

Effluent testing: a review of current status



With mounting regulatory pressures to show that health and environmental risks linked to effluents are minimal, tests are needed to evaluate the tendency for chemicals in effluents to be persistent, bioaccumulative or toxic. However, Whole Effluent Assessment (WEA) is a complex and developing area. To date, scientists have broad experience with general toxicity tests – both acute and, to a lesser extent, chronic – but less understanding of specific tests for characteristics such as genotoxicity. A better understanding of the effects of water quality parameters on tests is needed; confounding factors such as pH and ionic strength need more investigation. It is essential to know if a test is capable of predicting real adverse effects in the environment. Tests for persistence and bioaccumulation applicable to effluents are at a preliminary stage of development; reliable techniques are needed.

Current approaches

All surface waters can potentially be impacted by effluents; a system of permits regulating the amount and type of discharge at a local level has therefore been developed to protect the environment. Impact assessments to date for specific effluent discharge permits have mainly been based on general characteristics (such as volume, pH, temperature or biological oxygen demand), plus parameters such as levels of specific contaminants. Chemicals monitored are typically identified based on industry activities, but there are shortcomings to evaluate possible ecological impacts when relying only on testing single substances:

- Ecotoxicological data are not available for all substances, so chemical concentrations cannot always be used to predict ecological effects.
- Substances may be present for which there are no analytical techniques, or at levels below detection limits, but which may still have an ecological impact.
- In complex mixtures such as effluents, it is hard to predict ecotoxicological effects based on individual constituents. Substances can increase or decrease one another's effects, and these interactions can differ by organism.
- Chemical analyses generally measure total concentrations, whilst ecotoxicological effects are due only to the bioavailable fraction. Constituents such as organic matter can therefore result in misleading interpretations.

Attempts are being made to overcome these limitations, for example using biological analyses – termed bioassays – to directly evaluate potential toxicity. Test organisms are exposed to effluent samples, and factors such as mortality, growth, reproduction or biochemical parameters are then analysed.

Different types of tests

Up to now most experience in WET (Whole Effluent Testing) has been obtained with acute bioassays, covering exposures of a few minutes up to a few days, during a small part of the organism's lifespan. Tests to determine the impact of chronic exposure are also needed to measure long-term toxicity. Bioassays of organisms exposed for much of their life-cycle cost more, but are more sensitive than acute bioassays and are also being applied successfully to effluents.

The most common tests are with species from the following taxonomic groups: bacteria, algae, invertebrates and fish. Test organisms need to be sensitive to chemical effects but less responsive to conditions often found in effluents (turbidity, salinity or varying pH). Also quality control is essential to obtain meaningful results; standardised international protocols are available. In addition to these more accepted assays for general toxicity, tests to assess other parameters are being developed. Examples of such tests, which are at different stages of development, are:

- **Specific toxicity tests:** Examples are tests for genotoxicity (including carcinogenicity and mutagenicity), with effects of DNA damage usually measured at the cellular level.

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- ***In vitro* assays:** Advantages of *in vitro* tests (using parts of organisms) over *in vivo* ones (using whole animals) are their small volume, ease of testing large numbers of samples, and the potential to develop tests for highly specific substances or effects (see also KSIS on [in vitro testing](#)).
- **Test of bioaccumulation potential:** Bioaccumulative compounds can have indirect adverse effects higher up in food chains. Research is focused on determining the total amount of such compounds in effluents, including solid phase micro-extraction techniques (SPME).
- **Persistence and biological or chemical degradation:** Currently there are no tests capable of assessing “persistence” of unknown mixtures of chemicals such as effluents, and even for single substances identification of persistence on its own is debatable. Practical approaches are to assess whether measured “toxic responses” or “potential bioaccumulation responses” persist after a biodegradation step.

For any new test to be developed, two requirements are essential. One concerns the test itself; it should be suitable to apply to toxicants in effluents, which often presents practical problems, and results should be reproducible. The other requirement is to assess the capacity of the test to predict real impacts on the receiving waters. Combining results from chemical and biological monitoring with WEA results is needed for these reality checks on the tests.

Biological and chemical effects

In practice, bioassays and chemical analyses are complementary. For example, if an effluent contains high concentrations of various metals, bioassays would give greater insight into bioavailability. In complex effluents, bioassays can provide a more direct insight into ecological risks than a risk assessment based on chemical analyses of the separate substances.

Information on causes of toxicity can be obtained using Toxicity Identification and Evaluation (TIE) methods. For example, substreams can be tested with effluent tests to identify the source of a toxic response, followed by detailed (chemical) analysis.

Conclusions

Introducing WEA into legislation prematurely could increase the risk that inappropriate tests would be selected. WEA is a tool and the best way forward seems simply to apply current tests, even though they are not perfect, and try to interpret the results. The underlying science should then be developed by critically evaluating the results in combination with all available knowledge of the effluent and the receiving water; i.e. “learning by doing”. Environmental monitoring is challenging, time consuming and expensive but is nonetheless vital in helping to target actual impacts and improvements on the environment.

There are many good examples where industry has worked on environmental monitoring with authorities. The chlor-alkali industry is committed to working with regulators on science-based approaches for effluent testing and is keen to continue its work with authorities to further develop WEA methodology.

KEY SCIENCE INFORMATION SHEET

One of a series Euro Chlor is publishing to improve understanding by non-scientists of scientific issues. Each publication focuses on health or environmental aspects of the production, use and disposal of chlorine and its derivatives. Other information sheets available include dioxins, POPs and PBTs, marine risk assessments, children and exposure to highly-chlorinated chemicals, naturally-occurring organochlorines and effluent testing with cell-based *in vitro* bioassays.

Effluent testing: a review of current status and other publications can be found at chlorine online (<http://www.eurochlor.org>)