During this stage there would be huge pressure on the digital world to present more content cheaply and quickly, and it is important that the journal does not succumb to such pressures.

Sundar Sarukkai (National Institute of Advanced Studies) raised questions as to who should really be talking about science and society, and what skills or professional training one needs for the same. He mentioned that scientists, though important, did not have the final authority to speak on science and society, and as partners, needed to draw upon professionally trained historians, philosophers and sociologists. Such trained professionals are hard to find in India, as the country does not have a full-fledged programme in the history, philosophy and sociology of science. He urged that science education should be a broadened study of science through history, philosophy and sociology of science.

Shiv Visvanathan (Jindal Global Law School) emphasized the need for democracy within the scientific community, conversations between scientists and science policy makers as well as between scientists as citizens and other citizens. He felt that the dialogue with people needed to improve further. He urged scientists to use science to provide a more imaginative democracy and invited them to experiment within the democratic imagination.

In his concluding remarks, Ramaswamy hoped that the journal would see multiplicity in opinions, debates and serious engagement on important matters.

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MEETING REPORT

Environmental safeguards*

A workshop was organized recently in North East (NE) Region of India to review the implementation status of environmental safeguards mentioned in the environmental clearance letter for oil, petroleum and gas-based projects.

The discussion was organized as part of the mandate of the Regional Office, Shillong with the objective to achieve better coordination between the regulators, the projects and R&D institutes through discussion and interaction. Therefore, regulatory authorities and R&D organizations were invited for a deliberation on environment management, pollution control, resource and energy conservation, clean production and R&D needs, thereby benefiting the industry with respect to technological innovations in this sector and involvement of R&D organizations in the form of industry–institution joint collaborative programmes for the NE region of the country.

B. S. Kharmawphlang (Chief Controller of Forests (Central), Shillong) welcomed the delegates and emphasized the need for a proper dialogue between the regulating agencies and the project executors, so that the projects would be informed about changes in the guidelines. Development and compliance must go hand in hand. However in most cases, compliance checks are not followed-up and therefore there is need for such an interactive session, which would help in achieving excellence and benefit the stakeholders.

V. P. Upadhyay (MoEF) projected the uniqueness of the petroleum industry in our everyday life. It is the largest money earning industry, diverse in both products and pollutants, similar to coal industry. He highlighted the pollution issues in drilling, production, combustion of by-products as a result of flaring, production water containing dissolved and emulsified crude oil constituents, natural salts, organic chemicals and trace metals, solid wastes comprising drill cuttings and drilling fluid mud, oil spills, noise and exhaust gases from diesel engines and power generation sets. He underlined the importance of leachate collection system in the disposal of drill cuttings and drilling fluids originating from on-shore locations, which is not available at the project sites. According to the guidelines related to drill cuttings and drilling fluids for on-shore Installations (2005), only water-based mud is permitted for drilling; oil-based mud with low toxicity may be permitted only in special cases; chemical additives used in drilling fluid should be biodegradable and have low toxicity; chemicals should be biodegradable, waste pit should be covered with 1.5 mm thick liner and native soil, with proper slope, with the design of the waste pit and capping being approved by regulators like the Pollution Control Board. Upadhyay also mentioned that the projects have not made any inventories on the number of abandoned sites which have been restored or are yet to be reclaimed. He advised the project authorities to seek help from R&D institutes such as Rain Forest Research Institute (RFRI), Jorhat for reclamation or restoration process.

According to Upadhyay, there are three important aspects in respect of oil refineries: minimizing emissions, minimizing wastewater, and solid waste management. The oil zapper is being used at present for remediation of oil sludge from the industries. He requested the project authorities to let the Regional Office know about the end use and quality of the remediated oil sludge-contaminated habitat. The projects should support the NE institutes to carry out further research for alternative and better solutions than oil zapper to restore the fertility of abandoned sites. He emphasized further processing of petroleum coke, only by large-scale industries with proper pollution control systems. Petroleum coke should be sold to those industries which have proper Environmental Clearance (EC) (if applicable) and consent to operate. Oil refining and petrochemical projects generate solid wastes and sludge, some of which are hazardous

*A report on the 'Workshop on Environmental Compliance in Oil, Petroleum and Gas-based Projects of the North East Region' held on 24 March 2017 at the Regional Office, Ministry of Environment, Forest and Climate Change, Shillong.

in nature due to toxic organic chemicals and heavy metals (e.g. spent caustic). Proper facilities should be provided for handling and storage of hazardous waste. For final disposal, recycling/reuse should be given priority. For waste that can be incinerated, properly designed incinerators should be installed and non-incinerable hazardous waste should be disposed in secured landfills (SLFs). Spent catalyst with high calorific value can be used by cement kilns. Upadhyay urged the project authorities to take the help of R&D institutions to analyse the solid waste and have an inventory about their chemical composition and calorific value, which can then be used by the downstream industries instead of disposing solid waste in the SLFs.

Self-regulation is the only way to improve the projects, which are increasing each year; it is becoming difficult for the Regional Office to monitor all the projects each year. A number of chemical additives for hydraulic fracturing, acids (notably hydrochloric acid), bactericides, scale removers, and friction-reducing agents are used. Oil and gas development may pose health risks to nearby communities through contamination of drinking water sources with hazardous chemicals used in drilling, hydraulic fracturing of the wells, processing and refining of oil or gas, or disposal of wastewater. The projects lack an inventory of chemicals being used and the fate of these chemicals – whether they are toxic or non-toxic, biodegradable or non-biodegradable. Monitoring of naturally occurring radioactive material (NORM) waste arising from the oil and gas industry was also discussed. Drill cuttings and mud coming out during oil exploration have not yet been analysed for radioactivity at the drilling project site. Higher concentration of radio isotopes present in technologically enhanced NORM, often called TENORM, which results directly from human industrial activities, needs to be monitored. Scientists from the Atomic Mineral Directorate, Department of Atomic Energy, Shillong, regularly carry out such surveys and monitoring in the NE region. The oil exploration and production (E&P) projects may avail their expertise for such assessment. Other EC-related issues like treatment, storage and disposal facility (TSDF) membership, managing total dissolved solids (TDS) in demineralization (DM) plant effluents, report on the compliance of public hearing recommendations, environmental statement for each financial year, and time-bound action plan towards enterprise social commitment were also discussed.

Gas-based power plants use selective catalytic reduction (SCR) for NO_x control. Reductions in these emissions translate into public health benefits, as these pollutants have been linked with problems such as asthma, bronchitis, lung cancer and heart disease. Upadhyay urged the project authorities to monitor emissions of CO, CH_4 and non methane hydro carbon (NMHC) as stipulated in the EC conditions. However, he also mentioned that the environmental stressors from the gas power stations are few and far, less than those that result from today's coal-fired boilers.

The recent report of the Comptroller and Auditor General of India on environmental clearance and post-clearance monitoring has highlighted a number of violations in case of general and specific conditions. Non compliance or violation reflected poorly not only on the project authorities, but also on the efficiency of the Regional Offices.

Some of the other safeguards that are stipulated in the EC include greenhouse gas reduction and afforestation with indigenous species. It was suggested to avoid exotic species as they affect the ecological balance and food chain. The compliance by projects like Bongaigoan refinery, Guwahati refinery and Premier Oil in achieving excellence in afforestation, disposal of solid waste and reclamation of land, and water recycling was highlighted.

A. K. Acharya (Oil India Limited (OIL), Duliajan) discussed the issue of non-compliance of EC conditions for carrying out subsidence studies. He opined that since production of oil/gas in oil fields of Upper Assam is from the top part of the reservoir, the pressure is naturally maintained. Production from the reservoir is maintained through pressure maintenance by injecting water into the reservoir and subsidence study condition should be taken out from the EC. It was suggested that this should be taken up with Expert Appraisal Committee (EAC) and that OIL should have sufficient data to support that the fact that this condition is not required. With regard to 'Well site abandonment and restoration plan' the project authorities should submit the geographical coordinates of the abandoned well sites, so that the Regional Office can monitor those sites. Most of the DG sets are to be provided with acoustic data and vertical stacks to ensure compliance to recent notification and guidelines.

Atul Kumar Samant (ONGC, Jorhat) discussed the frequency of 'ambient air quality (AAQ) monitoring at the nearest human settlement and mercury analysis in air, water and drill cuttings during exploratory drilling period'. Z. Changsan (CPCB, Shillong) and Upadhyay informed that monitoring at least twice a week has to be done during the drilling period according to the National Ambient Air Quality Notification 2009. On the suggestion that frequency of monitoring should be relaxed in oil exploration and drilling projects, it was suggested that project authorities may seek relaxation from EAC for manual quarterly or monthly AAQ monitoring. However, an automatic AAQ monitoring machine can be used. Changsan also informed that some oil projects in Assam are using AAQ monitoring instruments which have been tampered. He urged the project authorities not to use altered or modified instruments for monitoring. With regard to environment audit that needs to be done to ensure implementation of Environment Management Plan, it was informed that an in-house audit can be done if the project authorities have the requisite expertise. Shantanu Dutta (Central Pollution Control Board (CPCB), Shillong) urged the project authorities to write to the cement plants that would be willing to use their oil sludge and spent catalysts as alternate fuel and raw material. Ajay Mehrotra (MoEF&CC, Chandigarh) stressed that an inventory of all the oil sludge and spent catalysts be prepared with the help of R&D institutes to characterize their chemical constituents and calorific value, thereby identifying the possible use of these materials. He opined that the project authorities can generate revenues through the utilization of these waste materials.

Samant spoke about the Institute of Biotechnology and Geotectonic Studies, Jorhat, an R&D institute of ONGC, which is approved by the Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India. Research in the Institute focuses on petroleum biotechnology, geomicrobial hydrocarbon prospecting and bacteriological monitoring.

He also informed that the Institute has identified new microbial strains for bioremediation that can bring down the oil content in effluents contaminated with oil to below 10 ppm in a few months.

Shantanu Dutta (CPCB) discussed the 'eco-restoration of degraded lands' following the Akira Miyawaki eco-restoration model. Successful implementation of model plantation has been carried out at various project sites in the NE states. Upadhyay informed that the survival rate of saplings of local species is more than 90% compared to the general plantation, where the survival rate is less than 30%. The expenditure for planting with the Akira Miyawaki model ranges from approximately Rs 50 to Rs 90 per sapling depending upon the availability of local material.

The plantation does not require much later care, weed growth is negligible, digging of large pits is not necessary, moisture retention is high and mulching helps in the preservation of soil nutrients and prevents erosion. As a result, it is a cost-effective method. The cost of plantation is borne by the projects. Ecological stability at a faster rate is the prime concern which can be achieved by eco-restoration of degraded areas in the projects.

Other points about compliance were discussed with the project executors and a few suggestions were made as follows:

1. Most of the exploration drilling operations are being carried out in violation of the condition of EC, which states that for further development drilling or in case of commercial viability, projects should seek fresh EC. This has never been complied with, and development and production drilling are completed without EC. After discussion it was suggested that only new fields should attract such conditions. It was agreed that the EAC should be appraised in the matter.

2. There is a condition that every project should become a member of the TSDF facility, which is never complied with. It was informed that such a facility has not yet been created by the NE states. Also, when SLFs are created by the projects and being used, the TSDF membership may not be required. The Ministry may waive this condition in such cases.

3. The projects are engaging laboratories which are not notified under Environment (Protection) Act 1986 and not accredited by National Accredition Board for Education and Training. Therefore, the condition is not complied with. It was discussed that when the condition for environmental laboratory is stipulated and the same is created, third party monitoring may not be insisted upon by the ministry/State Pollution Control Board (SPCB)/CPCB. There was a suggestion that 'self-monitoring and self-regulation' may be encouraged.

4. IIT Guwahati and Central Road Research Institute (CRRI) have undertaken projects for analysis and research on drill cuttings, and found that these are non-toxic and can be utilized by brick kilns or in road-making, instead of creating a permanent landfill without fruitful land use. It was suggested that project executors should collect comprehensive data in existing oil fields on chemical constitution and toxicity level of drill cuttings through a reputed institution. Drill cuttings may be collected as composite samples of various lithologies at specific depth intervals. Samples should also be collected from the depths when drilling/fracking chemicals are changed, to have data on toxicity impact of a particular chemical/group of chemicals. The EAC may be appraised about this accordingly.

5. The SPCBs in the NE region are still issuing consents to projects on a yearly basis, although guidelines to issue integrated consents for five years have been issued by the MoEF&CC and CPCB. Therefore, Boards should follow the guidelines.

There was discussion on these issues with experts from R&D institutes who spoke about their research work, possible industry–institute collaboration relating to various safeguards and taking up projects/programmes to increase the level of environmental compliance. R. K. Upadhyay (IIT-Guwahati) discussed the research work being carried out by his team at IIT Guwahati. The Institute wants to collaborate and take up the following R&D problems for industries which will help in the efficient utilization of resources and also increase environmental compliance:

1. TDS reduction in DM water.

2. Designing of catalytic converters for reduction of NO_x, particulate matter and soot particles from diesel engine exhaust that can be implemented in other places too, for both mobile and stationary applications.

3. Utilization of C1: working on the design of a compact membrane reactor which can convert C1 to ultra pure H_2 which can be combined with polymer electrolyte membrane fuel cell to provide clean energy.

4. Convert C1 and CO_2 to useful chemicals like methanol.

5. Identifying the calorific value of spent catalyst and its complete characterization, thereby suggesting the possible use of these catalysts.

6. Work on flow assurance which is an effective way to transport crude oil from pumping station to refinery. Effective ways can minimize the pumping requirement and hence the overall emission.

7. Characterization of drill cuttings and wastes to find the toxicity level and its impact.

8. ETP sludge analysis and converting greenhouse gases to useful gases.

T. Medhi (Department of Molecular Biology and Biotechnology, Tezpur University) mentioned that an abandoned site can be characterized by mobile simulator, thereby identifying the toxicity of that particular site and suggesting the kind of remediation needed and whether plantation can be taken up. One of his students is working on biosensors in the detection of hydrocarbon in various media including oil-contaminated sites. V. P. Upadhyay requested ONGC authorities to arrange for a meeting between ONGC and Tezpur University. The project authorities showed keen interest in biosensor research.

S. Borgohain (Dibrugarh University) emphasized that though Dibrugarh University is close to both ONGC and OIL projects, there is no linkage and discussion between the University and the project authorities and funding to the Petroleum Department in the University is negligible. He discussed his main research areas:

1. Identification of competent alkali–surfactant–polymer formulations for enhanced oil recovery of Assam crude oil.

2. Comparative study of natural lignosulphonate with its synthetic analogues for enhanced oil recovery (EOR).

3. Remediation of produced water from NE oil field by microbial and membrane intervention with modelling

of an effluent unit for the recovery of usable water.

4. Foam-assisted CO_2 flooding for the depleted reservoirs of Upper Assam Basin and in candidate reservoirs in Louisiana, USA.

Apart from the above, Borgohain emphasized work on the characterization of formation water. Project authorities were requested to seek R&D support, especially on water-related issues in projects and eco-friendly technology for EOR. During monitoring, it has been observed that formation water at many sites in the oil fields does not conform to the prescribed standard; so ETP needs revamping and further R&D in this aspect is needed.

D. J. Das (RFRI) stressed that though his Institute does not have collaboration with the oil sector, it can contribute in the monitoring of ecological biodiversity. The Institute has also completed a study on carrying capacity of Digboi forest and prepared a report on the impact of oil spills on biodiversity. Das has done a project with Coal India for preparing a biodiversity management plan. They have adopted villages and are training the villagers on how to avoid man–animal conflicts. They can help raise nurseries and provide native species as well. RFRI is so close to operational areas that environmental compliance, particularly related to biodiversity conservation, afforestation, greenbelt development, and socio-economic development can be significantly improved with help of the Institute.

Finally, the project executors were advised to submit time-bound action plans to increase the compliance and inventory of oil sludge and spent catalysts, including chemical and physical composition with the help of reputed institutions. Scientists from the SPCBs were also requested to take up the issues of oil sludge for co-processing in cement kilns.

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MEETING REPORT

Fighting antibiotic resistance through unified strategies*

A one-day international symposium was held recently in Bengaluru, India to discuss strategies to reduce antibiotic resistance by adopting a holistic approach to human, animal and environmental health. The excessive and indiscriminate use of antibiotics in human, agriculture and animal healthcare has resulted in antimicrobial resistance (AMR)[1]. It is estimated that, if unsolved, by 2050 AMR will cause 10 million deaths per year[2].

The symposium brought together expert veterinary medical professionals, dairy scientists as well as national and international representatives. Anurag Bhargava (Medical College, Mangalore) highlighted the need to work on a 'One Health' perspective. He gave examples from rural India, where human tuberculosis originating from cattle is increasingly prevalent and largely resistant to all antibiotics. He expressed his concern clearly when he stated: 'now we have bugs from hell'. Praveen Malik (Department of Animal Husbandry, Government of India) emphasized the challenge presented by the need to increase production and improve farmer income while reducing the use of antibiotics. He added that 'We are now in the post-antibiotic era and we need to focus on alternate solutions'.

As a response to this challenge, a five-layered strategy of Natural Livestock Farming (NLF; www.naturallivestock-farming.com) for reducing the use of antibiotics and other chemicals in dairy farming was presented by Katrien van't Hooft (Dutch Farm Experience/NLF Coordinator, The Netherlands). This strategy includes; (1) good animal management; (2) strategic use of local breeds; (3) use of medicinal plants and other natural products; (4) milk quality control, and (5) farm economics (cost reduction and/or improved prices).

Hari Kumar (National Dairy Development Board (NDDB), Gujarat) stressed upon the economic perspective, by citing the loss of over Rs 7000 cores per year due to udder infection in Indian cattle, the main reason for antibiotic use in the dairy sector. In order to reduce this dependence, the NDDB decided to adopt a formulation using medicinal plants – also known as ethno-veterinary practices (EVP) – developed by Trans-Disciplinary University (TDU, Bengaluru) and Tamil Nadu Veterinary Science University (TANUVAS, Chennai).

The Karnataka Milk Federation (KMF) was the first in India to venture into the use of medicinal plants for animal healthcare. Veterinarians and farmers from KMF were trained by TDU and TANUVAS to use EVP for 15 clinical conditions in dairy animals. Krishna Reddy (KMF) emphasized how KMF sees EVP as its top priority in order to contain the spread of mastitis and other infectious diseases. He stressed that, in 2016, this experiment had resulted in 1.8 lakh litres of extra milk production despite the prevailing drought. The pilot study by TDU in villages in Karnataka, Tamil Nadu and Kerala indicated 49% reduction of antibiotic residue in the milk in just one year.

International NLF partners from the Netherlands, Ethiopia and Uganda who attended the symposium indicated that they are facing similar challenges. Emmanuel Rutamwebwa (farmer and entrepreneur from Uganda) itemized the threats facing the dairy sector in his country. He described the way ticks had become resistant to all forms of chemical control, including acaricides. He made it clear that this is becoming the main economic and environmental degradation problem facing dairy farmers in Uganda. He said he had come to India to learn more about how medicinal plants, combined with good animal management and the strategic use of local breeds could help address these problems.

*A report on One Health Symposium on Antibiotic Resistance and Natural Livestock Farming, Bengaluru, India.