Contribution to the International Student Online Conference “Oil and Gas Fields Development in terms of Geology” holded by the Institute of Geology and Geoinformatics, Tyumen State Oil and Gas University, Russia, Oct. 30/31. 2006

ENVIRONMENTAL TOPICS AS A PART OF THE PETROLEUM ENGINEERING COURSE OF STUDIES

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In the European Union the so called **EIA Directive,** the directive 85/337/EWG on the environmental impact assessment (EIA) of certain projects, forms a major framework for obligational environmental investigations and assessments accompanying the development of oil- and gas fields. No matter, whether offshore-plattforms, onshore drilling stations or pipelines are planned. In any case certain environmental assessments on the construction, operation and reconstruction of these installations have to be done before the installation is approved by the authorities. Oil- and gas engineers should be able to handle the main EIA procedures as well as to implement mitigating measures to prevent environmental damage from oil- and gas development. Therefore the petroleum engineering course of studies has to focus on the issues, decribed on the following pages.

The EIA procedure starts with a “scoping process”, in which the main environmental aspects of the project will be discussed by engineers, authorities and others. In a second phase the collection of information follows and a draft „environmental impact statement“ will be written by ecological experts. Then a review process follows, which is accompanied by consultations of the public and several authorities and under circumstances participation of other states. Under consideration of the assessments in the consultation process a summary report of Environmental impacts will end up the procedure.

In general the scope of the EIA includes the effect of a project on:

- human beings, animals and plants,
- soil, water, air, climate and landscape,
- cultural heritage and other material assets,
- including the respective interactions between these factors.

Main environmental aspects of oil- and gasfield development include:

- Air emissions (CO2, VOC, NOx, SOx),

- Produced water handling,
- Soil and groundwater pollution,
- Drilling fluids and cuttings,
- Hazardous waste,
- Accidental oil spills.

Air emissions (CO2, NOx, SOx, VOC's) stem from most different sources. Especially exhaust gas from turbines for power generation, flare gas (CO2, NOx, VOC) and fugitive emissions (CH4 and nmVOC from valves and flanges) have to be investigated. Main environmental impacts or air emissions are climate change (CO2, VOC), harm to people (NOx, SOx), vegetation and agricultural damage (NOx, SOx, VOC).

Emission limits and/or targets for air emissions are defined by local and national administrations, World Bank or oil- and gas companies themselves.

Potential mitigation and control measures are:

- Maximized efficiency of power generation,
- CO2 extraction from gas,
- Low NOx burners in gas turbines (25 ppm NOx emission),
- Catalytic cleaning (SCR) of exhaust gas (5 ppm NOx emission).

Produced water stems from different sources. It may for example be formation water, condensed water or process water from drilling or desalting. Potential environmental impacts are groundwater pollution (drinking water), soil pollution, river pollution or sea pollution.

Emission limits and/or targets for produced water are defined by local and national administrations, World Bank or oil- and gas companies themselves.

Potential mitigation and control measures are:

- Isolation in reservoir or subsea separation,
- Reinjection into active reservoir for pressure support,
- Injection into non-active geological formation for disposal,
- Produced water cleaning and discharge to sea (offshore),
- Disposal into evaporation ponds (sealing by concrete, plastic, etc.).

Soil and groundwater pollution needs monitoring as a preventive measure. Laboratory analyses should be based on a network of sample stations. Most common parameters are: pH, salt content, hydrocarbons (THC/PAH), heavy metals (nickel, vanadium, zinc, lead, mercury, arsenic, cadmium, chromium, copper).

Drilling fluids are used for many purposes during the drilling process. They are able produce a wide range of ecological impacts. Most hazardous are biocides, defoamers, scavengers, descalers, heavy metals and corrosion inhibitors, used to protect instruments. Then there are surfactants, solvents, emulsifiers, thinners and lubricants that could harm environment. Alien environmental elements but less harmful are for example organic polymers, bentonites and other clays.

The selection of drilling fluid chemicals should always be based on an analysis of toxicity, biodegradation and bioaccumulation. In general water based drilling fluids should be used instead of oil based drilling fluids. A reuse of drilling fluids (batch drilling, storage facilities) should be considered.

Cuttings from drilling are handled in different ways. Water based cuttings are in some states discharged to sea, in some states precautionary disposed on land. Oil based cuttings are often collected and handled as hazardous waste (offshore and onshore). Under specific circumstances oil based cuttings are crushed, diluted with water and injected into a downhole geological formation.

Hazardous waste (waste from organic or inorganic chemicals, spent lube oils, other oily waste, etc) needs careful handling. In general a waste management plan should be established caring for safe collection, sorting, temporary storage, transport and disposal of waste. A frame agreement should be established with a waste contractor company approved by authorities. Hazardous waste in the end could be incinerated by high temperature or could be brought to a safe storage site.

Accidental oil spills need precautional preparation. Since 1994 the European Union requires risk assessment as acceptance criteria for all chemicals. The concept is based on the ratio between the environmental concentration and a defined tolerance level. If the environmental concentration exceeds the tolerance level, the environmental risk is regarded as unacceptable.

In western European states oil spill response systems are mainly created by states, federal states and (in certain cases) municipalities. Extended oil spill exercises should be conducted for training purposes.

Monitoring programmes have to focus on the above named factors. Monitoring activities could be integrated into an environmental management system according to the international standard ISO 14001. An environmental management system secures continuous reporting of the environmental state and continuous improvement of precautional actions. Many oil- and gas companies establish such an environmental management system on the oil- and gas fields as a standard.

Literature

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