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54 articles d'intérêt répertoriés pendant la période de **Mai à Août 2015**

LISTE INDICATIVE DES EXPERTS DU RESEAU POUR CHAQUE THEMATIQUE

NB : Cette liste n'est qu'indicative et ne prétend pas à l'exhaustivité des domaines couverts par chacun.

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I. MÉTROLOGIE (PROTOCOLES PRELEVEMENTS / ANALYSES / MODELISATION)

I.1 Gaz inorganiques / métaux

Rubrique N°1

a. Radon

1. Sorimachi, Tokonami et al. (2015). **Preliminary Experiments Using a Passive Detector for Measuring Indoor 220Rn Progeny Concentrations with an Aerosol Chamber**. Health Physics. 108**:** 597-606.

This paper describes preliminary experiments using a passive detector for integrating measurements of indoor thoron (Rn-220) progeny concentrations with an aerosol chamber. A solid state nuclear detector (CR-39) covered with a thin aluminum-vaporized polyethylene plate (Mylar film) was used to detect only alpha particles emitted from Po-212 due to Rn-220 progeny deposited on the detector surfaces. The initial experiment showed that Mylar film with area density of more than 5 mg cm(-2) was suitable to cut off completely alpha particles of 7.7 MeV from Po-214 of Rn-222 progeny decay. In the experiment using the passive detector, it was observed that the net track density increased linearly with an increase of time-integrating Rn-220 progeny concentration. As a result of dividing deposition rates by atom concentrations, the deposition velocity was given as 0.023 cm s(-1) for total Rn-220 progeny. The model estimates of deposition velocities were 0.330 cm s(-1) for unattached Rn-220 progeny and 0.0011 cm s(-1) for aerosol-attached Rn-220 progeny using Lai-Nazaroff formulae. These deposition velocities were in the same range with the results reported in the literature. It was also found that the exposure experiments showed little influence of vertical profiles and surface orientations of the passive detector in the chamber on the detection responses, which was in good agreement with that in the model estimates. Furthermore, it was inferred that the main uncertainty of the passive detector was inhomogeneous deposition of Rn-220 progeny onto its detection surfaces.

2. Cinelli and Tondeur (2015). **Log-normality of indoor radon data in the Walloon region of Belgium**. Journal of Environmental Radioactivity. 143**:** 100-109.

The deviations of the distribution of Belgian indoor radon data from the log-normal trend are examined. Simulated data are generated to provide a theoretical frame for understanding these deviations. It is shown that the 3-component structure of indoor radon (radon from subsoil, outdoor air and building materials) generates deviations in the low- and high-concentration tails, but this low-C trend can be almost completely compensated by the effect of measurement uncertainties and by possible small errors in background subtraction. The predicted low-C and high-C deviations are well observed in the Belgian data, when considering the global distribution of all data. The agreement with the log-normal model is improved when considering data organised in homogeneous geological groups. As the deviation from log-normality is often due to the low-C tail for which there is no interest, it is proposed to use the log-normal fit limited to the high-C half of the distribution. With this prescription, the vast majority of the geological groups of data are compatible with the log-normal model, the remaining deviations being mostly due to a few outliers, and rarely to a "fat tail". With very few exceptions, the log-normal modelling of the high-concentration part of indoor radon data is expected to give reasonable results, provided that the data are organised in homogeneous geological groups. (C) 2015 The Authors. Published by Elsevier Ltd.

3. Bossew (2015). **Estimation of radon prone areas through binary classification, part 2: radon prone geologies**. Journal of Environmental Radioactivity. 141**:** 44-50.

A radon prone geology is one for which the probability is increased that in a house built on it, elevated indoor Rn concentration will be encountered, or that its Rn potential will be increased. Labelling geological units as Rn prone or not can be an important support in deciding whether a geographical or administrative region in which that geological unit occurs, should be called Rn prone area, possibly in absence of other predictors. In this article a method is proposed which, given a set of geological classes, sorts the classes into Rn prone and non-Rn prone classes depending on a classification criterion which one can choose according the purpose. The method is computationally simple and is demonstrated on the example of Germany.

b. Métaux

Pas d'article

I.2 Composés Organiques Volatils, COSemi-Volatils

Rubrique N°2

a. COV / Aldéhydes

4. Bartzis, Wolkoff et al. (2015). **On organic emissions testing from indoor consumer products' use.** Journal of Hazardous Materials. 285: 37-45.

A wide range of consumer and personal care products may, during their use, release significant amounts of volatile organic compounds (VOC) into the air. The identification and quantification of the emissions from such sources is typically performed in emission test chambers. A major question is to what degree the obtained emissions are reproducible and directly applicable to real situations. The present work attempts partly to address this question by comparison of selected VOC emissions in specific consumer products tested in chambers of various dimensions. The measurements were performed in three test chambers of different volumes (0.26-20 m(3)). The analytic performance of the laboratories was rigorously assessed prior to chamber testing. The results show emission variation for major VOC (terpenes); however, it remains in general, within the same order of magnitude for all tests. This variability does not seem to correlate with the chamber volume. It rather depends on the overall testing conditions. The present work is undertaken in the frame of EPHECT European Project.

5. McAlary, Groenevelt et al. (2015). **Passive sampling for volatile organic compounds in indoor air-controlled laboratory comparison of four sampler types**. Environmental Science-Processes & Impacts. 17**:** 896-905.

This article describes laboratory testing of four passive diffusive samplers for assessing indoor air concentrations of volatile organic compounds (VOCs), including SKC Ultra II, Radiello (R), Waterloo Membrane Sampler (WMS) and Automated Thermal Desorption (ATD) tubes with two different sorbents (Tenax TA and Carbopack B). The testing included 10 VOCs (including chlorinated ethenes, ethanes, and methanes, aromatic and aliphatic hydrocarbons), spanning a range of properties and including some compounds expected to pose challenges (naphthalene, methyl ethyl ketone). Tests were conducted at different temperatures (17 to 30 degrees C), relative humidities (30 to 90% RH), face velocities (0.014 to 0.41 ms(-1)), concentrations (1 to 100 parts per billion by volume [ppb(v)]) and sampling durations (1 to 7 days). The results show that all of the passive samplers provided data that met the success criteria (relative percent difference [RPD] <= 45% of active sample concentrations and coefficient of variation [COV] <= 30%) in the majority of cases, but some compounds were problematic for some samplers. The passive sampler uptake rates depend

to varying degrees on the sampler, sorbent, target compounds and environmental conditions, so field calibration is advantageous for the highest levels of data quality.

b. COSV

6. Bur, Bastuck et al. (2015). **Discrimination and quantification of volatile organic compounds in the ppb-range with gas sensitive SiC-FETs using multivariate statistics**. Sensors and Actuators B-Chemical. 214**:** 225-233.

Gas sensitive field effect transistors based on silicon carbide, SiC-FETs, have been studied for indoor air quality applications. The selectivity of the sensors was increased by temperature cycled operation, TCO, and data evaluation based on multivariate statistics. Discrimination of benzene, naphthalene, and formaldehyde independent of the level of background humidity is possible by using shape describing features as input for Linear Discriminant Analysis, LDA, or Partial Least Squares - Discriminant Analysis, PLS-DA. Leave-one-out cross-validation leads to a correct classification rate of 90% for LDA, and for PLS-DA a classification rate of 83% is achieved. Quantification of naphthalene in the relevant concentration range, i.e., 0-40 ppb, was performed by Partial Least Squares Regression and a combination of LDA witha second order polynomial fit function. The resolution of the model based on a calibration with three concentrations was approximately 8 ppb at 40 ppb naphthalene for both algorithms. Hence, the suggested strategy is suitable for on demand ventilation control in indoor air quality application systems. (C) 2015 Elsevier B.V. All rights reserved.

7. Saini, Okeme et al. (2015). **Calibration of two passive air samplers for monitoring phthalates and brominated flame-retardants in indoor air**. Chemosphere. 137: 166-173.

Two passive air samplers (PAS), polyurethane foam (PUF) disks and Sorbent Impregnated PUF (SIP) disks, were characterized for uptake of phthalates and brominated flame-retardants (BFRs) indoors using fully and partially sheltered housings. Based on calibration against an active low-volume air sampler for gas- and particle-phase compounds, we recommend generic sampling rates of 3.5±0.9 and 1.0±0.4m(3)/day for partially and fully sheltered housing, respectively, which applies to gas-phase phthalates and BFRs as well as particle-phase DEHP (the later for the partially sheltered PAS). For phthalates, partially sheltered SIPs are recommended. Further, we recommend the use of partially sheltered PAS indoors and a deployment period of one month. The sampling rate for the partially sheltered PUF and SIP of 3.5±0.9m(3)/day is indistinguishable from that reported for fully sheltered PAS deployed outdoors, indicating the role of the housing outdoors to minimize the effect of variable wind velocities on chemical uptake, versus the partially sheltered PAS deployed indoors to maximize chemical uptake where air flow rates are low.

I.3 Réactions chimiques

8. Youssefi and Waring (2015). **Indoor transient SOA formation from ozone plus alpha-pinene reactions: Impacts of air exchange and initial product concentrations, and comparison to limonene ozonolysis**. Atmospheric Environment. 112**:** 106-115.

The ozonolysis of reactive organic gases (RUG), e.g. terpenes, generates secondary organic aerosol (SOA) indoors. The SOA formation strength of such reactions is parameterized by the aerosol mass fraction (AMF), a.k.a. SOA yield, which is the mass ratio of generated SOA to oxidized RUG. AMFs vary in magnitude both among and for individual ROGs. Here, we quantified dynamic SOA formation from the ozonolysis of alpha-pinene with 'transient AMFs,' which describe SOA formation due to pulse emission of a RUG in an indoor space with air exchange, as is common when consumer products are intermittently used in ventilated buildings. We performed 19 experiments at low, moderate, and high (0.30, 0.52, and 0.94 h(-

1), respectively) air exchange rates (AER) at varying concentrations of initial reactants. Transient AMFs as a function of peak SOA concentrations ranged from 0.071 to 0.25, and they tended to increase as the AER and product of the initial reactant concentrations increased. Compared to our similar research on limonene ozonolysis (Youssefi and Waring, 2014), for which formation strength was driven by secondary ozone reactions, the AER impact for alpha-pinene was opposite in direction and weaker, while the initial reactant product impact was in the same direction but stronger for alpha-pinene than for limonene. Linear fits of AMFs for alpha-pinene ozonolysis as a function of the AER and initial reactant concentrations are provided so that future indoor models can predict SOA formation strength.

9. Ourrad, Thevenet et al. (2015). **Limonene photocatalytic oxidation at ppb levels: Assessment of gas phase reaction intermediates and secondary organic aerosol heterogeneous formation**. Applied Catalysis B-Environmental. 168: 183-194.

This study investigates the photocatalytic oxidation of limonene, used as a model terpenoid, close to indoor air conditions. Besides the characterization of limonene removal kinetic on the ppb range, special attention has been paid to reaction intermediates and by-products: (i) in the gas phase, (ii) in the adsorbed phase and (iii) in the particulate phase. All along the oxidation reaction organic reaction intermediates have been monitored. Despite a high conversion rate of limonene after 10 h of treatment, 20 primary and secondary reaction intermediates were detected and quantified in the gas phase with acetone and acetaldehyde as the most abundant ones. The characterization of limonene adsorbed on TiO2 surface under UV illumination using DRIFTS pointed out the fact that the photocatalyst surface acts as a pool of heavy reaction intermediates, close to terpenoid structure, which may be responsible for the release of some secondary reaction intermediates. The mineralization of limonene has been assessed during the whole oxidation process through CO and CO2 monitoring. CO2 formation is observed more than 12 h beyond limonene complete removal, confirming the long term oxidation of the adsorbed phase. The photocatalytic heterogeneous formation of secondary organic aerosol is reported for the first time. A massive production of SOA since the first steps of limonene photocatalytic oxidation is evidenced. Based on the quantitative analyses performed, carbon mass balances have been calculated along the oxidation reaction advancement. The highest contributions of organic reaction intermediates and SOA in the carbon balance are respectively 12% and 1.6%. When limonene is removed from the gas phase, more than 60% of the carbon balance remains unidentified but this contribution can be mainly attributed to the adsorbed organic species. After 24h of treatment, almost 75% of the organics are mineralized into CO2.

I.4 Émission des matériaux

10. Liu, Guo et al. (2015). **Determination of fluorotelomer alcohols in selected consumer products and preliminary investigation of their fate in the indoor environment**. Chemosphere. 129: 81-86.

The U.S. Environmental Protection Agency (EPA) has established an ongoing effort to identify the major perfluorocarboxylic acid (PFCA) sources in nonoccupational indoor environments and characterize their transport and fate. This study determined the concentrations of fluorotelomer alcohols (FTOHs), which are the precursors to PFCAs, in fifty-four consumer products collected from the U.S. open market in the years of 2011 and 2013. The products included carpet, commercial carpet-care liquids, household carpet/fabric-care liquids, treated apparel, treated home textiles, treated non-woven medical garments, floor waxes, food-contact paper, membranes for apparel, and thread-sealant tapes. The FTOHs quantified were 1H,1H,2H,2H-perfluoro-1-octanol (6:2 FTOH), 1H,1H,2H,2H-perfluoro-1-decanol (8:2 FTOH), and 1H,1H,2H,2H-perfluoro-1-dodecanol (10:2 FTOH). The

content of 6:2 FTOH ranged from non-delectable to 331 mu g g(-1), 8:2 FTOH from non-delectable to 92 mu g g(-1), and 10:2 FTOH from non-detectable to 24 mu g g(-1). In addition, two consumer products from the home textile category were tested in the washing-drying process. One product from the treated apparel category and one from the home textile category were tested in the micro-scale chamber under elevated temperatures. The experimental data show that the washing-drying process with one cycle did not significantly reduce the FTOH concentrations in the tested consumer products. FTOH off-gassing was observed under accelerated aging conditions. Future tests should include air sampling to allow determination of the absolute emission rates at different temperatures. The results of this study should be informative to exposure assessment and risk management. Published by Elsevier Ltd.

I.5 Particules et fibres

Rubrique N°3

11. Mihucz, Szigeti et al. (2015). **An integrated approach for the chemical characterization and oxidative potential assessment of indoor PM2.5.** Microchemical Journal. 119: 22-29.

An integrated approach has been developed for the multi-component analysis of indoor PM2.5 collected onto the same quartz fiber filter (QFF) by using an innovative combination of techniques such as inductively coupled sector field plasma mass spectrometry (ICP-SF-MS) with vapor-phase microwave-assisted aqua regia or sonication-assisted water extraction, ion chromatography, thermal-optical transmittance as well as high performance liquid chromatography and enzyme-linked 5,5'-dithio-bis(2-nitrobenzoic acid) assay for the determination of elemental composition, major inorganic ions, elemental/organic carbon (EC/OC) as well as oxidative potential (OP) through ascorbate (AA) and reduced glutathione (GSH) depletion, respectively. The low mass of PM2.5 collectable indoors, the elemental blank values of the QFFs and the sample volume/acidity requirements of the ICP-SF-MS represented a challenge for elemental determination. Finally, this approach was successfully applied for determination of 15 elements (Al, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Rb, Sr, Mo, Cd, Sn and Pb) at the ng m(-3) level in more than two-thirds of indoor PM2.5 (n = 25) collected in mechanically ventilated offices within the European Union project OFFICAIR at increased sampling flow rates (0.6 m(3) h(-1)-2.3 m(3) h(-1)) and sampling time (cca. 100 h) in the acidic/aqueous extracts. The concentration of Cl-, NO3-, SO42-, Na+, NH4+, K+, Ca2+, Mg2+, OC and EC was at the mu g m(-3) level in the aqueous extracts. This new approach aiming at the comprehensive characterization,of low mass indoor PM2.5 samples allowed assessment of OPAA and OPGSH in all samples. The PM2.5 critical sample mass to achieve elemental determination was approximately 400 mu g. (C) 2014 Elsevier B.V. All rights reserved.

12. Salem, El-Haty et al. (2015). **Assessment and characterization of ambient indoor particulate matters using aerosol monitor, inductively coupled plasma mass spectrometry, and transmission electron microscopy**. Air Quality Atmosphere and Health. 8**:** 193-203.

In this work, we studied the levels of ambient indoor particulate matters in some work premises of Al-Ain city during the months June-July 2013. Work premises included United Arab Emirates University (UAEU) campus, hospitals, and schools. We also studied the chemical composition and morphology of collected particulate matters using inductively coupled plasma mass spectrometry (ICP-MS) and transmission electron microscope (TEM). Our results indicated average total concentrations less than 50.00 mu g/m(3) for PM1.0, PM2.5, PM4.0, plus PM10.0 in closed sites. Sites crowded with customers coming in and out such as entrances of hospitals and municipality gave average total concentrations in the range 160.0-200.0 mu g/m(3). Higher average total concentrations were found in sites with

high outdoor air exchange. Particulate matters in the city ambient air originate from neighboring deserts and mountain and carried out by storms covering the country for different time intervals over the year. Correlation between the levels of particulate matters (PMs) and metrological parameters during the time of study was found insignificant. ICP-MS elemental analysis of collected particulate matters revealed sulfur and silicon-based particles containing significant amounts of calcium, sodium, boron, aluminum, magnesium, potassium, and chlorine. TEM imaging of collected particles showed clusters of crystalline and amorphous particulates corresponding to the silicate and sulfate matrices, respectively. Although the levels we recorded for particulate matters are generally in accordance with the United Arab Emirates and WHO standards for indoor PMs, our findings are important since long exposures to silicate and sulfate particles represent high risk factors on public health.

I.6 Biocontaminants

Rubrique N°4

13. Adams, Bhangar et al. (2015). **Chamber Bioaerosol Study: Outdoor Air and Human Occupants as Sources of Indoor Airborne Microbes**. Plos One. 10**:** 18.

Human occupants are an important source of microbes in indoor environments. In this study, we used DNA sequencing of filter samples to assess the fungal and bacterial composition of air in an environmental chamber under different levels of occupancy, activity, and exposed or covered carpeting. In this office-like, mechanically ventilated environment, results showed a strong influence of outdoor-derived particles, with the indoor microbial composition tracking that of outdoor air for the 2-hour sampling periods. The number of occupants and their activity played a significant but smaller role influencing the composition of indoor bioaerosols. Human-associated taxa were observed but were not particularly abundant, except in the case of one fungus that appeared to be transported into the chamber on the clothing of a study participant. Overall, this study revealed a smaller signature of human body-associated taxa than had been expected based on recent studies of indoor microbiomes, suggesting that occupants may not exert a strong influence on bioaerosol microbial composition in a space that, like many offices, is well ventilated with air that is moderately filtered and moderately occupied.

14. Romano, Gusten et al. (2015). **Some aspects on the sampling efficiency of microbial impaction air samplers**. Particuology. 20**:** 110-113.

Indoor microbial monitoring is an important health issue in many sectors of society. In particular, it is important to monitor microbial concentrations in environments dealing with bio-susceptible products. Many human diseases are related to high, undesired microbial airborne concentrations. However, the lack of a standardized and well-accepted methodology for testing and ranking the performance of microbial air samplers is a source of uncertainty in such measurements. Several works clearly show that results obtained from microbial air sampling depend largely on measuring techniques, especially the air samplers' physical parameters, such as d(50), as well as environmental conditions, sources, and concentrations of microbial organisms in the environment. Furthermore, personnel using cleanroom clothing can reduce the microbial burden within a clean environment. To evaluate this effect, we carried out experimental comparison tests in a cleanroom of class ISO 5 with different air samplers under various microbial concentration levels, generated by a human source dressed in different quality cleanroom clothing. Our results confirm that in addition to the measuring technique, cleanroom clothing does influence microbial contamination, affecting air sampler measurements. (C) 2015 Chinese Society of Particuology and Institute of Process Engineering, Chinese Academy of Sciences. Published by Elsevier B.V. All rights reserved.

15. Blais-Lecours, Perrott et al. (2015). **Non-culturable bioaerosols in indoor settings: Impact on health and molecular approaches for detection**. Atmospheric Environment. 110**:** 45-53.

Despite their significant impact on respiratory health, bioaerosols in indoor settings remain understudied and misunderstood. Culture techniques, predominantly used for bioaerosol characterisation in the past, allow for the recovery of only a small fraction of the real airborne microbial burden in indoor settings, given the inability of several microorganisms to grow on agar plates. However, with the development of new tools to detect non-culturable environmental microorganisms, the study of bioaerosols has advanced significantly. Most importantly, these techniques have revealed a more complex bioaerosol burden that also includes non-culturable microorganisms, such as archaea and viruses. Nevertheless, air quality specialists and consultants remain reluctant to adopt these new research-developed techniques, given that there are relatively few studies found in the literature, making it difficult to find a point of comparison. Furthermore, it is unclear as to how this new non-culturable data can be used to assess the impact of bioaerosol exposure on human health. This article reviews the literature that describes the non-culturable fraction of bioaerosols, focussing on bacteria, archaea and viruses, and examines its impact on bioaerosol-related diseases. It also outlines available molecular tools for the detection and quantification of these microorganisms and states various research needs in this field.

I.7 Ventilation

Rubrique N° 5

pas d'article

I.8 Modélisation

Rubrique N° 6

pas d'article

I.9 Études/ méthode

Rubrique N° 7

pas d'article

II. CONNAISSANCES DES CONCENTRATIONS ET DES EXPOSITIONS

II.1 Logement

Rubrique N°8

a. COV

16. Hanoune and Carteret (2015). **Impact of kerosene space heaters on indoor air quality**. Chemosphere. 134: 581-587.

In recent years, the use of kerosene space heaters as additional or principal heat source has been increasing, because these heaters allow a continuous control on the energy cost. These devices are unvented, and all combustion products are released into the room where the heaters are operated. The indoor air quality of seven private homes using wick-type or electronic injection-type kerosene space heaters was investigated. Concentrations of CO, CO2, NOx, formaldehyde and particulate matter (0.02-10 mu m) were measured, using time-resolved instruments when available. All heaters tested are significant sources of submicron particles, NOx and CO2. The average NO2 and CO2 concentrations are determined by the duration of use of the kerosene heaters. These results stress the need to regulate the use of unvented combustion appliances to decrease the exposure of people to air contaminants. (C) 2014 Elsevier Ltd. All rights reserved.

17. Uchiyama, Tomizawa et al. (2015). **Gaseous chemical compounds in indoor and outdoor air of 602 houses throughout Japan in winter and summer**. Environmental Research. 137**:** 364-372.

A nationwide survey of indoor air quality in Japan was conducted using four types of diffusive samplers. Gaseous chemical compounds such as carbonyls, volatile organic compounds (VOC), acid gases, basic gases, and ozone were measured in indoor and outdoor air of 602 houses throughout Japan in winter and summer. Four kinds of diffusive samplers were used in this study: DSD-BPE/DNPH packed with 2,4-dinitrophenyl hydrazine and trans-1,2-bis(2-pyridyl)ethylene coated silica for ozone and carbonyls; VOC-SD packed with Carboxen 564 particles for volatile organic compounds; DSD-TEA packed with triethanolamine impregnated silica for acid gases; and DSD-NH3 packed with phosphoric acid impregnated silica for basic gases. These samplers are small and lightweight and do not require a power source, hence, it was possible to obtain a large number of air samples via mail from throughout Japan. Almost all compounds in indoor air were present at higher levels in summer than in winter. In particular, formaldehyde, toluene, and ammonia were strongly dependent on temperature, and their levels increased with temperature. The nitrogen dioxide concentration in indoor air particularly increased only during winter and was well correlated with the formic acid concentration (correlation coefficient=0.959). Ozone concentrations in indoor air were extremely low compared with the outdoor concentrations. Ozone flowing from outdoor air may be decomposed quickly by chemical compounds in indoor air; therefore, it is suggested that the indoor/outdoor ratio of ozone represents the ventilation of the indoor environment. (C) 2014 Elsevier Inc. All rights reserved.

b. COSV

18. Tran, Abualnaja et al. (2015). **A survey of cyclic and linear siloxanes in indoor dust and their implications for human exposures in twelve countries**. Environment International. 78**:** 39-44.

Siloxanes are used widely in a variety of consumer products, including cosmetics, personal care products, medical and electrical devices, cookware, and building materials. Nevertheless, little is known on the occurrence of siloxanes in indoor dust. In this survey, five cyclic (D3-D7) and 11 linear (L4-L14) siloxanes were determined in 310 indoor dust samples

collected from 12 countries. Dust samples collected from Greece contained the highest concentrations of total cyclic siloxanes (TCSi), ranging from 118 to 25,100 ng/g (median: 1380), and total linear siloxanes (TLSi), ranging from 129 to 4990 ng/g (median: 772). The median total siloxane (TSi) concentrations in dust samples from 12 countries were in the following decreasing order: Greece (2970 ng/g), Kuwait (2400), South Korea (1810), Japan (1500), the USA (1220), China (1070), Romania (538), Colombia (230), Vietnam (206), Saudi Arabia (132), India (116), and Pakistan (68.3). TLSi concentrations as high as 42,800 ng/g (Kuwait) and TCSi concentrations as high as 25,000 ng/g (Greece) were found in indoor dust samples. Among the 16 siloxanes determined, decamethylcyclopentasiloxane (D5) was found at the highest concentration in dust samples from all countries, except for Japan and South Korea, with a predominance of L11; Kuwait, with L10; and Pakistan and Romania, with L12. The composition profiles of 16 siloxanes in dust samples varied by country. TCSi accounted for a major proportion of TSi concentrations in dust collected from Colombia (90%), India (80%) and Saudi Arabia (70%), whereas TLSi predominated in samples collected from Japan (89%), Kuwait (85%), and South Korea (78%). Based on the measured median TSi concentrations in indoor dust, we estimated human exposure doses through indoor dust ingestion for various age groups. The exposure doses ranged from 0.27 to 11.9 ng/kg-bw/d for toddlers and 0.06 to 2.48 ng/kg-bw/d for adults. (C) 2015 Elsevier Ltd. All rights reserved.

19. La Guardia and Hale (2015). **Halogenated flame-retardant concentrations in settled dust, respirable and inhalable particulates and polyurethane foam at gymnastic training facilities and residences**. Environment International. 79**:** 106-114.

Halogenated flame-retardants (FRs) are used in a wide array of polymer-containing products. Animal studies and structure-activity modeling exercises suggest that FR exposure may result in detrimental toxicological effects. Workers with extended contact with such polymers (e.g., electronic dismantlers, carpet installers and aircraft personnel) have previously been observed to exhibit elevated body burdens of FRs, e.g., polybrominated diphenyl ethers (PBDEs). Recently, elevated PBDE blood levels were also reported in a non-occupational exposure group, gymnasts. These levels were hypothesized to be related to the large volumes of FR-treated polyurethane foam in gymnastics facilities. To further our understanding of workers' potential exposure, we analyzed FR concentrations in indoor dust and size-fractionated air particulates (respirable (<4 mu m) and inhalable (>4 mu m)) from gymnastic studios. Values were compared to samples from the homes of coaches employed at these facilities. Polyurethane foam blocks (Le., pit foam) were also analyzed to characterize potential FR sources. FRs examined included those used to flame-retard polyurethane foam: 8 PBDE congeners, two brominated components of Firemaster 550 (2-ethylhexyl 2, 3, 4, 5-tetrabromobenzoate (TBB) and bis(2-ethylhexyl) 3, 4, 5, 6-tetrabromophthalate (TBPH)) and three chlorinated organophosphates (tris(2-chloroethyl) phosphate (TCEP), tris(1-chloro-2-propyl) phosphate (TCPP) and tris(1,3-dichloro-2-propyl) phosphate (TDCPP)). Several additional FRs not used in polyurethane were also evaluated. These have also been detected in indoor dust and air and may also lead to adverse health effects. These include: BDE-183 and its replacement product (1, 2-bis(2, 4, 6-tribromophenoxy) ethane (BTBPE), two congeners of the deca-BDE formulation (BDE-206, -209) and their replacement decabromodiphenyl ethane (DBDPE) and hexabromocyclododecane (alpha-, beta-, gamma-HBCD), and tetrabromobisphenol-A (TBBPA)). Pit foam contained multiple FRs at cumulative concentrations of 12,100 to 25,800 mu g g(-1), or 1.2% to 2.6% by weight. TBB and TBPH were the most abundant FRs detected, followed by TDCPP and several PBDEs. The mean total FR burden detected at the gyms was 8.6-fold higher (574 mu g g(-1)) than that observed in the house dust samples (66.8 mu g g(-1)). However, the polyurethane additives TBB and TDCPP were the only FRs that exhibited significantly greater levels ($P < 0.05$) in gym than house dust Mean levels of five FRs (BDE-99, -100, -153, -209 and TDCPP) were also higher in respirable particulates from the gyms than the homes and four FRs (BDE-47, TBB, TBPH and DBDPE) were higher

at the homes than the gyms; these differences were not significant (P > 0.05). Several additional FRs were detected in inhalable particulates; mean levels of BDE-66, -206 and TCPP were higher in the homes and BDE-47, -85, -99, -100, -153, -209, TBB, TBPH, and TDCPP were higher at the gyms. But, only the polyurethane additives i.e., BDE-100, TBB and TDCPP were significantly greater (Pc 0.05) in inhalable particulates from the gyms than at the homes. In conclusion, polyurethane foam collected from gymnastic studios exhibited a variety of FR compositional signatures; likely reflective of changes in FR usage over time and by different manufacturers. FR concentrations and compositional signatures also differed between settled dust, respirable and inhalable particulates between the gyms and homes. Concentrations of FRs used in polyurethane foam were higher in gym air and dust compared to homes, particularly TBB and TDCPP - which were also the primary FRs detected in the pit foam samples. Although these results should be interpreted with caution, as the sample size was small, these findings do suggest that FR concentrations observed in dust and air particulates from the gymnastic studios are further evidence that individuals frequenting these environments are at greater risk for exposure to these polymer additives.

c. Particules/métaux/fibres

20. Bari, Kindzierski et al. (2015). **Indoor and Outdoor Levels and Sources of Submicron Particles (PM1) at Homes in Edmonton, Canada**. Environmental Science & Technology. 49: 6419-6429.

Exposure to submicron particles (PM1) is of interest due to their possible chronic and acute health effects. Seven consecutive 24-h PM1 samples were collected during winter and summer 2010 in a total of 74 nonsmoking homes in Edmonton, Canada. Median winter concentrations of PM1 were 2.2 mu g/m(3) (interquartile range, IQR = 0.8-6.1 mu g/m(3)) and 3.3 mu g/m(3) (IQR = 1.5-6.9 mu g/m(3)) for indoors and outdoors, respectively. In the summer, indoor (median 4.4 mu g/m3, IQR = 2.48.6 mu g/m3) and outdoor (median 4.3 mu g/m(3), IQR = 2.6-7.4 mu g/m(3)) levels were similar. Positive matrix factorization (PMF) was applied to identify and apportion indoor and outdoor sources of elements in PM1 mass. Nine sources contributing to both indoor and outdoor PM1 concentrations were identified including secondary sulfate, soil, biomass smoke and environmental tobacco smoke (ETS), traffic, settled and mixed dust, coal combustion, road salt/road dust, and urban mixture. Three additional indoor sources were identified i.e., carpet dust, copper-rich, and silver-rich. Secondary sulfate, soil, biomass smoke and ETS contributed more than 70% (indoors: 0.29 mu g/m(3), outdoors: 0.39 mu g/m(3)) of measured elemental mass in PM1. These findings can aid understanding of relationships between submicron particles and health outcomes for indoor/outdoor sources.

21. Anaf, Bencs et al. (2015). **Indoor particulate matter in four Belgian heritage sites: Case studies on the deposition of dark-colored and hygroscopic particles.** Science of the Total Environment. 506: 361-368.

Atmospheric total suspended particulate (TSP) was passively sampled by means of deployed horizontal and vertical filters in various rooms of four Belgian cultural heritage buildings, installed with various heating/ventilation systems. Soiling/blackening and deposition of inorganic, water-soluble aerosol components were considered. The extent of soiling was determined by means of two independent methods: (1) in terms of the covering rate of the samplers by optical reflection microscopy and (2) the reduction in lightness of the samplers using the CIE L*a*b* color space by spectrophotometry. A fairly good correlation was found between both methods. The inorganic composition of the deposited water-soluble TSP was quantified by means of ion chromatography. Compared to controlled environments, uncontrolled environments showed increased water-soluble aerosol content of the total deposited mass. Higher chloride deposition was observed on horizontal surfaces, compared to vertical surfaces.

22. Wilson, Dixon et al. (2015). **An investigation into porch dust lead levels**. Environmental Research. 137**:** 129-135.

Lead in porch dust can expose children through direct contact or track-in to the home, but has not been adequately evaluated. At homes undergoing lead hazard control in Rochester, NY, we sampled settled dust lead on exterior porch floors at baseline, immediately post-lead hazard control and one-year post-work (n=79 homes with complete data) via wipe sampling and collected housing, neighborhood and soil data. Baseline GM porch floor dust lead loading (PbPD) was 68 mu g/ft(2), almost four times more than baseline GM interior floor dust lead (18 mu g/ft(2)). Immediate post-work PbPD declined 55% after porch floor replacement and 53% after porch floor paint stabilization (p =0.009 and p=0.041, respectively). When no porch floor work was conducted but lead hazard control was conducted elsewhere, immediate post-work PbPD increased 97% (p=0.008). At one-year, GM PbPD continued to decline for porch replacement (77% below baseline) and paint stabilization (72% below baseline), but where no porch floor work was done, GM PbPD was not significantly different than baseline ($p < 0.001$, $p = 0.028$ and $p = 0.504$, respectively). Modeling determined that porch floor replacement had significantly lower one-year PbPD than stabilization when baseline PbPD levels were higher than 148 p,mu g/ft(2) (the 77th percentile) but not at lower levels. Treatment of porches with lead paint results in substantial declines in PbPD levels. It is of concern that PbPD levels increased significantly at immediate post-work when lead hazard control was not conducted on the porch but was conducted elsewhere. Standards for porch lead dust should be adopted to protect children from inadequate clean-up after lead hazard control.

23. Semmens, Noonan et al. (2015). **Indoor particulate matter in rural, wood stove heated homes**. Environmental Research. 138**:** 93-100.

Ambient particulate matter (PM) exposures have adverse impacts on public health, but research evaluating indoor PM concentrations in rural homes in the United States using wood as fuel for heating is limited. Our objectives were to characterize indoor PM mass and particle number concentrations (PNCs), quantify infiltration of outdoor PM into the indoor environment, and investigate potential predictors of concentrations and infiltration in 96 homes in the northwestern US and Alaska using wood stoves as the primary source of heating. During two forty-eight hour sampling periods during the pre-intervention winter of a randomized trial, we assessed PM mass (< 2.5 mu m) and PNCs (particles/cm(3)) in six size fractions (0.30-0.49, 0.50-0.99, 1.00-2.49, 2.5-5.0, 5.0-10.0, 10.0+ mu m). Daily mean (sd) PM2.5 concentrations were 28.8 (28.5) mu g/m(3) during the first sampling period and 29.1 (30.1) mu g/m(3) during the second period. In repeated measures analyses, household income was inversely associated with PM2.5 and smaller size fraction PNCs, in particular. Time of day was a significant predictor of indoor and outdoor PM2.5 concentrations, and infiltration efficiency was relatively low (F-inf (sd)=0.27 (0.20)). Our findings demonstrate relatively high mean PM concentrations in these wood burning homes and suggest potential targets for interventions for improving indoor air quality and health in rural settings.

d. Biocontaminants

24. Tischer, Zock et al. (2015). **Predictors of microbial agents in dust and respiratory health in the Ecrhs**. Bmc Pulmonary Medicine. 15**:** 11.

Background: Dampness and mould exposure have been repeatedly associated with respiratory health. However, less is known about the specific agents provoking or arresting health effects in adult populations. We aimed to assess predictors of microbial agents in mattress dust throughout Europe and to investigate associations between microbial exposures, home characteristics and respiratory health. Methods: Seven different fungal and bacterial parameters were assessed in mattress dust from 956 adult ECRHS II participants in

addition to interview based home characteristics. Associations between microbial parameters and the asthma score and lung function were examined using mixed negative binomial regression and linear mixed models, respectively. Results: Indoor dampness and pet keeping were significant predictors for higher microbial agent concentrations in mattress dust. Current mould and condensation in the bedroom were significantly associated with lung function decline and current mould at home was positively associated with the asthma score. Higher concentrations of muramic acid were associated with higher mean ratios of the asthma score (aMR 1.37, 95% CI 1.17-1.61). There was no evidence for any association between fungal and bacterial components and lung function. Conclusion: Indoor dampness was associated with microbial levels in mattress dust which in turn was positively associated with asthma symptoms.

25. Kettleson, Adhikari et al. (2015). **Key determinants of the fungal and bacterial microbiomes in homes**. Environmental Research. 138**:** 130-135.

Background: The microbiome of the home is of great interest because of its possible impact on health. Our goal was to identify some of the factors that determine the richness, evenness and diversity of the home's fungal and bacterial microbiomes. Method: Vacuumed settled dust from homes (n=35) in Cincinnati, OH, were analyzed by pyrosequencing to determine the fungal and bacterial relative sequence occurrence. The correlation coefficients between home environmental characteristics, including age of home, Environmental Relative Moldiness Index (ERMI) values, occupant number, relative humidity and temperature, as well as pets (dog and cat) were evaluated for their influence on fungal and bacterial communities. In addition, linear discriminant analysis (LDA) was used for identifying fungal and bacterial genera and species associated with those housing determinants found to be significant. Results: The fungal richness was found to be positively correlated with age of home (p =0.002), ERMI value (p=0.003), and relative humidity (p=0.015) in the home. However, fungal evenness and diversity were only correlated with the age of home (p =0.001). Diversity and evenness (not richness) of the bacterial microbiome in the homes were associated with dog ownership. Linear discriminant analysis showed total of 39 putative fungal genera/species with significantly higher LDA scores in high ERMI homes and 47 genera/species with significantly higher LDA scores in homes with high relative humidity. When categorized according to the age of the home, a total of 67 fungal genera/species had LDA scores above the significance threshold. Dog ownership appeared to have the most influence on the bacterial microbiome, since a total of 130 bacterial genera/species had significantly higher LDA scores in homes with dogs. Conclusions: Some key determinants of the fungal and bacterial microbiome appear to be excess moisture, age of the home and dog ownership.

26. Crawford, Rosenbaum et al. (2015). **Indicators of airborne fungal concentrations in urban homes: Understanding the conditions that affect indoor fungal exposures**. Science of the Total Environment. 517**:** 113-124.

Indoor fungal exposure can compromise respiratory health. Low-income urban areas are of concern because of high asthma and allergy rates and housing disrepair. Understanding the conditions that affect indoor fungal exposures is important for assessing health risks and for developing mitigation strategies. We examined the types and concentrations of airborne fungi inside and outside of homes in low-income areas of Syracuse, NY as well as the effect of snow cover on fungal levels. At 103 homes, air samples for viable fungi were collected, occupants were interviewed and homes were inspected for visible mold, musty odors, water problems and other factors. Multivariable logistic regression was used to relate high fungal levels to home conditions. Predominant indoor fungi included Cladosporium, Penicillium, Aspergillus, Alternaria and hyaline unknowns. Basidiomycetes and an uncommon genus Acrodontium were also found frequently due to analysis methods developed for this project. With snow cover, outdoor total fungal levels were depressed and indoor concentrations were three times higher than outdoor on average with a maximum of 29 times higher. Visible mold was related to elevated levels of Penicillium (OR 4.11 95% CI 1.37-14.0) and bacteria (OR

3.79 95% CI 1.41-11.2). Musty, moldy odors were associated with elevated concentrations of total fungi (OR 3.48 95% CI 1.13-11.6) and basidiomycetes. Cockroaches, an indicator of moisture, were associated with elevated levels of Penicillium (OR 3.66 95% CI 1.16-13.1) and Aspergillus (OR 436 95% CI 1.60-13.4). Increasing relative humidity was associated with higher concentrations of Penicillium, yeasts and basidiomycetes. Visible mold, musty odors, indoor humidity and cockroaches are modifiable factors that were important determinants of indoor fungal exposures. Indoor air investigators should interpret indoor:outdoor fungal ratios cautiously when snow cover is present. (C) 2015 Elsevier B.V. All rights reserved.

27. Leduc, Qi et al. (2015). **Long-term effect of acaricides pre-treated home furnishings on mite allergen exposure**. Revue Francaise d Allergologie. 55**:** 57-63.

Background. - Global allergen reduction including use of acaricides has been shown to be efficient on asthma symptoms in children. The aim of our study was to assess with 3 protocols the efficiency of 3 acaricides incorporated in different textiles during 2 years. Materials and methods. - Protocol 1: 60 rooms were randomized into 4 groups: old bedding items (A); new bedding items (B); bedding items pre-treated by Microstop(R) (C) or by Greenfirst(R) (D). Derp1 and Derf1 concentrations were measured at day pre-selection (D-1), D0, M3, M6, M12 and M24. Protocol 2: 48 rooms randomized into 4 groups: bedding items and carpet pre-treated with Actigard(R) (A); old bedding items (B); only carpet pre-treated by Actigard(R) (C); only mattress pre-treated by Actigard(R) (D). Protocol 3: 20 rooms divided into 2 groups: old bedding items (A), or new bedding items (B). Results. - Protocol 1: mite allergens levels remained higher at all points in group B. No difference was found between group A, C and D at M12. At M24, allergens levels in group B was higher than C and D. Protocol 2: at M12, Derp1 and Derf1 levels in mattress dust for groups A and D (1.55 mu g/g and 2.54 mu g/g) were significantly lower than groups B and C (26.71 mu g/g and 28.78 mu g/g). Protocol 3: at M12, there were no differences between the two groups. Conclusion. - Our 3 protocols demonstrated that acaricides treated items sustainably reduced mite infestation compared to untreated items at M12 and M24. Change for new items, even untreated, allowed a reduction of allergen concentrations, but only at M12. These studies were supported by Sanitized and Breyner. (C) 2014 Elsevier Masson SAS. All rights reserved.

28. Madureira, Paciencia et al. (2015). **Assessment and determinants of airborne bacterial and fungal concentrations in different indoor environments: Homes, child day-care centres, primary schools and elderly care centres**. Atmospheric Environment. 109**:** 139-146.

Until now the influence of risk factors resulting from exposure to biological agents in indoor air has been far less studied than outdoor pollution; therefore the uncertainty of health risks, and how to effectively prevent these, remains. This study aimed (i) to quantify airborne cultivable bacterial and fungal concentrations in four different types of indoor environment as well as to identify the recovered fungi; (ii) to assess the impact of outdoor bacterial and fungal concentrations on indoor air; (iii) to investigate the influence of carbon dioxide (CO2), temperature and relative humidity on bacterial and fungal concentrations; and (iv) to estimate bacterial and fungal dose rate for children (3-5 years old and 8-10 years old) in comparison with the elderly. Air samples were collected in 68 homes, 9 child day-care centres, 20 primary schools and 22 elderly care centres, in a total of 264 rooms with a microbiological air sampler and using tryptic soy agar and malt extract agar culture media for bacteria and fungi growth, respectively. For each building, one outdoor representative location were identified and simultaneously studied. The results showed that child day-care centres were the indoor microenvironment with the highest median bacterial and fungal concentrations (3870 CFU/m(3) and 415 CFU/m(3), respectively), whereas the lowest median concentrations were observed in elderly care centres (222 CFU/m(3) and 180 CFU/m(3), respectively). Indoor bacterial concentrations were significantly higher than outdoor concentrations ($p < 0.05$); whereas the indoor/outdoor ratios for the obtained fungal concentrations were approximately around the unit. Indoor CO2 levels were associated with the bacterial concentration, probably

due to occupancy and insufficient ventilation. Penicillium and Cladosporium were the most frequently occurring fungi. Children's had two times higher dose rate to biological pollutants when compared to adult individuals. Thus, due to children's susceptibility, special attention should be given to educational settings in order to guarantee their healthy future development. (C) 2015 Elsevier Ltd. All rights reserved.

e. QAI

29. Brown, Dassonville et al. (2015). **Relationships between socioeconomic and lifestyle factors and indoor air quality in French dwellings**. Environmental Research. 140: 385-396.

Background: To date, few studies have analyzed the relationships between socioeconomic status (SES) and indoor air quality (IAQ). Objective: The aim of this study was to examine the relationships between socioeconomic and other factors and indoor air pollutant levels in French homes. Methods: The indoor air concentrations of thirty chemical, biological and physical parameters were measured over one week in a sample of 567 dwellings representative of the French housing stock between September 2003 and December 2005. Information on SES (household structure, educational attainment, income, and occupation), building characteristics, and occupants' habits and activities (smoking, cooking, cleaning, etc.) were collected through administered questionnaires. Separate stepwise linear regression models were fitted to log-transformed concentrations on SES and other factors. Logistic regression was performed on fungal contamination data. Results: Households with lower income were more likely to have higher indoor concentrations of formaldehyde, but lower perchloroethylene indoor concentrations. Formaldehyde indoor concentrations were also associated with newly built buildings. Smoking was associated with increasing acetaldehyde and PM2.5 levels and the risk of a positive fungal contamination index. BTEX levels were also associated with occupant density and having an attached garage. The major predictors for fungal contamination were dampness and absolute humidity. Conclusion: These results, obtained from a large sample of dwellings, show for the first time in France the relationships between SES factors and indoor air pollutants, and believe they should be considered alongside occupant activities and building characteristics when study IAQ in homes. Crown Copyright (C) 2015 Published by Elsevier Inc. All rights reserved.

II.2 Transports

Rubrique N°9
pas d'article

II.3 Bureaux

Rubrique N°10

30. Zhao, Gao et al. (2015). **The Effects of Cleaning Way on Pollution Characteristics of Indoor Air Particles in an Office Environment**. International Conference on Energy and Environment Engineering (Iceee 2015)**:** 239-244.

This article compares the effects of cleaning way on pollution characteristics of indoor particles. Three conditions such as mopping floor, wiping table, sweeping floor were performed. It analyzes the distribution of indoor particles with different sizes in each condition. The results indicate that, mopping and sweeping floor have significant impacts on the mass and number concentrations of indoor particles, especially sweeping floor causes a sharp increase of the large particles, while mopping floor leads to a decrease of the fine particles. Wiping table has no significant effect on indoor particles.

II.4 ERP

Rubrique N°11

a. Ecoles/crêches

31. Nunes, Branco et al. (2015). **Particulate matter in rural and urban nursery schools in Portugal**. Environmental Pollution. 202**:** 7-16.

Studies have been showing strong associations between exposures to indoor particulate matter (PM) and health effects on children. Urban and rural nursery schools have different known environmental and social differences which make their study relevant. Thus, this study aimed to evaluate indoor PM concentrations on different microenvironments of three rural nursery schools and one urban nursery school, being the only study comparing urban and rural nursery schools considering the PM1, PM2.5 and PM10 fractions (measured continuously and in terms of mass). Outdoor PM2.5 and PM10 were also obtained and I/O ratios have been determined. Indoor PM mean concentrations were higher in the urban nursery than in rural ones, which might have been related to traffic emissions. However, I/O ratios allowed concluding that the recorded concentrations depended more significantly of indoor sources. WHO guidelines and Portuguese legislation exceedances for PM2.5 and PM10 were observed mainly in the urban nursery school. (C) 2015 Elsevier Ltd. All rights reserved.

32. Yamamoto, Hospodsky et al. (2015). **Indoor Emissions as a Primary Source of Airborne Allergenic Fungal Particles in Classrooms**. Environmental Science & Technology. 49**:** 5098-5106.

This study quantifies the influence of ventilation and indoor emissions on concentrations and particle sizes of airborne indoor allergenic fungal taxa and further examines geographical variability; each of which may affect personal exposures to allergenic fungi. Quantitative PCR and multiplexed DNA sequencing were employed to count and identify allergenic fungal aerosol particles indoors and outdoors in seven school classrooms in four:different countries. Quantitative,diversity analysis Was combined with building characterization and mass balance modeling to apportion source contributions of indoor allergenic airborne fungal particles. Mass balance calculations indicate that 76% of indoor fungal aerosol particles and 80% of airborne allergenic fungal taxa were associated With indoor emissions; on average, 81% of allergenic fungi from indoor sources originated from occupant-generated emissions. Principal coordinate analysis revealed geographical variations in fungal communities among sites in China, Europe, and North America ($p < 0.05$, analysis of similarity), demonstrating that geography may also affect personal exposures to allergenic fungi. Indoor emissions including those released with occupancy contribute more substantially to allergenic fungal exposures in classrooms sampled than do outdoor contributions from ventilation. The results suggest that design and maintenance of buildings to control indoor emissions may enable reduced indoor inhalation exposures to fungal allergens.

II.5 Autres lieux de vie / loisirs

Rubrique N°12

33. Castro, Calvo et al. (2015). **Indoor aerosol size distributions in a gymnasium**. Science of the Total Environment. 524**:** 178-186.

In this study, an indoor/outdoor monitoring program was carried out in a gymnasium at the University of Leon, Spain. The main goal was a characterization of aerosol size distributions in a university gymnasium under different conditions and sports activities (with and without magnesia alba) and the study of the mass fraction deposited in each of the path of the respiratory tract. The aerosol particles were measured in 31 discrete channels (size rangs using a laser spectrometer probe. Aerosol size distributions were studied under different

conditions: i) before sports activities, ii) activities without using magnesia alba, iii) activities using magnesia alba, iv) cleaning procedures, and v) outdoors. The aerosol refractive index and density indoors were estimated from the aerosol composition: 1577-0.003i and 2055 g cm(-3), respectively. Using the estimated density, the mass concentration was calculated, and the evolution of PM1, PM2.5 and PM10 for different activities was assessed. The quality of the air in the gymnasium was strongly influenced by the use of magnesia alba (MgCO3) and the number of gymnasts who were training. Due to the climbing chalk and the constant process of resuspension, average PM-to concentrations of over 440 mu g m(-3) were reached. The maximum daily concentrations ranged from 500 to 900 mu g m(-3). Particle size determines the place in the respiratoiy tract where the deposition occurs. For this reason, the inhalable, thoracic, tracheobronchial and respirable fractions were assessed for healthy adults and high risk people, according to international standards. The estimations show that, for healthy adults, up to 300 mu g iii can be retained by the trachea and bronchi, and 130 mu g m(-3) may each the alveolar region. The different physical activities and the attendance rates in the sports facility have a significant influence on the concentration and size distributions observed. (C) 2015 Elsevier B.V. All rights reserved.

34. Tirler and Settimo (2015). **Incense, sparklers and cigarettes are significant contributors to indoor benzene and particle levels**. Annali Dell Istituto Superiore Di Sanita. 51**:** 28-33.

Introduction. The increased use of incense, magic candles and other flameless products often produces indoor pollutants that may represent a health risk for humans. Today, in fact, incense and air fresheners are used inside homes as well as in public places including stores, shopping malls and places of worship. As a source of indoor contamination, the impact of smoke, incense and sparklers on human health cannot be ignored. Aim. In the present work, we report the results of an emission study regarding particles (PM10 and particle number concentration, PNC) and benzene, produced by various incense sticks and sparklers. Results and discussion. The results obtained for benzene, PM10 and PNC, showed a strong negative influence on air quality when these products were used indoors. Various incense sticks gave completely different benzene results: from a small increase of the benzene concentration in the air, just slightly above the background levels of ambient air, to very high concentrations, of more than 200 mu g/m(3) of benzene in the test room after the incense sticks had been tested.

II.6 Ventilation

Rubrique N°13

35. Liu, Zhang et al. (2015). **The effect of ventilation on indoor exposure to semivolatile organic compounds**. Indoor Air. 25**:** 285-296.

A mechanistic model was developed to examine how natural ventilation influences residential indoor exposure to semivolatile organic compounds (SVOCs) via inhalation, dermal sorption, and dust ingestion. The effect of ventilation on indoor particle mass concentration and mass transfer at source/sink surfaces, and the enhancing effect of particles on mass transfer at source/sink surfaces are included. When air exchange rate increases from 0.6/h to 1.8/h(,) the steady-state SVOC (gas-phase plus particle phase with log K-OA varying from 9 to 13) concentration in the idealized model decreases by about 60%. In contrast, for the same change in ventilation, the simulated indoor formaldehyde (representing volatile organic compounds) gas-phase concentration decreases by about 70%. The effect of ventilation on exposure via each pathway has a relatively insignificant association with the K-OA of the SVOCs: a change of K-OA from 10(9) to 10(13) results in a change of only 2-30%. Sensitivity analysis identifies the deposition rate of PM2.5 as a primary factor influencing the relationship between ventilation and exposure for SVOCs with log K-OA=13. The relationship between ventilation rate and air speed near surfaces needs to be further substantiated.

II.7 Modélisation

Rubrique N°14

a. Radon

pas d'article

b. Intrusion de vapeurs (sites et sols pollues)

pas d'article

c. Autres (particules, QAI, Confort,…)

pas d'article

II.8 Air extérieur – Air intérieur

Rubrique N°15

36. Newton, Sellstrom et al. (2015). **Emerging Flame Retardants, PBDEs, and HBCDDs in Indoor and Outdoor Media in Stockholm, Sweden**. Environmental Science & Technology. 49**:** 2912-2920.

Dust, indoor air, outgoing air from ventilation systems, outdoor air, and soil were sampled in and around Stockholm, Sweden during the winter and spring 2012. The concentrations of several emerging flame retardants (EFRs), polybrominated diphenyl ethers (PBDEs), and isomers of hexabromocyclododecane (HBCDD) were measured. The most commonly found EFR was 1,2-dibromo-4-(1,2 dibromoethyl)cyclohexane (TBECH or DBE-DBCH), which was found in nearly all indoor, ventilation, and outdoor air samples, most dust samples, but not in soil samples. Other frequently detected EFRs included pentabromotoluene (PBT), hexabromobenzene (HBB), 2,3,4,5-tetrabromo-ethylhexylbenzoate (EHTBB), 2,3,4,5-tetrabromo-bis(2-ethylhexyl) phthalate (BEH-TEBP), and decabromodiphenyl ethane (DBDPE). PBDE concentrations were significantly lower in air and dust samples compared to a previous study in Stockholm. In outdoor air, DBE-DBCH, PBT, EHTBB, DBDPE, and PBDEs showed an "urban pulse" with concentrations increasing as samples were taken in more urban areas compared to rural areas. These EFRs show similar environmental behavior as PBDEs. Higher brominated BDEs showed this same urban pulse in soil but lower brominated BDEs did not. Air-soil fugacity fractions were calculated, and these indicated that most compounds are undergoing net deposition from atmosphere to soil, with the higher brominated PBDEs furthest from equilibrium.

III. RISQUE ET IMPACT SUR LA SANTE

III.1 Toxicologie

Rubrique N°16
pas d'article

III.2 Expologie

Rubrique N° 17

37. Ramos, Reis et al. (2015). **Estimating the inhaled dose of pollutants during indoor physical activity**. Science of the Total Environment. 527**:** 111-118.

Background: It is undeniable that many benefits come from physical activity. People exercise in fitness centers to improve their health and well-being, prevent disease and to increase physical attractiveness. However, these facilities join conditions that cause poor indoor air quality. Moreover, increased inhalation rates during exercise have influence on inhaled doses of air pollution. Objectives: This study aims to calculate the inhaled dose of air pollutants during exercise, by estimating minute ventilation of participants and measuring air pollutant concentrations in fitness centers. Methods: Firstly, the 20 participants performed an incremental test on a treadmill, where heart rate and minute ventilation were measured simultaneously to develop individual exponential regression equations. Secondly, heart rate was measured during fitness classes and minute ventilation was estimated based on the calculated regression coefficients. Finally, the inhaled dose of air pollutants was calculated using the estimated minute ventilation and the concentrations of the pollutants measured in a monitoring program performed in 63 fitness classes. Results: Estimated inhaled doses were higher in aerobic classes than in holistic classes. The main difference was registered for PM10 inhaled dose that presented an average ratio between aerobic and holistic classes greater than four. Minute ventilation and PM10 concentrations in aerobic classes were, on average, 2.0 times higher than in holistic classes. Results showed that inhalation of pollutants is increased during heavy exercise, demonstrating the need to maintain high indoor air quality in fitness centers. Conclusions: This study illustrates the importance of inclusion minute ventilation data when comparing inhaled doses of air pollution between different population groups. This work has estimated for the first time the minute ventilation for different fitness classes. Also constitutes an important contribution for the assessment of inhaled dose in future studies to be performed in fitness centers.

38. Morrison, Li et al. (2015). **Airborne phthalate partitioning to cotton clothing**. Atmospheric Environment. 115**:** 149-152.

Accumulation on indoor surfaces and fabrics can increase dermal uptake and non-dietary ingestion of semi-volatile organic compounds. To better understand the potential for dermal uptake of phthalates from clothing, we measured the mass accumulation on cotton fabrics of two phthalate esters commonly identified in indoor air: diethylphthalate (DEP) and di-n-butyl phthalate (DnBP). In 10-day chamber experiments, we observed strong air-to-cloth partitioning of these phthalates to shirts and jean material. Area-normalized partition coefficients ranged from 209 to 411 (mu g/m(2))/(mu g/m(3)) for DEP and 2850 to 6580 (mu g/m(2))/(mu g/m(3)) for DnBP. Clothing volume-normalized partition coefficients averaged 2.6 x 10(5) (mu g/m(3))/ (mu g/m(3)) for DEP and 3.9 x 10(6) (mu g/m(3))/(mu g/m(3)) for DnBP. At equilibrium, we estimate that a typical set of cotton clothing can sorb DnBP from the equivalent of >10,000 m(3) of indoor air, thereby substantially decreasing external mass-transfer barriers to dermal uptake. Further, we estimate that a significant fraction of a child's body burden of DnBP may come from mouthing fabric material that has been equilibrated with indoor air.

39. Beko, Kjeldsen et al. (2015). **Contribution of various microenvironments to the daily personal exposure to ultrafine particles: Personal monitoring coupled with GPS tracking**. Atmospheric Environment. 110**:** 122-129.

Exposure to ultrafine particles (UFP) may have adverse health effects. Central monitoring stations do not represent the personal exposure to UFP accurately. Few studies have previously focused on personal exposure to UFP. Sixty non-smoking residents living in Copenhagen, Denmark were asked to carry a backpack equipped with a portable monitor, continuously recording particle number concentrations (PN), in order to measure the real-time individual exposure over a period of similar to 48 h. A GPS logger was carried along with the particle monitor and allowed us to estimate the contribution of UFP exposure occurring in various microenvironments (residence, during active and passive transport, other indoor and outdoor environments) to the total daily exposure. On average, the fractional contribution of each microenvironment to the daily integrated personal exposure roughly corresponded to the fractions of the day the subjects spent in each microenvironment. The home environment accounted for 50% of the daily personal exposure. Indoor environments other than home or vehicles contributed with similar to 40%. The highest median UFP concentration was obtained during passive transport (vehicles). However, being in transit or outdoors contributed 5% or less to the daily exposure. Additionally, the subjects recorded in a diary the periods when they were at home. With this approach, 66% of the total daily exposure was attributable to the home environment. The subjects spent 28% more time at home according to the diary, compared to the GPS. These results may indicate limitations of using diaries, but also possible inaccuracy and miss-classification in the GPS data.

40. Rocchi, Richaud-Thiriez et al. (2015). **Evaluation of mold exposure in cystic fibrosis patients' dwellings and allergic bronchopulmonary risk**. Journal of Cystic Fibrosis. 14**:** 242-247.

Very few studies have been conducted on cystic fibrosis (CF) patients' exposure to the indoor environment and, to our knowledge, there are no studies dealing with the link between specific fungal environmental exposure at home and fungal colonization resulting in allergic bronchopulmonary aspergillosis (ABPA). Fungal exposure of CF adult patients with ABPA (n = 4) with fungal sensitization (n = 7) and with no ABPA (n = 5) was assessed in 16 homes by dust sampling with electrostatic dust fall collectors (EDCs). Aspergillus fumigatus was specifically quantified by real-time quantitative polymerase chain reactions (qPCRs), and A. fumigatus DNA concentrations were significantly higher in homes of ABPA patients ($p < 0.001$). Results indicate that indoor fungal contamination could be a factor favoring ABPA and suggest that environmental surveys could help in preventing fungal risk in CF patients.

III.3 Épidémiologie

Rubrique N°18

41. Philippat, Bennett et al. (2015). **Phthalate concentrations in house dust in relation to autism spectrum disorder and developmental delay in the CHildhood Autism Risks from Genetics and the Environment (CHARGE) study**. Environmental Health. 14**:** 56-56.

Background: Phthalates are endocrine-disrupting chemicals that influence thyroid hormones and sex steroids, both critical for brain development. Aim: We studied phthalate concentrations in house dust in relation to the risks of developing autism spectrum disorder (ASD) or developmental delay (DD). Methods: Participants were a subset of children from the CHARGE (CHildhood Autism Risks from Genetics and the Environment) case-control

study. ASD and DD cases were identified through the California Department of Developmental Services system or referrals; general population controls were randomly sampled from state birth files and frequency-matched on age, sex, and broad geographic region to ASD cases. All children (50 ASD, 27 DD, 68 typically developing (TD) were assessed with Mullen Scales of Early Learning, Vineland Adaptive Behavior Scales (VABS) and Aberrant Behavior Checklist. We measured 5 phthalates in dust collected in the child's home using a high volume small surface sampler. Results: None of the phthalates measured in dust was associated with ASD. After adjustment, we observed greater di(2-ethylhexyl) phthalate (DEHP) and butylbenzyl phthalate (BBzP) concentrations in indoor dust from homes of DD children: Odds ratios (OR) were 2.10 (95 % confidence interval (CI); 1.10; 4.09) and 1.40 (95 % CI; 0.97; 2.04) for a one-unit increase in the In-transformed DEHP and BBzP concentrations, respectively. Among TD children, VABS communication, daily living, and adaptive composite standard scores were lower, in association with increased diethyl phthalate (DEP) concentrations in dust. Participants with higher dibutyl phthalate (DBP) concentrations in house dust also trended toward reduced performance on these subscales. Among ASD and DD boys, higher indoor dust concentrations of DEP and DBP were associated with greater hyperactivity-impulsivity and inattention. Discussion and conclusion: House dust levels of phthalates were not associated with ASD. The inability to distinguish past from recent exposures in house dust and the fact that house dust does not capture exposure from all sources, limit the interpretation of both positive and null findings and further work is needed. However, the associations observed for DEP and DBP with impairments in several adaptive functions and greater hyperactivity, along with evidence for increased risk of DD raise concerns that these chemicals may affect neurodevelopment in children.

42. Tiesler, Thiering et al. (2015). **Exposure to visible mould or dampness at home and sleep problems in children: Results from the LISAplus study**. Environmental Research. 137**:** 357-363.

Background: Exposure to mould or dampness at home has been associated with adverse respiratory effects in all age groups. This exposure has also been related to insomnia in adults. We aimed to investigate the association between exposure to visible mould or dampness at home and sleep problems in children. Methods: The study population consisted of 1719 10-year-old children from the German population-based birth cohort LISAplus with available data on current mould or dampness at home and sleep problems. The presence of visible mould or dampness at home was assessed by questionnaire. Parent-reported sleep problems of their child were analysed by four binary variables: presence of any sleep problems, problems to fall asleep, problems sleeping through the night and a 24 h sleep time of less than 9 h. Logistic regression models adjusted for study centre, sex, age and level of parental education were applied to examine the association between visible mould or dampness at home and sleep problems. Sensitivity analyses included a further adjustment for bedroom sharing and subgroup analyses in children without current allergic diseases. Results: Thirteen percent of parents reported visible mould or dampness at home. We observed creased risks for all four sleep problem variables for children exposed to visible mould or dampness at home. Results were significant for any sleep problems (odds ratio (OR) = 1.77 (95%-confidence interval (CI): 1.21-2.60), problems sleeping through the night (OR=2.52(1.27-5.00) and a short sleep time (OR=1.68(1.09-2.61)). While a further adjustment for bedroom sharing and the exclusion of children with asthma or eczema led to similar results, only the association with a short sleep time was still present in children without allergic rhinoconjunctivitis. Conclusion: Our data suggests that visible mould or dampness at home might negatively influence sleep in children. The influence of allergic rhinoconjunctivitis on this association needs to be investigated in future studies.

43. Ji and Zhao (2015). **Estimating Mortality Derived from Indoor Exposure to Particles of Outdoor Origin**. Plos One. 10**:** 15.

Following an extensive review of the literature, we further analyze the published data to examine the health effects of indoor exposure to particulate matter (PM) of outdoor origin. We obtained data on all-cause, cardiovascular, and respiratory mortality per 10 mu g/m(3) increase in outdoor PM10 or PM2.5; the infiltration factors for buildings; and estimated time spent outdoors by individuals in the United States, Europe, China, and globally. These data were combined log-linear exposure-response model to estimate the all-cause, cardiovascular, and respiratory mortality of exposure to indoor PM pollution of outdoor origin. Indoor PM pollution of outdoor origin is a cause of considerable mortality, accounting for 81% to 89% of the total increase in mortality associated with exposure to outdoor PM pollution for the studied regions. The findings suggest that enhancing the capacity of buildings to protect occupants against exposure to outdoor PM pollution has significant potential to improve public health outcomes.

44. Norback and Cai (2015). **Dampness, indoor mould, fungal DNA and respiratory health - molecular methods in indoor epidemiology**. Clinical and Experimental Allergy. 45**:** 840-843.

Building dampness and indoor mould growth are recognized risk factors for respiratory health, including asthma, rhinitis and asthmatic symptoms [1]. One meta-analysis on the prevalence of dampness and mould in the European housing stock, including published data from 31 European countries, concluded that 12.1% of the homes in Europe had dampness, 10.3% indoor mould and 10.0% water damage [2]. Even higher prevalence of dampness and mould in European homes were found in the European Community Respiratory Health Survey (ECRHS), where 24.8% of the participants reported that they had ever seen mould in their current home and 27.9% reported water damage. Researchers who visited a subset of the homes observed mould in 13.6% and damp spots in 18.2% of the homes [3]. A number of review articles and meta-analysis have been published suggesting associations between dampness and indoor mould and rhinitis [4], bronchitis and airway infections [5] and onset of asthma [6]. These studies are mostly based on population samples and have not specifically studied exacerbation of asthma. One recent review on indoor environmental exposure has focused on exacerbation of asthma [7]. They concluded that there is sufficient evidence of a causal association between outdoor culturable fungal exposure and exacerbation in asthmatics sensitized to fungi. They also concluded that there is limited or suggestive evidence of an association between indoor culturable Penicillium exposure and exacerbation in asthmatic children with specific sensitization, any fungal sensitization, or unspecific sensitization. Moreover, they concluded that there is limited or suggestive evidence of an association between indoor total culturable fungal exposure and exacerbation of asthma in children with any fungal sensitization. The study has no conclusions concerning exacerbation of asthma in adults in relation to indoor exposure to dampness or mould [7].

III.4 Sick Buildings Syndrome (SBS)

45. Jafari, Khajevandi et al. (2015). **Association of Sick Building Syndrome with Indoor Air Parameters**. Tanaffos. 14**:** 55-62.

BACKGROUND: Energy crisis in 1973 led to smaller residential and office buildings with lower air changes. This resulted in development of Sick Building Syndrome (SBS). The objective of this study was to assess the association of SBS with individual factors and indoor air pollutants among employees in two office buildings of Petroleum Industry Health Organization in Tehran city.
MATERIALS AND METHODS: The association between personal and environmental factors and SBS symptoms was examined by a reliable and valid combined questionnaire. Environmental parameters were measured using calibrated instruments.

RESULTS: The results suggested that SBS symptoms were more common in women than men. Malaise and headache were the most common symptoms in women and men. Throat dryness, cough, sputum, and wheezing were less prevalent among employees in both offices. Light-intensity was significantly associated with some symptoms such as skin dryness (P = 0.049), eye pain (P = 0.026), and malaise (P = 0.043). There were no significant differences in prevalence of SBS symptoms between female workers of the two offices (P>0.05).
CONCLUSION: The main causes of SBS among the employees were recycling of air in rooms using fan coils, traffic noise, poor lighting, and buildings located in a polluted metropolitan area.Jafari, Khajevandi et al. (2015).

III.5 Populations sensibles

46. Bentayeb, Norback et al. (2015). **Indoor air quality, ventilation and respiratory health in elderly residents Living in nursing homes in Europe**. European Respiratory Journal. 45: 1228-1238.

Few data exist on respiratory effects of indoor air quality and comfort parameters in the elderly. In the context of the GERIE study, we investigated for the first time the relationships of these factors to respiratory morbidity among elderly people permanently living in nursing homes in seven European countries. 600 elderly people from 50 nursing homes underwent a medical examination and completed a standardised questionnaire. Air quality and comfort parameters were objectively assessed in situ in the nursing home. Mean concentrations of air pollutants did not exceed the existing standards. Forced expiratory volume in 1 s/forced vital capacity ratio was highly significantly related to elevated levels of particles with a 50% cut-off aerodynamic diameter of <0.1 mu m (PM0.1) (adjusted OR 8.16, 95% CI 2.24-29.3) and nitrogen dioxide (aOR 3.74, 95% CI 1.06-13.1). Excess risks for usual breathlessness and cough were found with elevated PM10 (aOR 1.53 (95% CI 1.15-2.07) and aOR 1.73 (95% CI 1.17-10.3), respectively) and nitrogen dioxide (aOR 1.58 (95% CI 1.15-2.20) and aOR 1.56 (95% CI 1.03-2.41), respectively). Excess risks for wheeze in the past year were found with PM0.1 (aOR 2.82, 95% CI 1.15-7.02) and for chronic obstructive pulmonary disease and exhaled carbon monoxide with formaldehyde (aOR 3.49 (95% CI 1.17-10.3) and aOR 1.25 (95% CI 1.02-1.55), respectively). Breathlessness and cough were associated with higher carbon dioxide. Relative humidity was inversely related to wheeze in the past year and usual cough. Elderly subjects aged >= 80 years were at higher risk. Pollutant effects were more pronounced in the case of poor ventilation. Even at low levels, indoor air quality affected respiratory health in elderly people permanently living in nursing homes, with frailty increasing with age. The effects were modulated by ventilation.

III.6 Évaluation des risques

Rubrique N°19

47. Villanueva, Tapia et al. (2015). **Levels and sources of volatile organic compounds including carbonyls in indoor air of homes of Puertollano, the most industrialized city in central Iberian Peninsula. Estimation of health risk**. International Journal of Hygiene and Environmental Health. 218**:** 522-534.

Twenty nine organic air pollutants including carbonyl compounds, alkanes, aromatic hydrocarbons and terpenes were measured in the indoor environment of different houses together with the corresponding outdoor measurements in Puertollano, the most industrialized city in central Iberian Peninsula. VOCs were sampled during 8 weeks using Radiello (R) passive samplers, and a questionnaire on potential VOCs sources was filled out by the occupants. The results show that formaldehyde and hexanal was the most abundant VOCs measured in indoor air, with a median concentration of 55.5 and 46.4 mu g m(-3),

respectively followed by butanal (29.1 mu g m(-3)), acetone (28.414 m-3) and acetaldehyde (21.4 mu g m(-3)). After carbonyls, n-dodecane (13.1 mu g m(-3)) and terpenes (alpha-pinene, 13.4 mu g m(-3) and limonene, 13.4 mu g m(-3)) were the compounds with higher median concentrations. The indoor/outdoor (I/O) ratios demonstrated that sources in the indoor environment are prevailing for most of the investigated VOCs especially for limonene, alpha-pinene, hexanal, formaldehyde, pentanal, acetaldehyde, o-xylene, n-dodecane and acetone with I/O ratio >6. Multiple linear regressions were applied to investigate the indoor VOC determinants and Spearman correlation coefficients were used to establish common sources between VOCs. Finally, the life-time cancer risk associated to formaldehyde, acetaldehyde and benzene exposure was estimated and they varied from 7.8 x 10(-5) to 4.1 x 10(-4) for formaldehyde, from 8.6 x 10(-6) to 3.5 x 10(-5) for acetaldehyde and from 2.0 x 10(-6) to 1.5 x 10(-5) for benzene. For formaldehyde, the attributed risk in most sampled homes was two orders of magnitude higher than the one (10(-6)) proposed as acceptable by risk management bodies.

IV. GESTION / DIVERS

IV.1 Systèmes de ventilation

Rubrique N°20
pas d'article

IV.2 Analyse coût-bénéfice

Rubrique N°21
pas d'article

IV.3 Technique

Rubrique N°22

48. Ogar, Tylko et al. (2015). **Antifungal properties of silver nanoparticles against indoor mould growth**. Science of the Total Environment. 521**:** 305-314.

The presence of moulds in indoor environments causes serious diseases and acute or chronic toxicological syndromes. In order to inhibit or prevent the growth of microorganisms on building materials, the disruption of their vital processes or the reduction of reproduction is required. The development of novel techniques that impair the growth of microorganisms on building materials is usually based on silver nanoparticles (AgNPs). It makes them an alternative to other biocides. AgNPs have proven antibacterial activity and became promising in relation to fungi. The aim of the study was to assess growth and morphology of mycelia of typical indoor fungal species: Penicillium brevicompactum, Aspergillus fumigatus, Cladosporium cladosporoides, Chaetomium globosum and Stachybotrys chartarum as well as Mortierella alpina, cultured on agar media. The antifungal activity of AgNPs was also tested in relation to C. globosum and S. chartarum grown on the surface of gypsum drywall. It was found that the presence of AgNPs in concentrations of 30-200 mg/l significantly decreased the growth of fungi. However, in the case of M. alpina, AgNPs stimulated its growth. Moreover, strong changes in moulds morphology and colour were observed after administration of AgNPs. Parameters of conidiophores/sporangiophores varied depending on mould region and changed significantly after treatment with AgNPs. The experiments have shown antifungal properties of AgNPs against common indoor mould species. Their application to building materials could effectively protect indoor environments from mould development. However, consideration must be given to the fact that the growth of some fungal strains might be stimulated by AgNPs.

49. Costarramone, Kartheuser et al. (2015). **Efficiency and harmfulness of air-purifying photocatalytic commercial devices: From standardized chamber tests to nanoparticles release**. Catalysis Today. 252**:** 35-40.

The aim of this study was the comparison of the efficiency of several commercial photocatalytic air-purifiers according to the French XP B44-013 AFNOR standard test (soon European) in a large closed chamber at the ppbV level under controlled conditions representative of indoor air. After inter-lab comparisons validating the method and analytical procedures, the commercial devices were evaluated for the mineralization of a mixture of four representative VOCs (acetaldehyde, acetone, n-heptane and toluene). Comparison of the degradation rate allowed the determination of the clean air delivery rate (CADR), while the mineralization efficiency was determined from CO2 analysis. The devices could be ranked in two classes: class 1 for efficient devices (high CADR, extended mineralization, no by-product) and class 2 for inefficient and unsafe ones (by-product release even in the absence of VOCs, low CADR and mineralization). Electrical low pressure impactor (ELPI) could not evidence any nanoparticles release with any of the studied devices. Formaldehyde was the main by-product detected in all cases, but the concentration remained low and decreased with time due to its total mineralization with class 1 devices. For class 2 devices, formaldehyde concentration was higher and went on increasing with time. These experimental data point out the urgent need of careful evaluation and certification of commercial photocatalytic air-purifiers for consumer's safety and secure development of the technology. (C) 2015 Elsevier B.V. All rights reserved.

50. Etzov, Cohen et al. (2015). **Bioluminescent Liquid Light Guide Pad Biosensor for Indoor Air Toxicity Monitoring**. Analytical Chemistry. 87**:** 3655-3661.

Indoor air pollution became a recent concern found to be oftentimes worse than outdoor air quality. We developed a tool that is cheap and simple and enables continuous monitoring of air toxicity. It is a biosensor with both a nondisposable (monitor) and disposable (calcium alginate pads with immobilized bacteria) elements. Various parameters to enhance its signal have been tested (including the effect of the pad's orientation, it's exposure to either temperature or time with the air toxicant analyte, and various concentrations thereof). Lastly, the sensor has demonstrated its ability to sense the presence of chemicals in a real, indoor environment. This is the first step in the creation of a sensitive and simple operative tool that may be used in different indoor environments.

51. Lorencik, Yu et al. (2015). **Design and performance evaluation of the functional coating for air purification under indoor conditions**. Applied Catalysis B-Environmental. 168**:** 77-86.

The present work aims to develop a photocatalytic coating for the improvement of indoor air quality. Two types of visible-light responsive photocatalysts (powder and suspension form) were applied into a. water-based acrylic coating. The applied materials were characterized and the developed coatings were tested for the pollutant removal efficiency under visible-light irradiation. The coatings containing a stabilized C-TiO2 suspension showed nano-scale and uniform particle distributions. A UV treatment was found to be necessary, in order to expose the nano-photocatalytic particle and to promote the NOx removal efficiency under visible light irradiation, from 5 h (7% de-NOx) to 10 h (18% de-NOx). In addition, the distribution and the incorporation of the catalyst were significantly improved in case of the coatings incorporating C-TiO2 suspension. (C) 2014 Elsevier B.V. All rights reserved.

IV.4 Réglementaire/certification

52. Wei, Ramalho et al. (2015). **Indoor air quality requirements in green building certifications.** Building and Environment. 92: 10-19.

Green building certifications aim to achieve sustainable buildings that are healthy, energy-saving, and environmentally friendly. To construct healthy built environments for occupants, a high indoor environment quality (IEQ) has to be maintained. The goal of this paper is to analyze how and to what extent indoor air quality (IAQ), as a subset of IEQ is taken into account in green building certifications worldwide. Thus, IAQ requirements were reviewed in 31 green building certifications from 30,countries worldwide. These certification programs include 13 countries in Asia, 9 in Europe, 5 in Americas, 2 in Oceania, and 1 in Africa. Fifty-five green building schemes were selected from among the 31 certifications. Rating systems are commonly used in green building schemes to evaluate the capability and level of a building to achieve life-cycle sustainability. The average contribution of IAQ to green building schemes worldwide is 7.5%. Volatile organic compounds (VOCs), formaldehyde, and carbon dioxide (CO2) are the indoor air pollutants most frequently considered. Ozone (O-3) and semi-volatile organic compounds (SVOCs) are mentioned in less than 6.7% of the certifications worldwide. Emission source control, ventilation, and indoor air measurement are the three main pathways used in green building schemes for IAQ management. All of the certifications include ventilation as a way to manage IAQ Emission source control is included in 77% of the certifications and is mainly targeted at building material emissions. Indoor air measurement is included in 65% of the certifications but may be optional.

IV.5 gestion/management de la QAI

53. Rogawansamy, Gaskin et al. (2015). **An Evaluation of Antifungal Agents for the Treatment of Fungal Contamination in Indoor Air Environments**. International Journal of Environmental Research and Public Health. 12**:** 6319-6332.

Fungal contamination in indoor environments has been associated with adverse health effects for the inhabitants. Remediation of fungal contamination requires removal of the fungi present and modifying the indoor environment to become less favourable to growth. This may include treatment of indoor environments with an antifungal agent to prevent future growth. However there are limited published data or advice on chemical agents suitable for indoor fungal remediation. The aim of this study was to assess the relative efficacies of five commercially available cleaning agents with published or anecdotal use for indoor fungal remediation. The five agents included two common multi-purpose industrial disinfectants (Cavicide((R)) and Virkon((R))), 70% ethanol, vinegar (4.0%-4.2% acetic acid), and a plant-derived compound (tea tree (Melaleuca alternifolia) oil) tested in both a liquid and vapour form. Tea tree oil has recently generated interest for its antimicrobial efficacy in clinical settings, but has not been widely employed for fungal remediation. Each antifungal agent was assessed for fungal growth inhibition using a disc diffusion method against a representative species from two common fungal genera, (Aspergillus fumigatus and Penicillium chrysogenum), which were isolated from air samples and are commonly found in indoor air. Tea tree oil demonstrated the greatest inhibitory effect on the growth of both fungi, applied in either a liquid or vapour form. Cavicide((R)) and Virkon((R)) demonstrated similar, although less, growth inhibition of both genera. Vinegar (4.0%-4.2% acetic acid) was found to only inhibit the growth of P. chrysogenum, while 70% ethanol was found to have no inhibitory effect on the growth of either fungi. There was a notable inhibition in sporulation, distinct from growth inhibition after exposure to tea tree oil, Virkon((R)), Cavicide((R)) and vinegar. Results demonstrate that common cleaning and antifungal agents differ in their capacity to inhibit the growth of fungal genera found in the indoor air environment. The results indicate that tea tree oil was the most effective antifungal agent tested, and may have industrial application for the remediation of fungal contamination in residential and occupational buildings.

54. Pastor Perez (2015). **Indoor air quality: from scientific studies to everyday management**. Gefahrstoffe Reinhaltung Der Luft. 75**:** 246-252.

It is well known that urban population spends most of its time indoors working in commercial buildings, enjoying leisure time in hotels or shopping malls, or using services in hospitals and transportation centers. There are hundreds of scientific studies showing the special characteristics of indoor air pollution that make enclosed spaces quite different from outdoor environments. There is a lot of knowledge about this problem, however, there is a lack of practical application of most of this information in everydays life for the general public. Generally speaking, facility managers do not apply rigorous protocols and maintenance programs intended to enhance indoor air quality (IAQ). Controlling the indoor air quality might undoubtedly have enormous social benefits in terms of comfort and health of the population, and thus enhance productivity and minimize absenteeism in commercial premises or diminish nosocomial infections in hospital environments.-This article describes the characteristics of the Spanish Standard Series UNE 171330 dealing with the implementation of a certifiable indoor air quality management system (IAQMS).

IV.6 Divers

pas d'article

**********♈♉♊♋♌♍♎♏♐♑♒♓**********