Oil Vapor & Oil Mist in Drilling Operations

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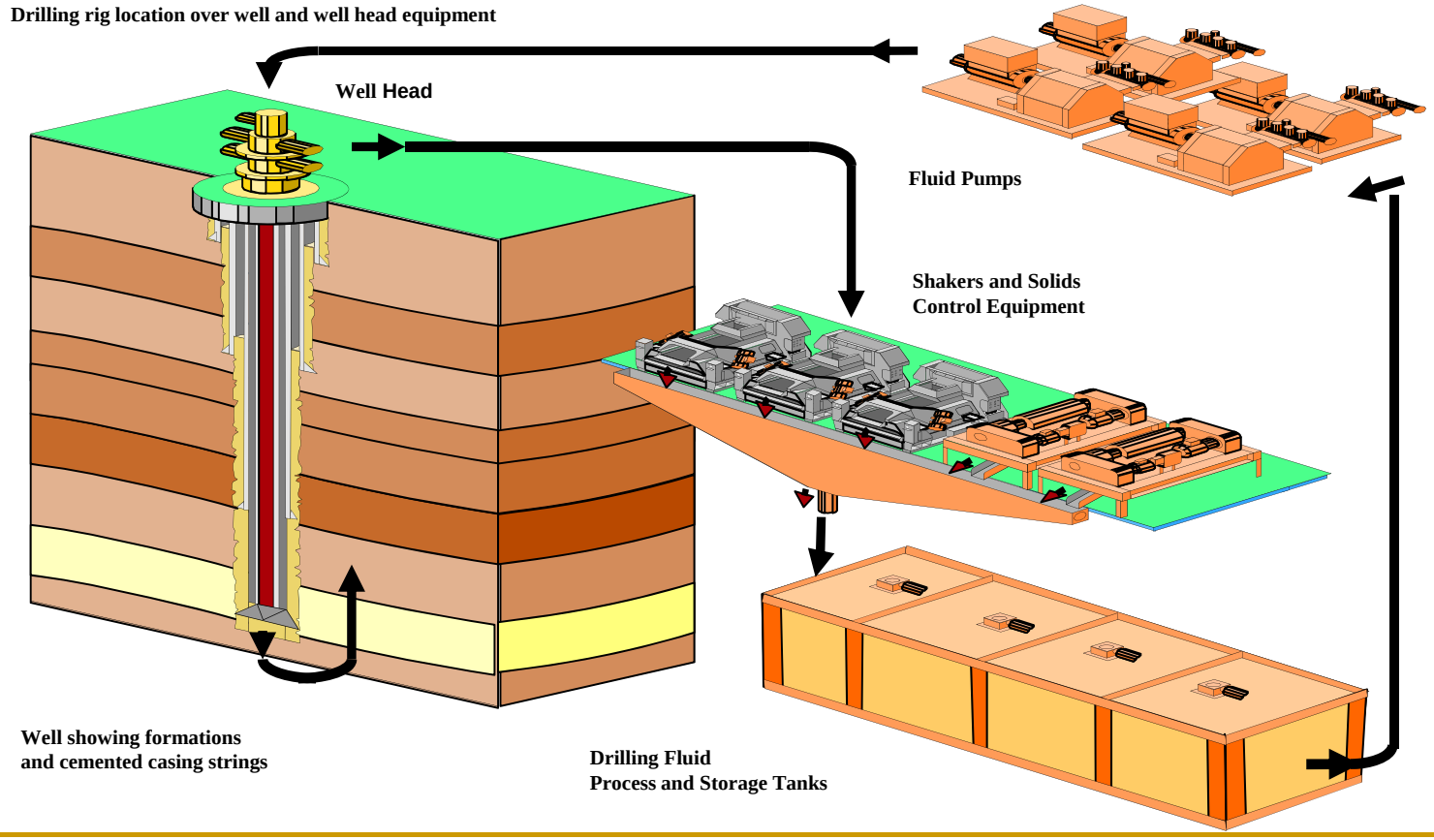
Oil vapor & Oil Mist

- Drilling fluids are exclusively used in the upstream oil and gas industry and represent a major potential for exposure and health effects. During drilling, a large volume of drilling fluid is circulated in an open or semi-enclosed system, at elevated temperature, with agitation, exposing workers to respiratory and dermal contact with the fluid.

Oil Vapor & Oil Mist



Function of drilling fluid

- **Barrier for Well Control.** The drilling fluid is recognised as a primary barrier in a well for controlling downhole pressures and for the consequential avoidance of uncontrolled gas or fluid intrusions from the formations being drilled or exposed.
- **Cuttings Removal.** Drilling fluids must be able to remove cuttings from the well bore as they are produced. Drilling fluid is pumped down the drillstring and out through the bit, circulating cuttings to the surface up the annulus where they are removed by solids removal equipment. The fluid is then re-circulated through the hole. This process is repeated as drilling progresses. To lift the cuttings out of the hole effectively, the fluid must have some viscosity. Clays and polymers can provide this viscosity.

Function of drilling fluid

- **Suspension of Cuttings.** When drilling fluid circulation is stopped, the instantaneous gel strength of the drilling fluid must be sufficient to maintain the cuttings in suspension for a reasonable period of time. The additives used to increase drilling fluid viscosity, such as clays and polymers are also selected for their properties as gelling agents.

Function of drilling fluids

- **Maintaining Pressure on the Formation.** The hydrostatic pressure of the drilling fluid must be sufficient to prevent inflow of formation fluids into the well, and also prevent the wall of the well collapsing. In the majority of cases a weighting agent is added to the drilling fluid, commonly barium sulphate (barite), or occasionally hematite or ilmenite to give the necessary density.
- **Filtration Loss Control.** Drilling fluid loss can occur when drilling through porous and permeable formations. A wide range of materials as simple as shredded paper and straw to more complex blends, or proprietary polymer products are used to control filtration rates. Control of fluid loss is important both for maintaining pressure control and reducing damage to the formation.

Function of drilling fluids

- **Transmission of Hydraulic Power to the Drilling Bit.** There is a relationship between the rate of penetration (ROP) and the hydraulic power of the drilling fluid exiting the drill bit. By selecting fluid components to ensure that as much hydraulic pressure as possible is dropped across the bit, rather than in other sections of the circulation system, the ROP may be substantially improved. Pressure drops arising from viscosity and friction with the drillpipe and bore walls reduce the available hydraulic power. Drilling fluids having high lubricity coefficients and low viscosity characteristics while in circulation may thus be required.
- **Minimizing Formation Damage.** Depending upon the drilling fluid and the formation contacted, fluids may interact with formations. Formation damage is more prevalent with water-based fluids, as the water may interact with salt-bearing and clay formations. The formulation of new inhibitive water-based fluids has led to a wide selection of suitable additives which provide less formation damage potential than traditional water-based drilling fluids. Interactions between non-aqueous fluid (NAF) based drilling fluids and formations are significantly reduced as the drilling fluids are more inhibitive, reduce water contact with the formation, and allow less complex drilling fluid formulations of higher technical performance.

Function of drilling fluids

- **Cooling and Lubrication of the Drill Bit and Drillstring.** Cooling and lubricating the drill bit and drillstring are important, especially when drilling in deep or highly deviated wells where temperatures are hotter and the torque on the drill is higher. Hydrocarbons, graphitic or microspheres may be used to increase lubricity in water-based fluids. NAF based drilling fluids have an inherent lubricity. Both water- and NAF-based systems are effective at cooling the drill bit. NAF-based drilling fluids can generally be used at higher temperatures due to the adverse reactions of many water-based products when exposed to higher temperatures.
- **Data Logging.** Drilling fluids characteristics need to be controlled so that logging instruments can accurately provide information about the well and formations being drilled.

Oil based drilling fluids

Classification of Non-Aqueous Fluids		
Non-Aqueous Category	**Components**	**Aromatic Content**
Group I: High-Aromatic-Content Fluids	Crude oil, diesel oil, and conventional mineral oil	5 to 35%
Group II: Medium-Aromatic-Content Fluids	Low-toxicity mineral oil	0.5 to 5%
Group III: Low/Negligible-Aromatic-Content Fluids	Ester, LAO, IO, PAO, linear paraffin and highly processed mineral oil	<0.5% and PAH lower than 0.001%

Health Hazards of Drilling Fluid Systems

- The most commonly observed health effects of drilling fluids in humans are skin irritation and contact dermatitis. Least frequently reported effects are headache, nausea, eye irritation and coughing. The effects depend on the route of exposure and are caused by the physic-chemical properties of the drilling fluid as well as the inherent properties of drilling fluid constituents.

Todays situation

- Highly refined mineral oils with no are used today with low aromatic content in Norway.
- New technical challenges will demand the use of low viscosity base oil in the future
- Due to this no compromise must be done due to the potential health effects
- OEL
  - Oil mist 0,6 mg/m3
  - Oil Vapor 30 mg/m3

Health Hazards of Drilling Fluid Systems

- **Inhalation**
- In case of non-aqueous drilling fluids the vapours consist of the low-boiling-point fraction of hydrocarbons (paraffin's, olefins, naphthenes and aromatics) and the mist contains droplets of the hydrocarbon fraction used. This hydrocarbon fraction may contain additives, sulphur, mono-aromatics and/or polycyclic aromatics. However, knowledge about the detailed composition, and size of the aerosol droplets is limited.

Health Hazards of Drilling Fluid Systems

- **Odour.**
  - An issue indirectly related to health, but directly related to the working environment is the odour of drilling fluids. Some drilling fluids may have an objectionable odour caused by the main constituents or specific additives. During operations the drilling fluids may be contaminated with crude oil and drilling cuttings, which may change the odorous properties of the drilling fluid.

Health Hazards of Drilling Fluid Systems

- ***Neurotoxicity.***
  - Inhalation of high concentrations of hydrocarbons may result in hydrocarbon-induced neurotoxicity, a non-specific effect resulting in headache, nausea, dizziness, fatigue, lack of coordination, problems with attention and memory, gait disturbances and narcosis. These symptoms are of a temporary nature and are only observed at extremely high concentrations

Health Hazards of Drilling Fluid Systems

- ***Pulmonary effects.*** The most observed symptoms in workers exposed to NAF and aqueous fluid aerosols are cough and phlegm. Epidemiological studies of workers exposed to mist and vapour from mineral oils indicated increased prevalence of pulmonary fibrosis. More recent inhalation toxicology studies show that exposures to high concentrations of aerosols of mineral-based oils resulted mainly in concentration related accumulation in the lung of alveolar macrophages laden with oil droplets.
- Inflammatory cells were observed with higher aerosol concentrations, consistent with the clinical literature from highly exposed workers. These pulmonary changes appeared to be a non-specific response to the presence of deposited aerosol and are not related to vapour exposure. The results on various petroleum mineral oils support the ACGIH TLV of 5 mg/m3 for mineral-oil mist.
- Inhalation studies with aerosols from an olefin (polybutene) also resulted in elevated numbers of pulmonary macrophages and increased macrophage vacuolization.

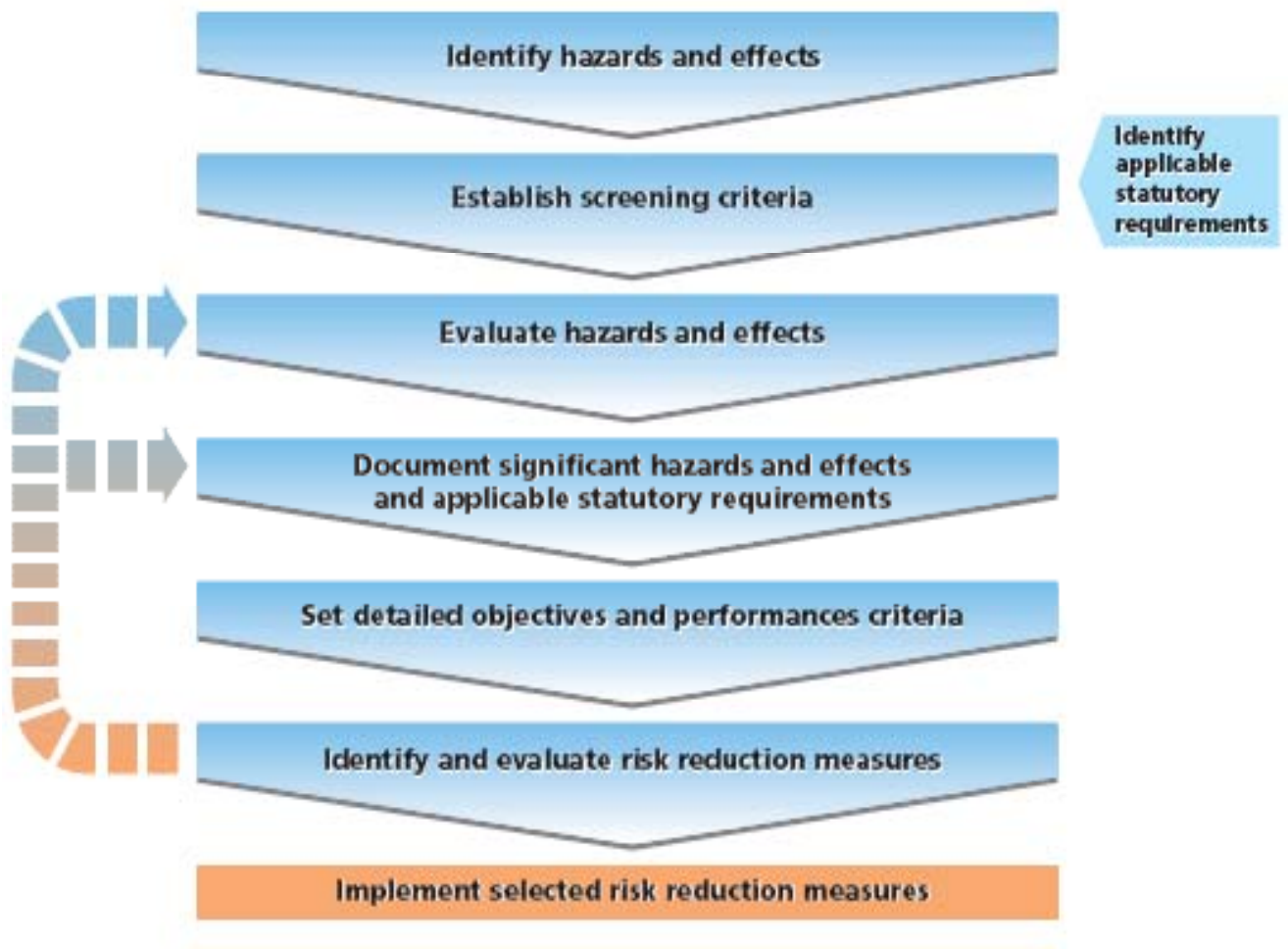
Health Hazards of Drilling Fluid Systems

- ***Carcinogenicity (Inhalation Exposure).***
  - The olefins, esters and paraffin commonly used in drilling fluids (Group III–Negligible Aromatic-Content Fluids) do not contain specific carcinogenic compounds such as benzene or polycyclic aromatic hydrocarbons (PAHs). Tests in laboratory animals have shown that these substances are not genotoxic or carcinogenic through inhalation.

Dermal exposure

- **Dermal.** Since drilling fluids are circulated in an open system with agitation, there is a high likelihood of dermal exposure. The potential dermal exposure is not limited to the hands and forearms, but extends to all parts of the body. Actual exposure depends on the drilling system and the use of personal protection equipment (PPE).

Risk Assessment Process



Action hierarchy

- Eliminate
- Substitute
- Engineering controls
- Administrative controls
- Personal Protective Equipment

Biological monitoring

- Literature search shows that there has not been any proper investigation or research of exposure to bacteria's and endotoxins.
- This may not been the same issue that the oil industry have seen in hydraulic fluid systems due to temperature and pressure .
- Mud is reused and will contain water.
- The salinity level will vary. Lime is typical 2 w% of the total volume in oil based fluid.