated waste consists of a large range of waste streams related to the exploration and production (E&P) of oil and natural gas including drilling muds (fresh/salt water or synthetic/oil-based muds) and cuttings from drilling operations. They also cover tank bottoms, separator sludges, oily debris, contaminated soils, workover fluids, construction debris, packaging materials, unused stimulation fluids, and solvents.

Presently, waste management is familiar as a basis to conserve the acceptability of a company. Before performing any action, a potent control over mud mixing and waste management could have a considerable impact on the efficiency of the operation and the final cost of the fluid. The critical part of waste reduction is minimizing the source of waste. A particular waste management approach was introduced by the US Congress as a regulatory concept in the 1984 Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act (RCRA) of 1976. Therefore, this research suggests many expensive and complex waste treatment methods/technics but accurate and effective to be assigned in the oil field. Then, based on the available environmental evaluation, the appropriate ones for Lebanese oil field would be recommended.

## 2. MAIN HAZARDS AND TREATMENTS

Environmental effects of petroleum waste (hydrocarbons, salt, and heavy metals) are toxic to aquatic organisms. The best way to estimate those impacts is through the information delivered on Material Safety Data Sheets (MSDS) which summarize the appropriate toxicity, flammability or ignitability data related to different material (Morillon et al., 2002). It is used by a supervisory society to regulate and control the allowable amount of discharge relevant to any petroleum activity according to their potential hazard. Atmospheric emissions (e.g. CO2, H2S) coming from flaring, combustion operations and processes, etc. are remarkable from both industrial and governmental points of view. This has forced the oil and gas E&P industry to design, develop, and update procedures and technologies to minimize the releases. Aquatic influences are also seen as important hazards generated by aqueous waste streams like produced water and drilling fluids ... In addition, physical disturbance and contamination resulting from construction and leakage or solid waste disposal are real sources for terrestrial impacts. This leads to soil erosion, vegetation damage and consequently ecological problems.

According to the "EPA pollution prevention" definition, the recommended strategy for drilling and completion of new wells should include the following features:

- Separating the uncontaminated drill cuttings and drilling mud from the contaminated wastes. By this approach, the volume of contaminated waste and consequently the cost of waste handling is reduced. Technologies for treating and disposing of uncontaminated wastes are relatively simple (e.g. land spreading of uncontaminated liquids and solids) and relatively not very costly.

- Using more extensive solids control equipment to increase the "reduce, recycle, and reuse" capabilities (MI Company, 2008).

One of the recommended solutions for produced water (the largest volume of waste generated by the oil and gas industry) is to be injected into the subsurface in onshore operations for example. This procedure should first select a site that is easily accessible by the operators and its geology beneath the surface location is well known (a porous, permeable and non-hydrocarbon bearing zone would be suitable for brine disposal). As well, the depth at which the surface casing will be run is important; it is usually estimated within several hundred feet beyond the deepest known aquifer in an area. The cement is circulated, and the well is then drilled to the desired depth for the zone targeted for disposal. Once a well has been placed in service, several tests should be carried out such as the pressure test for casing or the step rate test to determine maximum surface injection pressure. In the step rate test, a fluid similar to that expected to be injected into the well once it is in service is pumped into the well at gradually increasing rates where bottom hole pressure is recorded during this period to determine the maximum surface injection pressure. The economics of operation normally varies from one country to another, but the average cost of disposal is often less than $0.25 per barrel of fluid. This would be compatible and available in the case of the Lebanese oil and gas field, especially for wells that inject for enhanced oil recovery, dispose of fluids associated with oil and gas production and inject liquid hydrocarbon for storage. Of course, further drilling and geology studies in Lebanon are crucial to adapt or not these kinds of solutions for brine disposal.

In general, Figure 1 resumes a wise rule for waste management in any phase of petroleum industry activities:

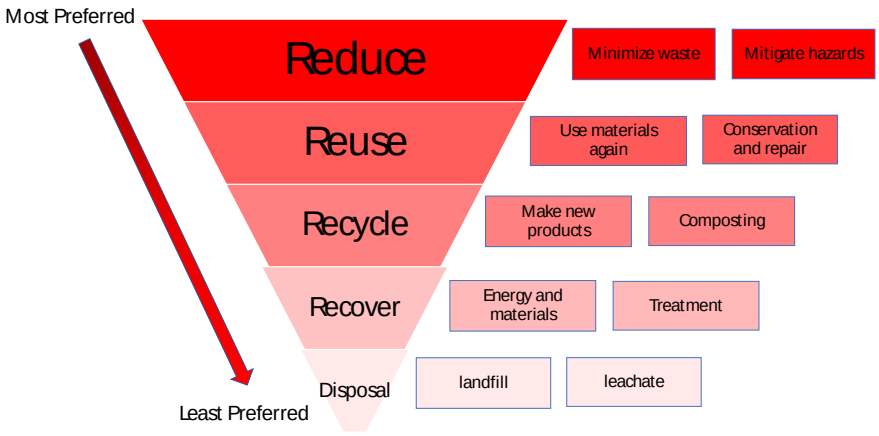


Fig.1: Waste management hierarchy
Reference: Designed by Rami Harkouss November 2020

Certainly, many systems satisfy this overall management strategy for drilling operations. One of these main methods is Performance Fluid Management (PFM) which is a worldwide management system for integrating drilling fluids, completion fluids, solids control, waste management and waste disposal. The Total Fluid Management (TFM) method also addresses all aspects of drilling efficiency and waste generation in drilling operations, to resolve a holistic compromise that is considered to be a sustainable practice (Petrusak *et al.*, 2000).

## 3. REGULATION

There are four basic drivers of legislation/regulation:

1. Protect and preserve the environment and public health.
2. International organizations and treaties.
3. Communities enforcing the government to control pollution.
4. Pressure from foreign markets and developing economies.

In the US, although most E&P wastes are exempt from the hazardous waste regulations of the Resource Conservation and Recovery Act (RCRA), they remain heavily regulated. Oil operators are guided by state and federal regulations that specify how certain wastes must be managed. Then, disposal costs, facility location, and responsibility and liability for the protection of human health and the environment from harmful waste management practices are considered. One of the US environmental legislation is the National Environmental Policy Act. It recommends that the Federal Government consider the environmental impacts of any proposed actions as well as their reasonable (United States Environmental Protection Agency | US EPA). Through management techniques such as Environmental Assessments and Environmental Impact Statements (EIS), companies proposing offshore projects would better take decisions on how to manage environmental consequences. Another US example, the Clean Water Act (CWA). This is a primary law that governs the discharge of pollutants into all US surface waters and requires that the oil content of the discharged fluid cannot exceed 15 ppm.

One of the developed countries in the Middle East is the United Arab Emirates (UAE). Environmental protection is principally subject to UAE Federal Law no. 24 of 1999 for the Protection and Development of the Environment. The most important objectives are to preserve the quality and the natural balance of the environment, to control the pollution and avoid immediate or long-term damage resulting from economic development, to preserve biological diversity within the country, besides to protect of Human and animal health (Retrieved from extwprlegs1.fao.org)

Latin American governments have also sought to clarify their environmental legislation. The development of the regulatory framework has been oriented by standards from Europe, North America, and international treaties and organizations.

Europe has the advantage of a developed regulatory and legislative framework with a well-established infrastructure as the result of years of work and experience. The key factors that affect the constitutional provision and legislative policies in European operations are International Treaties, National Legislation, and Regional enforcement of national regulation.

The Lebanese State has put in place a legislative framework adapted for the petroleum sector. It includes laws, decrees and decisions, based on clear and transparent rules that cover the different phases of the petroleum industry (Exploration and Appraisal, Development and Production...). The article no. 60 (Environmental Protection and Related Measures) in chapter 9 of the Law no. 132/2010 (Offshore Petroleum Resources Law, issued by the Parliament on 24 August 2010) states that the protection of the environment shall apply to any offshore activity without exception. In addition, the Ministry of Environment control and supervise, in close collaboration with the concerned authorities, environmental matters to minimize their negative impact on local communities and the environment (Retrieved from www.lpa.gov.lb).

Countries like Indonesia, Iran, and many other developed countries have also passed their environmental regulatory. However, the lack of adequate funding and qualified personnel makes it difficult to fully implement and enforce the legislative and constitutional provisions. This could be also the case in Lebanon in the future. Thus, since most waste management techniques and standards are developed based on climate and soil of accepting sources, it would be smart to take advantage from other countries' experience instead of wasting time and economic resources on research to find the best techniques.

Achieving this goal, understanding the climate and soil types of oil-producing regions of Lebanon, and finding similar regions in other parts of the world would be very helpful. For instance, some regions of Northern Iran including the southern coast of the Caspian Sea are similar to other zones in the Middle East. Gilan and Mazandaran are covered with forests, snow-covered mountains, and impressive seashores - Plain moderate climate: covering central and western plains of Mazandaran. It looks like the Lebanese mountains near the Mediterranean coast. In addition, regarding Koeppen's climate classification in 1997, Lebanon and North Iran are classified as a temperate climate, more specifically as the *Csa* climate (Retrieved from www.weatheronline.co.uk). This could be a good primary approach for the Lebanese case where there are some similarities in climate and even by the existence of oil and gas under the sea water (the Mediterranean and the Caspian Sea). However, the consortium led by Total acting as the operator (40%) and composed of ENI (40%) and Novatek (20%) has recently completed the first exploration well in Block 4 (Lebanon) on 26 April 2020 (Retrieved from www.total-liban.com). The studies and tests on cuttings and samples are indispensable to confirm or to deny this approach.

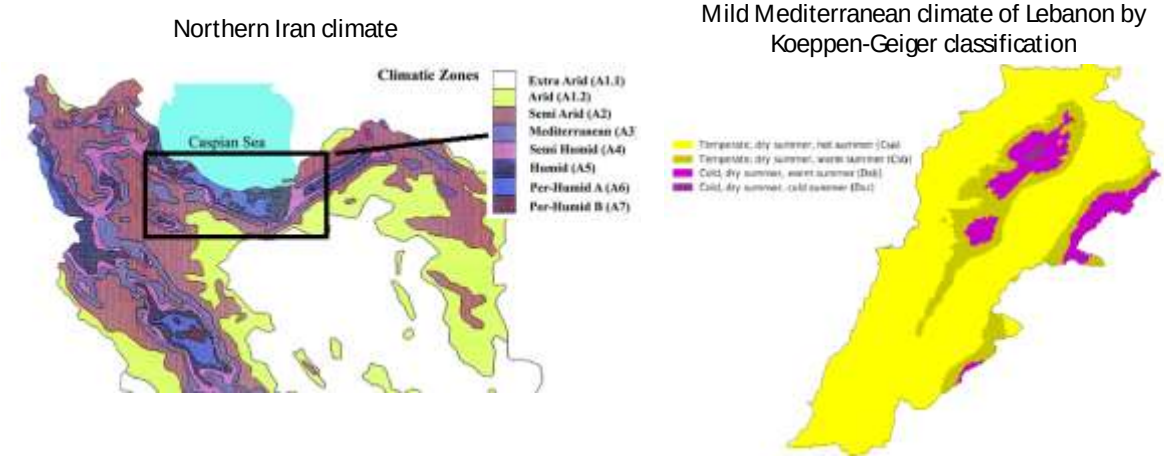


Fig.2: Similarity in North-Iran and Lebanon climate (Mediterranean type)
Reference: Designed by Rami Harkouss November 2020

According to article 50 of the constitution of the Islamic Republic of Iran, the preservation of the environment is regarded as a public duty. Economic and other activities that inevitably pollute or cause irreparable damage to the environment are therefore forbidden. Some of the operational decrees are given as follow:

a. The regulations should result in less waste production during production and consumption.

b. The facilities for production and consumption of products which can be easily recycled should be provided.

c. Strategies have to be taken in such a way that recycled row material usage could be increased.

d. Producers have to pay for a portion of recycling costs.

Besides, companies and organizations, which produce waste that have at least one of the special waste specifications, must minimize them by process improvement, recycling, and keeping its specifications within legal limits. To keep, mixing, gatherings, transportation, to sell or buy, disposal, and exportation of wastes obey the above regulations. Otherwise, those who break it criminally liable to fine of 50 US$ to 10,000 US$ for ordinary waste while the fine for other kind of waste is between 200 and 10,000 US$. For further breakage, the fine would be doubled each time. In general, these Iranian regulations could be adapted and other legislations from other developed countries would be taken into account to enhance the waste management regulations in Lebanon.

## 4. DISCUSSION

Drilling waste management options can be roughly grouped into three categories: offshore discharge, onshore disposal, and re-injection on-site. These three groups of waste management come with their own set of advantages and limitations. A deeper understanding of the specifics of each technology is required to make the best decisions in the regulatory process. In this paper, the offshore discharge will be discussed regarding its importance for the Lebanese case. In general, offshore discharge is crucial for deep water exploratory drilling where the distance from shore and technological limitations constrain the use of other disposal options. That is why the future of offshore discharge as a waste management option will depend largely on regulatory development. Direct discharges of water-based drilling muds and associated cuttings have been shown to have little or no impact and, therefore, are allowed in nearly all offshore drilling sectors. On the other hand, nearly all offshore jurisdictions prohibit the direct discharge of non-aqueous muds, while the on-site discharge of the associated cuttings is subject to local regulations. If drilling waste is not handled onsite via discharge, they will need to be transported to shore for disposal. Consideration of any onshore disposal option must also include consideration of the offshore operations and transport associated with getting the drilling waste to shore (Retrieved from www.longdom.org).

However, there are some environmental, operational, and economic disadvantages to this selection. For example, these operations require extensive use of support vessels to take the cuttings to a shore location. Furthermore, fuel is expended by the workboats during the offshore loading and transport process, resulting in air emissions. These operations are very costly and risky. For these reasons, waste management would be crucial. Unfortunately, two reasons might make efforts for waste management to be not successful: limited experts and national regulations.

## 5. CONCLUSIONS

Based on all the facts explained above, the very first attempt for drilling waste management should employ the performance fluid management and then total fluid management, through which the necessary decisions would be made for waste reduction and then reuse, recycle, recover, and finally residue waste. It is also recommended that the techniques that have been used successfully in similar regions as Lebanon would be utilized to avoid extra costs on trial and error methods for choosing appropriate methods. Finally, the regulations should be revised and specialized for the petroleum industry and punishments should be imposed to force companies to consider environmental issues.

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