

# Unit title: Industrial Chemistry

Unit code: **F/601/0413**

QCF level: **4**

Credit value: **15**

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## Aim

The unit enables learners to gain an understanding of the factors affecting the successful operation and sustainability of an industrial process including its location, operation, health and safety and environmental issues.

## Unit abstract

The unit provides a flexible framework that will allow centres and learners to make a detailed study of an industrial process closely linked to their own interests, employer needs or local employment opportunities.

Learners will acquire an in-depth appreciation of all the factors that affect the successful operation of an industrial process and by applying chemical principles from other units achieve an understanding of the chemical processes involved in industrial manufacture.

## Learning outcomes

### On successful completion of this unit a learner will:

- 1 Understand factors affecting the location of a chemical plant
- 2 Understand factors affecting the selection of a chemical process
- 3 Understand the physico-chemical aspects of an industrial process
- 4 Understand the chemistry of the industrial process.

## Unit content

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### 1 Understand factors affecting the location of a chemical plant

*Location factors:* geological factors (drainage, waste removal); geographical factors (brownfield/greenfield, location, planning requirements); economic factors (subsidies, ESF support); environmental impact (location, sustainability, disposal of waste, treatment of effluent)

*Transportation costs:* raw materials; products; natural resources; energy; workforce

*Availability of resources:* energy; water; raw materials

*Environmental audit:* effect on nearby properties; waste disposal; deliveries and transport; pollution e.g. noise, effluent, gaseous discharge

*Socio-economic factors:* availability of skilled labour; financial support

### 2 Understand factors affecting the selection of a chemical process

*Process factors:* raw materials (availability, purity, costs, transport); yield (main products, co-products, waste materials); time factor (relative rates, balance of yield versus rate); operating conditions (costs, benefits in relation to yield and rate for chosen route); sustainability (carbon footprint)

*Quality of product:* ease of separation; purification; side products; quality control

*Other products:* co- and side-products (ease of separation, possible uses); transport

*Environmental Protection Act:* control and monitoring of effluents; safe disposal of waste products; the possible effects of operating the process on the immediate environment of the plant

*Safety aspects:* risk analysis for complete process; COSHH assessment

### 3 Understand the physico-chemical aspects of an industrial process

*Energetic factors:* energy requirements; energy flow; heat transfer

*Equilibrium factors:* equilibrium yield; operating conditions: balance of yield versus operating conditions; kinetic factors

*Kinetic factors:* factors affecting rate; choice of catalyst; reaction route; reaction conditions

*Separation and purification:* principles of phase equilibria underlying distillation; solvent extraction; chromatography; crystallisation/evaporation; scale e.g. research and development, pilot scale, plant scale

*Transfer of materials and resources:* water; raw materials; products; energy

#### 4 **Understand the chemistry of the industrial process**

*Choice of reaction:* possible reaction pathways; reagents; reasons for selection

*Mechanism of reaction:* evaluation of mechanism for each stage

*Reaction conditions:* effect of temperature; effect of pressure; effect of catalyst; effect of other conditions on product and yield

*Yield:* of all possible pathways; factors affecting yields

*Separation/purification:* description of techniques used; evaluation of the effect on yield and quality of product

*Use and recycling of co-products:* separation; use; recycling; commercial value

## Learning outcomes and assessment criteria

<b>Learning outcomes</b> On successful completion of this unit a learner will:	<b>Assessment criteria for pass</b> The learner can:
LO1 Understand factors affecting the location of a chemical plant	1.1 explain how factors influence the choice of location 1.2 assess the relevance of transportation costs and explain the importance of available resources 1.3 review the effect of an environmental audit on the planning process 1.4 explain the relevance of socio-economic issues
LO2 Understand factors affecting the selection of a chemical process	2.1 explain the relevance of process factors to a chemical process 2.2 explain the importance of the quality of the product 2.3 explain the importance of co- and side-products on the overall profitability of the process 2.4 assess safety aspects and discuss measures required for compliance with the Environmental Protection Act
LO3 Understand the physico-chemical aspects of an industrial process	3.1 explain how energetic, equilibrium and kinetic factors influence the selected industrial process 3.2 explain the principles of separation and purification used in the process 3.3 explain the impact of the transfer of materials used in the process
LO4 Understand the chemistry of the industrial process	4.1 justify the choice of reaction and identify the mechanism of each stage and its relation to the reaction conditions 4.2 explain the factors affecting yields including those of alternative pathways 4.3 describe the processes of separation and purification and their influence on the overall yield of product achievable 4.4 explain the potential uses and commercial values of the principal and co-products

## Guidance

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### 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 J/601/0364: Physical Chemistry of Spectroscopy, Surfaces and Chemical and Phase Equilibria.*
- *Unit reference number M/601/0360: Inorganic Chemistry of Crystal Structures and Transition Metal Complexes*
- *Unit reference number A/601/0362: Organic Chemistry of Aromatic and Carbonyl Compounds*

### Essential requirements

#### Delivery

Delivery must encourage learners to reflect on all aspects of the selected industrial process and to develop an awareness of business, socio-economic, health and safety and environmental considerations.

#### Assessment

Learners must select an industrial process with guidance from tutors. It is envisaged that learners will build up a comprehensive and detailed case study of the process covered. They must demonstrate the ability to synthesise and apply concepts developed in the core units to the process.

Learners should also show an awareness of business, environmental, health and safety and socio-economic factors affecting the chemical industry.

#### Resources

Ideally the primary resource for this unit is the learner's place of employment or other local chemical industry plant. If learners are not using their own place of employment, then appropriate visits are essential. In addition, museum visits to, for example the Science Museum or the Catalyst Museum would be beneficial.

#### Employer engagement and vocational contexts

Learners will benefit from visits to industrial chemistry sites to observe manufacturing practice.