Unit title: Environmental Chemical Analysis

Unit code: **T/601/0411**

QCF level: **5**

Credit value: **15**

Aim

The unit applies chemical principles to understanding environmental contexts. The complexity of sampling within the environmental matrix and appropriate strategies for accurate analyses are examined.

Unit abstract

All industrial chemical processes are analysed for their environmental impact and many industries routinely carry out environmental monitoring and pollution control on a 24 hour basis.

This unit uses knowledge gained from the core units covering organic, inorganic, physical and analytical chemistry and applies it to the complex requirements of environmental analysis. Learners will learn how the chemical and physical properties of materials influence their transport in the natural environment.

Key analytical chemistry techniques of sampling, storage and analysis are reinforced through laboratory exercises. Learners are introduced to the specific requirements of environmental analysis, for example chemical analysis in the field, continuous sampling procedures and the use of remote sensing. Industrial visits allow learners to observe typical sampling protocols and the training required by the operatives involved. Those learners who work on an industrial site where effluent treatment takes place should be encouraged to research the treatment process. Those not in a suitable industrial setting should have opportunity for site visits to better understand the complexities of treatment processes.

There is opportunity to experience sampling in the field, coupled with planning for suitable controls, before chemical analysis takes place. This process provides an understanding of the difficulties of analysing complex, interactive and non-steady state chemical systems.

The use of climate change modelling in shaping economic activity is an important current issue. Through this unit, learners are encouraged to research the evidence and link the chemistry underpinning the modelling to the economic consequences of the model's application.

Learning outcomes

On successful completion of this unit a learner will:

1 Understand chemical principles in an environmental context

2 Understand how chemical analysis is used in environmental monitoring

3 Be able to carry out quantitative environmental analysis

4 Understand the applications of environmental modelling.

Unit content

1 Understand chemical principles in an environmental context

Distribution of neutral organic compounds: sources; bioconcentration; accumulation in sediments; biomagnification; degradation

Distribution of metal ions: sources; solubilisation; deposition in sediments; uptake by organisms

Mobilisation of chemical species: influence of pH and redox conditions on mobilisation of inorganic and organic species

2 Understand how chemical analysis is used in environmental monitoring

General approach to sampling: sampling strategies eg spot and continuous sampling; sample extraction; storage; separation of interfering species

Analytical techniques: chromatographic, spectroscopic and electrochemical techniques

Portable analytical equipment: analysis of air, water and soil quality in the field; equipment design for field use; applications and limitations of portable analytical systems

Remote sensing: application eg current developments in remote sensing technologies

3 Be able to carry out quantitative environmental analysis

The environmental matrix: the complexity of the matrix and the difficulty of detecting analytes in the natural environment; factors affecting detection sensitivity

Analytical schemes: sampling methods; sample pre treatment; sample preparation eg extraction, dissolution, separation of interfering species, concentration of extracted analyte; analytical techniques

Reference standards: the importance of reference standards or effective matrix matching; advantages of standards additions (spiking) as opposed to calibration standardisation

Water quality: dissolved oxygen and oxygen demand in natural waters; comparison of biochemical and chemical oxygen demand and their relationship to specific concentrations of dissolved organic compounds; measurement of total organic carbon in water

4 Understand the applications of environmental modelling

Chemical speciation modelling: modelling the relationship between the chemical form of an element, mobility and bioavailability

*Environmental models and environmental qua*lity: the development of environmental models; acidification of upland environments through anthropogenic sulfur dioxide emissions; stratospheric ozone depletion modelling; climate change models linked to anthropogenic activity

Impact of environmental models on economic activity: changes in economic activity through predictive modelling eg alternative fuels for power generation, biofuels, energy conservation, carbon reduction targets

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:	**Assessment criteria for pass** The learner can:
LO1 Understand chemical principles in an environmental context	1.1 explain methods by which organic materials are distributed in the environment 1.2 explain methods by which inorganic materials are distributed in the environment 1.3 explain the chemical principles which account for the mobilisation of chemical species in the environment
LO2 Understand how chemical analysis is used in environmental monitoring	2.1 assess the importance of correct methods of sampling 2.2 review analytical techniques for determining the composition of environmental samples 2.3 explain how portable analytical instrumentation can be used for environmental sampling 2.4 discuss the application of remote sensing in environmental analysis
LO3 Be able to carry out quantitative environmental analysis	3.1 demonstrate the complexity of the environmental matrix 3.2 implement analytical schemes appropriate for the natural environment 3.3 apply appropriate environmental reference standards in analysis of samples 3.4 measure the quality of a sample of water
LO4 Understand the applications of environmental modelling	4.1 assess chemical speciation modelling as a viable alternative to an experimental study of environmental systems 4.2 explain the role of environmental models in predicting change given the concern over the current and future quality of the environment 4.3 assess the impact of the application of results of environmental models on economic activity

Guidance

Links

This unit has particular links with the following units within this qualification:

- *Unit reference number R/601/0352: Organic Chemistry*
- *Unit reference number R/601/0349: Inorganic Chemistry*
- *Unit reference number Y/601/0353: Physical Chemistry*
- *Unit reference number H/601/0355: Chemical Laboratory Techniques*
- *Unit reference number F/601/0220: Analysis of Scientific Data and Information*
- *Unit reference number M/601/0410: Analytical Chemistry*
- *Unit reference number Y/601/0238: Environmental Monitoring and Analysis*

Essential requirements

Delivery

The complexity of sampling and analysis of the natural environment must be stressed. An appreciation of this must be gained through carrying out an appropriate analysis for learning outcome 3. Learners must select a suitable analysis with guidance from tutors. Sampling of the natural environment and planning for the use of reference standards may be undertaken as group work. The measurement of water quality may include simulated effluent for the determination of pH, chemical oxygen demand (COD), biological oxygen demand (BOD) and suspended solids.

Learning outcome 4 presents an opportunity to discuss current environmental models and their impact on economic activity. An example of this may be the impact of climate change modelling on government policies relating to carbon emissions. Guest speakers working on environmental modelling, or its impacts, would be a useful addition to the lecture programme.

Assessment

Learning outcome 1 involves the principles of general chemistry as applied to the environment. Learning outcomes 2 and 3 involve the application of analytical techniques to environmental scenarios. These learning outcomes will involve laboratory investigations, fieldwork, and case studies to cover a wide range of analytical techniques. Learning outcome 4 will be mainly case study-based with consideration of suitable current environmental models.

Resources

Learners require access to analytical instrumentation for practical exercises and computing facilities for research into environmental models.

Employer engagement and vocational contexts

Learners would benefit from visits to industrial settings where effluent treatment and environmental monitoring can be observed. A visit to a sewage treatment works or water treatment facility would be helpful in setting environmental chemistry in the context of large-scale continuous processing.

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