Preface to the special issue: Environmental aspects of oil industry

Gabriela Sánchez-Reyna* and
Jorge Ancheyta

Instituto Mexicano del Petróleo,
Eje Central Lázaro Cárdenas Norte 152,
Col. San Bartolo Atepehuacan,
Mexico City, 07730, Mexico
Fax: + 52-55-9175-8429
E-mail: gsanchez@imp.mx
E-mail: jancheyt@imp.mx
*Corresponding author

Biographical notes: Gabriela Sánchez-Reyna holds a Bachelor's degree from the Universidad Nacional Autónoma de México, a Master's degree from the Instituto Politécnico Nacional of Mexico, and a PhD from the University of Bristol, England. She has 15 years of experience in the analysis and modelling of air quality in mega-cities such as Mexico. Her main current research interest is the modelling of production and transport of aerosols and volatile organic compounds in the troposphere.

Jorge Ancheyta has more than 20 years of experience in areas associated to refining processes, mainly in hydrotreating, reforming, FCC, and upgrading of heavy oil. He has published more than 120 scientific papers. He has also edited various special issues in prestigious journals such as *Catal. Today*, *Petr. Sci. Techn.*, *Fuel*, *Ind. Eng. Chem. Res.*, and published two books, *Hydroprocessing of Heavy Oils and Residua* and *Asphaltenes: Chemical Transformation during Hydroprocessing of Heavy Oils*.

Over the last century, the oil industry has emerged as the world primary fuel source. At present, the life style of human societies depends on energy. Without commercial energy (e.g. electricity, natural gas, crude oil and its refined products and coal) societies as we know them would crumble. In particular, fossil fuels are essential for electricity generation and for modern transportation systems. However, parallel to the remarkable contributions of the oil industry to the global economy, there have been some adverse environmental impacts coming from oil drilling, refinery waste, oil spillage, gas and flaring.

In recent years concern over environmental protection has become a critical issue, this means that the geopolitics of oil are stretching further than supplying security to the combustion of oil itself.

A considerable amount of investment and effort has produced a significant advance in the fields of prevention, mitigation and reconciliation of the environment and the industry, as well as new promising renewable sources of energy. Therefore, the articles selected for this especial issue on environmental aspects of oil industry have been devoted to offer a slice of the current understanding in the aforementioned research

fields, especially in the repercussions of the upstream activities of oil industry on the environment.

In the first article, a proposal to measure, monitor and compare the interactions between the oil industry and the ecosystems is described. The study is based on the case of Mexico, which is considered a mega-diverse country because at least 10% of the existing species on the planet are located in its territory. The national oil company, Petróleos Mexicanos (PEMEX), has facilities located throughout the country, from coastal ecosystems to volcanic plains, where a variety of social, economic, political and environmental aspects need to be taken into consideration. Internationally there have been various efforts to assess the interactions between the oil industry and the ecosystems but the scale of the indicators is at corporate or country level, thus difficult to apply at the installation level because at this scale ecosystem interactions are more specific and numerous. Therefore, a methodology to assess the interaction of PEMEX facilities with the environment is presented, based on a small number of environmental indicators in air, water and soil, along with society and economic aspects. The study emphasises that emissions of greenhouse gases, nitrogen oxides and suspended particles need to be considered, as well as the effects of the various oil sectors (refining, petrochemical, gas and extraction) on local water demand and discharged water quality. In addition, soil organic matter and species diversity are suggested as reliable indicators of environmental impact.

The potentially hazardous pollutants that can arise from the formations being drilled are not always predictable. In this sense, the environmental and health risk assessment of the more common contaminants is discussed in the second article of this issue. A multimedia exposure model was applied to assess the dose exposure, toxicity, risk characterisation and management in air, soil and water over an oil-contaminated area which has been under the pressure of oil industry activities for more than 70 years.

The use of technologies that have been applied successfully to remediate environmental problems are described in detail in two articles. One of them deals with the treatment of contaminated areas by polyaromatic hydrocarbons using biostimulation and bioaugmentation techniques, emphasising the importance of the type of pollutant, oxygen concentration and type of microorganisms on the success of remediation techniques. The biological processes that can contribute to the containment and/or remediation of contaminants, as well as the mechanisms in phytoremediation are described in the fourth article. The authors give a detailed discussion of the key physiological processes in which phytoremediation techniques are based, such as the transfer of pollutants from roots to other parts of the plant, and the removal of contaminants via phytostabilisation or phytodegradation.

In addition to the assessment of environmental damage – either potential or present – and the best techniques of remediation, an enormous effort on research is given to develop alternative fuels, which must be environmentally friendly and capable to satisfy the each time bigger energy demand; as it is estimated (with high uncertainty) that supplies of fossil fuels will be exhausted in around 35 years for oil, 107 for coal and 37 years for gas. This means that coal reserves may be available up to 2112, and may be the only fossil fuel remaining after 2042, according to Shahriar and Topal (2009).

Using biomass to generate energy is seen as a way to enhance energy security and tackle global warming by reducing greenhouse gases emissions; this has become in recent years the strongest driver for the introduction of biofuels, especially in the transport sector. However, it is critical to evaluate all aspects of introducing new energy sources.

Under this frame, an article has been included in which changes in key atmospheric species known to have negative effects upon human health (hydrocarbons, nitrogen oxides, carbon monoxide and particulate matter) were estimated by using a global three-dimensional chemistry transport model, in an effort to contribute to the understanding of how the usage of new fuels may affect the air pollution and composition on a global scale.

Finally, the sixth article deals with the use of fossil fuels and related technologies to decrease CO_2 emissions to the environment and the CO_2 re-use, which is an emerging research area. Today, the only technology that may be able to cope up with the vast amounts of carbon emissions is carbon sequestration. However, this can be costly and there is limited number of sequestration sites, hence developing a new method to deal with carbon emissions could help in the decrease of carbon sequestration sites and would be useful and even profitable. One method being proposed is to activate carbon dioxide and re-use the carbon to form valuable products. This method could also be potentially economically efficient by selling the products of the activated carbon dioxide for a profit. This process could use 'free' solar light to drive the catalytic reactions to reduce carbon into methane, ethane, or other valuable organic compounds. Under this perspective, the article presents the properties of Fe-doped-titanium dioxide which make it suitable as catalyst to activate carbon dioxide.

As it was mentioned, the consequences of oil industry activities on the local and even global environment have been recently considered as a critical subject in the research and political agendas. Even though the interactions environment-industry are currently understood in an acceptable level, there is still much work to do: the articles presented in this issue highlight the importance of a continuous research and implementation of actions, if we want to preserve our planet to future generations.

References

Shahriar, S. and Topal, E. (2009) 'When will fossil fuel reserves be diminished?', *Energy Policy*, Vol. 37, pp.181–189.