INCA
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Excerpt from

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Macro-area IV - Applications

A) Environment and Cultural Heritage

Although currently technicians and researchers often focus their attention on organic pollutants (down to those present at trace level), historically inorganic contaminants were first studied and many monitoring stations of inorganic pollutants in urban environments detect molecules such as CO, NO_X, and SO_2. The first environmental traffic emergency ever detected was due to inorganic pollutants, namely to lead compounds previously used as anti-detonation agents in gasoline (petrol).

Besides their direct impact on environment and health, inorganic pollutants also act indirectly by reacting with each other, or with other natural or anthropogenic atmospheric compounds. In this way they alter the cycles of relevant chemical species in the atmosphere (radicals, ozone, halogenated compounds). Furthermore, they have an impact on environmental protection and preservation and can influence the quality of habitats and of the whole ecosystem.

Another important issue it the effect of inorganic pollutants on cultural heritage. They can damage materials of artistic manufactures in different ways, such as: the reaction between SO_x and calcareous materials, the corrosion of metals, the hydrolysis of cellulose and lignin. So, it is obvious that the defence of cultural heritage depends primarily on the protection of the environment in which they are located. This can be achieved only with a multidisciplinary approach.

Acid atmospheric depositions (rain, snow, dew, and, in particular, fog), commonly tagged as "acid rains": they are the major threat to cultural heritage. Sulphur oxides transform into acids which can react with marble turning it into gypsum, less valuable and stable. The acidity of the atmosphere can corrode metallic materials both in dry and wet conditions and it can hydrolyze lignin and cellulose, damaging their mechanical properties. This last phenomenon is particularly relevant to paper historical documents.

Besides acidity in the atmosphere, we can find further noxious compounds, such as radicals deriving from incomplete combustions of fuels for energy production, including engines of vehicles. Radicals are instable and reactive species, due to their nature they can interact and damage several biological and non-biological matrices.

Knowledge, prevention, restoration, consolidation, and stabilization are the phases of a proper program to remediate damages to the cultural heritage provoked by environmental pollution.

B) Urban Pollution Monitoring

The term monitoring indicates the observation of the destiny of a xenobiotic from its detection in the environment to its action in our body. The monitoring aim is that of providing data for the adoption of proper prevention systems, through a continuous or periodic evaluation of the exposure and of the effects, along with a correct interpretation of collected data.

Excluding the sanitary surveillance, we find two types of monitoring: i) environmental and ii) biological. The goal of the first one is the evaluation of the exposition levels by the analysis of matrices such as air, water, soils and food. Conversely, in biological monitoring we analyze biomarkers (also called biological indicators), they can be chemical compounds or their metabolites. Biochemical effects produced by both can also be investigated. A wide variety of biological samples can be tested: blood, urine, exhalants.

The emission of aromatic carcinogens, such as benzene and analogous molecules, into the urban environment has increased as a consequence of the elimination of lead from gasoline. Unleaded gasoline shows an high concentration of such compounds, in order to reach a proper octane rating. Its approximate composition is:

- n-paraffins, 15%
- iso-paraffins, 30%
- cycle-paraffins, 12%
- aromatics, 35%
- olefins, 8%
- oxygenated compounds, *in traces*.

When using such a fuel, emissions greatly depend also on the efficiency of the catalytic converter, which in its turn depends on the degree of wearing and on the running conditions.

About 17-19% of the benzene found in urban atmosphere comes from its evaporation during storage (including the vehicles tanks), transportation, and fuelling. The remaining part comes from exhaust gases according to the equation:

“benzene weight % = 0.5 + 0.44 bz + 0.04 ar”

where

bz = percent weight of benzene in gasoline
ar = percent weight of other aromatics in gasoline

Part of the other aromatics can be converted into benzene during the combustion.

Monitoring is presently evolving into increasingly selective methods, with reduced separation phases for mixtures and a higher accuracy of measurements. They should possibly provide real-time results (in order to identify possible health risks immediately), show a linear response and be performed by automated small-sized instruments, in order to be located into urban monitoring stations. At preset time, great attention is given to the contribution of single chemical species to total concentration of a class of atmospheric pollutants.

C) Ecological Footprint of Food

Irrespective of its actual causes and fine mechanisms, global warming forces our society to strive for the reduction of CO_2 emissions. In our time a dietary regime does not represent just a way to intake a proper amount of nutrients and energy, it is also important for prevention and wellness with a minimum use of medicines. In such a context, it is important to understand the environmental impact of food production in terms of CO_2 equivalent emissions.
The ecological footprint of food industry is represented by the result of the life cycle assessment (LCA) analysis of a food considered as an end-product (or a process) reported in terms of emitted CO_2-eq. The proper evaluation of such footprint still requires further research, in order to upgrade and optimize the available LCA methods.