in Brussels, Belgium. The 7th Congress will be in 2019, which will provide possibility of knowledge and experience sharing among international delegates.
**Conclusion** FOHNEU has grown and changed over the past 25 years. This work give an overview about FOHNEU's history and development since the constitution. FOHNEU look forward to the continuing and developing collaborative projects through the strong links created with new and existing memberships.

# Occupational Health in the Chemical Industry

## 1135 IMPLEMENTING GOOD PRACTICES FOR THE SAMPLING OF CHEMICALS: THE ALTREX SOFTWARE

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**Introduction** During their work shift, workers may be exposed to chemicals. In France, when a risk is identified to a workplace, atmospheric concentrations must be measured to determine worker's exposure.
**Methods** The regulatory authorities in France have published a list of Occupational Exposure Limits Values (OELV) concerning 143 substances and guidelines to establish the sampling strategy, including statistical methods to determine when exposure exceeds its OELV. This approach is similar to the one that will soon be published in the European standard EN689.
**Result** The good practices for the sampling strategy promoted by INRS begin with a comprehensive chemical risk assessment. The similar exposure groups and the number of samples to be collected have to be determined, as well as the organisation of the sampling in the company: this is the sampling strategy. Afterwards, the statistical assessment can be performed if enough data is collected. In this situation, several computing methods can be applied, these are implemented in the open source Expostats library. To assist hygienists in designing strategies and assessing exposure, INRS launches a new version of Altrex, a web-based software that use Expostats.
**Discussion** The old version of Altrex required important update to conform to current good practices promoted by INRS. The good practices proposed and the assistance provided with Altrex can help industrial hygienists in performing a correct risk assessment and thus implementing appropriate risk management measures.

## 1435 OCCUPATIONAL EXPOSURE TO CARBON NANOTUBES: THE STATE OF KNOWLEDGE

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**Introduction** In an emerging field of nanotechnologies, assessment of exposure is an integral component of occupational and environmental epidemiology, risk assessment and management, as well as regulatory actions. This review focuses occupational exposure to carbon nanotubes (CNT).
**Methods** PubMed and Scopus databases were searched for period 2000–2017 using all keywords combinations based on the following structure: 'assessment' and 'exposure' and 'carbon nanotube'. The words 'assessment' and 'exposure' were alternatively replaced by 'measurement' and by 'human' and 'occupational', respectively. The word 'carbon nanotube' was alternatively replaced by 'single-walled carbon nanotube', 'double-walled carbon nanotube', 'multi-walled carbon nanotube', and their abbreviations. Only field-studies conducted in occupational settings were included. The quality of the exposure measurement protocol and results reporting were reviewed. The results were compared with the current NIOSH recommended exposure limit (REL) of 1 $\mu g/m^3$ respirable elemental carbon (EC) mass-concentration as an 8 hour time-weighted average.
**Result** Twenty-five studies conducted in R and D laboratories, small-scale pilot-production facilities, and, more rarely, large-scale primary or secondary manufacturer/user facilities in the USA (eleven), the Republic of Korea (four), Japan (four), Russia (one) and Europe (four) were reviewed. Open handling of CNT powder during the sieving, mechanical work-up, packaging, and clean-up work-tasks was classified at highest likelihood of exposure. Fourteen most recent studies measured EC concentration, although using different methods and aerosol fractions. All but one studies observed EC values exceeding the REL. The quantification of CNT agglomerates and/or CNT-contained particles lacks methodological standardisation and precluded any comparison of results.
**Discussion** Currently available occupational-exposure data are limited, because production and use of CNT are relatively recent and workforce sizes remain small. Due to high variability of methods and instruments used for exposure sampling and analysis and of criteria used for interpreting their results, results are difficult to compare. Further effort of methodological standardisation is warranted.

## 1458 PERFORMANCE OF MODELS TO ESTIMATE OCCUPATIONAL EXPOSURE

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**Introduction** Increasingly, models and tools are used by occupational hygienists, risk assessors and risk managers for estimating exposure to and risk from chemical agents in the workplace. These range from simple, screening tools (tier 1 tools) that provide conservative exposure estimate, to more complex higher tier exposure models. In Europe, tools such as ECETOC TRA, STOFFENMANAGER and ART have been developed and are used predominantly for risk assessment as part of the REACH regulations. Furthermore, tools for estimating exposure to nano-sized particles have been developed (e.g. NANOSAFER, Stoffenmanager-NANO). In recent years, several studies have been carried out to test the performance of these tools.
**Methods** Several studies were carried out to determine the performance of the exposure tools for chemical agents and nano-materials, including comparison with measurement data as well as inter-user comparisons.
**Results** The comparison of tool estimates with measurement data suggested that the tier 1 tools appear to be conservative, although

this varied between tools and type of exposure. Correlations between the measurement results and tool predictions also varied with tool and exposure type. Furthermore, a wide range of exposure estimates were observed when different users were asked to apply the same tools to the same scenario conditions.

**Conclusion** Models to estimate exposure and risk are essential elements of the toolbox of occupational hygienists and risk assessors and managers. However, there is increasing evidence that performance varies between tools, type of exposure and scenario conditions. More importantly, users appear to struggle to apply the tools consistently, leading to wide ranges in estimated exposures. There is an urgent need for the development and implementation of generic quality control procedures for use of exposure tools, to reduce the large uncertainties when applying these tools, both to prevent workers from being excessively exposed and unnecessarily implementation of stringent exposure control measures.

## 169 A QUASI EXPERIMENTAL UNCONTROLLED BEFORE-AFTER STUDY TO ASSESS IMPACT OF CASHE INTERVENTIONS IN THE YEAR 2016–2017 AT PETROCHEMICAL INDUSTRY

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**Introduction** To inculcate best practices in the field of OH; RIL has launched the initiative in 2003 known as CASHe in all 7 manufacturing sites. The various interventions under this project are excellent examples of team work of medical, safety, environment and technical department of respective manufacturing sites. Previously there wasn't any scientific research approach to evaluate their outcomes at RIL-DMD-which is amongst the largest petrochemical site of RIL. So the present study was carried out to address this need.

**Methods** There are total 12 manufacturing plants and each of them were considered as a unit of the study. The secondary data from all these 12 plants were collected going 1 year retrospectively using semi-structured proforma regarding various CASHe interventions and compiled using MS Excel 2007. Data triangulation was done using OHC data (IH Surveys and HMIS) with plant data. After necessary editing and exclusion (i.e. projects lacking before-after data, qualitative data) student paired T test was applied to find out statistical significance.

**Result** There were total 187 interventions (mean-15.58/plant) addressing noise, heat, chemical exposure, ergonomics, safety and environmental hazards. Out them 142 completed and 45 in progress. Total 3316 persons (928 employee and 2388 contract workers) trained for different OH training with average 600 man hours/department. Central theme for CASHe: 2016–2017 achieved statistically significant result in term of reduction in no. of Pre-diabetic cases up to 30% compared to previous year. Other significant interventions were reduction in exposure to benzene vapour by vapour recovery unit ($p=0.01$), noise ($p=0.001$) and heat etc.

**Discussion** CASHe projects outcomes were successful in terms of reducing hazards, workplace improvements and wellness of employee. So the present study experiments guide other industries to deal with noise, heat, highly toxic material safely and reduce their exposure along with taking care of life style diseases of their employees.

## 216 MAKING WORKPLACE HEALTHY & SAFE THROUGH INNOVATIVE & SUSTAINABLE CASHE PROGRAM (CHANGE AGENTS FOR SAFETY HEALTH & ENVIRONMENT)

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**Introduction** Reliance Industries Jamnagar Manufacturing Division is world's largest refining hub. CASHe is an innovative program with a proactive preventive approach comprising team work of Medical, Safety, Environment and Technical department helps to bring positive change and continual improvement in occupational health practices. This helps to steer plant management in a focused way to look into the work place hazards and take appropriate control measures.

**Methods** CASHe program has defined annual road map which comprises formation of CASHe Team, field visit, IH-OH survey, submission of project charter, monthly CASHe team meetings with progress reports, midyear project review, final survey with report submission and plant inter-site competition for evaluation. Multidisciplinary CASHe team continuously work on this road map to achieve project goals.

**Result** In 2016 −17, Total 302 projects out of 408 were completed (74%). To inculcate best projects like Chemical Exposure reduction from 2.64 PPM to 0 PPM (close loop sampling system at benzene storage tank), dust exposure reduction from 13.21 mg/m3 to 0.26 mg/m3 (substitute with direct bulker unloading instead of manual bag unloading system), catalyst replacement activity to reduce nickel exposure from 33 mg/m3 to <1 mg/m3 (local exhaust ventilation system at loading point), Noise exposure reduction from 96.2 dBA to 85 dBA by providing acoustic insulation, Heat stress reduction for workers working inside sea water pipe line by providing forced cool air ventilation system. Ergonomic improvement project of implementing vertical lifting machine at material storage location.

**Discussion** CASHe program at Reliance proves that team approach, creating awareness, positive attitude and implementation of innovative interventions are win-win prospect and makes good business sense. CASHe program is an endless journey of awareness and workplace improvements.

## 1715 MEDICHEM SYMPOSIUM: HOW EPIDEMIOLOGY CAN INFORM NON-LINEAR DOSE-RESPONSES FOR OCCUPATIONAL CARCINOGENS

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**Aim of special session** Epidemiological evidence challenges the linear no-threshold default model for cancer risks. The methodological and regulatory implications are explored.

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