Comprehensive Assessment of Produced Water Toxicity

Insights into Organic Compounds, Metals, and Ecotoxicity

N. Bonciani, M. Ottaviani, S. Brooks, M. M. Larsen, J. H. Christiansen, N. J. Nielsen, K. L. Feilberg

Subsurface oil extraction generates large volumes of produced water (PW), with Danish offshore operations alone producing around 30 billion cubic meters annually. Due to reservoir damage, only part of this PW is reinjected, while much of it is discharged directly into the marine environment. Current regulations focus mainly on limiting dispersed oil content, regulated at 30 mg/l by OSPAR, which accounts for less than 1% of the total environmental impact. There is limited knowledge of the broader ecological risks posed by other PW constituents, which can be harmful even at low concentrations, and data on their specific effects on marine species is scarce.

This study emphasizes the need for precise measurements of organic compounds in PW, such as BTEX (Benzene, Toluene, Ethylbenzene, Xylenes) and PAHs (Polycyclic Aromatic Hydrocarbons), both toxic and carcinogenic to marine life. It also highlights concerns about production additives like formaldehyde and glutaraldehyde, indicating the potential overuse of biocides. Trace elements and metalloids, including Hg, As, Se, and Sb, are also found in PW at higher concentrations than in seawater, requiring rapid sampling and dedicated equipment (such as cold vapor atomic fluorescence spectroscopy) to avoid reporting errors.

Biological impacts were studied through sub-lethal testing on oyster embryos, revealing significant variability in toxicity across oil platforms. The sensitivity of different species, like Temora longicornis, was also examined, showing the importance of selecting appropriate test organisms. The role of suspended particulate matter (SPM) in PW toxicity was found to be significant, often contributing more to overall toxicity than volatile compounds.

The study concludes that current PW management practices, focused solely on dispersed oil content, could be improved upon to minimize harmful emissions to the environment. A more comprehensive approach is needed, with additional research and more detailed testing protocols to fully understand and mitigate the environmental risks of PW discharges.