Unit 133: Basic Polymer Technology

Unit code: Y/602/3457

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit enables learners to gain a knowledge of the classification of polymers, the modification of their properties using additives and the processing methods used to produce them. The unit also enables learners to gain skills in testing the physical properties of polymers.

Unit introduction

This unit introduces learners to the terminology, materials and processes associated with the polymer industry. It is intended for learners who may be commencing a career in polymers or have little prior knowledge of the industry. Topics covered are relevant to both the plastics and rubber sectors of the industry. The unit covers the fundamental concepts which formulate the way in which polymers and their starting materials sources are classified. Learners will gain a knowledge of how to modify the properties of polymers by the use of additives to enable them to be suitable for a range of applications in everyday use. They will be introduced to processing methods of how to produce products such as plastic bottles and damp proof membranes. It is important that learners develop skills to enable them to investigate the properties of polymers such as their impact and tensile strength. Learners will also gain a knowledge of the sources of starting materials, their sustainability, a knowledge of polymers that can be recycled and the environmental effects of polymers.

Learning outcomes

On completion of this unit a learner should:

1 Know how to classify polymers and their sources using correct terminology

2 Know how additives modify polymer properties

3 Be able to investigate processing methods by which polymers can be processed into products

4 Be able to investigate the testing of materials to determine the physical properties of polymers.

Unit content

1 Know how to classify polymers and their sources using correct terminology

Terminology and definitions: natural, synthetic, monomer; polymer; co-polymer; composites; polymerisation; elasticity; plasticity

Classification of polymers: thermoplastic; thermoset; elastomer; bioplastic; standard abbreviation in each classification

Physical Properties: tensile strength; hardness; impact strength; density; decomposition (biodegradability); environmental effects

Sources of starting materials: petroleum oil; sugars; cornstarch; cellulose; hydroxycarboxylic acids; recycling; sustainability

2 Know how additives modify polymer properties

Basic properties of polymers: basic molecular chain and 3-dimensional structures

Modification of polymers: modification eg strength, stiffness, service life, costs

Function of additives: fillers; plasticizers; cross-linking agents; impact modifiers; antioxidants; stabilisers; blowing agents

Calculations: mix densities; material costs; energy costs

3 Be able to investigate processing methods by which polymers can be processed into products

Construction and operation of processing equipment: two roll mill; internal mixers; extruders; calenders; presses; injection moulding machines; thermoforming; blow moulding

4 Be able to investigate the testing of materials to determine the physical properties of polymers

National and international standards for materials testing: BS; ISO; ASTM; DIN

Standard testing procedures: tensile strength; hardness; impact strength; density; melt flow; state of cure

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 describe polymers and their sources using correct terminology [RL6]	**M1** explain the classification of polymers with reference to general molecular structures	**D1** evaluate the classification of polymers using examples of actual polymeric materials
P2 describe the modification of polymer properties by the addition of various additives [RL6]	**M2** explain the effect of various additives on polymer properties	**D2** evaluate the effect of a range of additives on polymer properties with reference to their effect on molecular structure
P3 carry out processing methods by which polymers can be processed into products, using safe working practices [IE1, IE2, IE4, SM3, EP2]	**M3** explain the operation of polymer processing equipment	**D3** justify the process selected for the production of polymer products
P4 describe the test procedures used to determine the physical properties of polymers [RL6]	**M4** explain the reasons for standardisation of testing procedures.	**D4** compare and contrast the results obtained from standard laboratory tests with the characteristics of a product in service.
P5 carry out the testing of materials to determine the physical properties of polymers, using safe working practices. [EP2, SM3]		

PLTS: This summary references where applicable in the pass criteria, in the square brackets, the elements of the personal, learning and thinking skills. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers	RL – reflective learners TW – team workers	SM – self-managers EP – effective participators

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Essential guidance for tutors

Delivery

The fundamental concepts in this unit should be introduced through a programme of tuition, practical laboratory work and problem solving.

Learners should build on the concepts learnt in Key Stage 4 or on other programmes of study, for example, BTEC Level 2 Diploma in Applied Science.

Any opportunity to gather information from industry-based learners or from visits to industry should be taken to help relate fundamental concepts to applications in relevant industries. This will contextualise the knowledge and understanding to the appropriate vocational routes. Emphasis should also be placed on the sustainability of sources of starting materials, energy usage, effects on the environment and recycling of plastics.

Today's polymer laboratories are becoming increasingly dependent on computer-based measurement and opportunities to gather and analyse data in this way should be taken. Polymer technicians need to be familiar with the basic terminology and principles associated with measurement systems and their communications with computers.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction to unit.
Formal input: classification of polymers.
Demonstration showing different types of polymers and their applications.
Case studies on sustainability, recycling and environmental effects of polymers.
Learner initiated study on types of polymers and their sources.
Assignment 1: Classification of Polymers, their Sources and their Properties (P1, M1, D1)
Formal input on additives.
Demonstration showing different types of additives.
Case studies of the effects of additives.
Calculations on mix densities, material and energy costs.
Assignment 2: Modification of Polymer Properties (P2, M2, D2)
Formal input: Processing methods.
Visit to polymer manufacturer/video of polymer processing.
Demonstration of available processing equipment.
Learner initiated study on processing.
Assignment 3: Processing Methods (P3, M3, D3)
Formal input: National and international standards.

Topic and suggested assignments/activities and/assessment
Demonstration of testing equipment.
Formal input and briefing on following practical procedures.
Data sets on properties of polymers.
Formative work on testing of materials.
Assignment 4: Testing of Materials (P4, P5, M4, D4)
Review of unit and results of unit assessment.

Assessment

Evidence is best produced as a series of reports of learners' investigatory work, and related interpretative exercises. Presentations are also an appropriate method through which learners can generate evidence to meet the assessment and grading criteria. If presentations are selected as an assessment method they must be supported by assessor witness testimony to confirm criteria achieved.

To meet the assessment criteria for a pass grade, learners must be familiar with polymer-related terminology and be able to classify polymers and their starting material sources. They need to include the emphasis on sustainability, recycling and the effects of polymers on the environment. They must provide evidence which describes how polymers are modified by various additives, the processing methods used and the testing of materials to determine the physical properties of polymers.

For the merit criteria, learners need to explain the classification of polymers to general molecular structures; the effect of additives on polymer properties; the operation of the processing equipment and reasons for standardisation of testing procedures. Learners should start by introducing the topics and then give the 'how' or 'why' to fully support their explanations.

For the distinction criteria, learners need to evaluate techniques and processes used in the polymer industry and investigate standard laboratory test results with products in service.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, M1, D1	Classification of Polymers, their Sources and Properties	Training officer has been asked to produce materials for a polymer conference.	Posters, leaflet.
P2, M2, D2	Modification of Polymer Properties	Laboratory technician to produce materials on the effects of additives on polymers.	Table, report.

Criteria covered	Assignment title	Scenario	Assessment method
P3, M3, D3	Processing Methods	Laboratory technician/operative uses processes (or reports on) to produce polymer products.	Laboratory report.
P4, P5, M4, D4	Testing of Materials	Laboratory technician has been asked to carry out and report on the properties of a number of polymers.	Laboratory report.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Applied Science sector suite. This unit has particular links with the following unit titles in the BTEC Applied Science suite:

Level 2	Level 3
Chemistry and Our Earth	Plastics Materials
Applications of Chemical Substances	Plastics Processing
	Polymer Process Engineering
	Scientific Practical Techniques
	Fundamentals of Science
	Industrial Applications of Organic Chemistry
	Industrial Chemical Reactions

Essential resources

Learners need access to appropriate laboratory facilities and specialist resources to cover the contextualisation of the underlying concepts to their polymer specialism eg plastics, rubber or related areas. Site visits to relevant industrial facilities to see practical techniques in operation would be invaluable. Input from industry experts as guest speakers would enhance unit delivery.

Employer engagement and vocational contexts

British Plastics Federation

Cogent – Sector Skills Council

Network for Science, Technology, Engineering and Maths – Network Ambassadors Scheme

The Polymer Society

Indicative reading for learners

Journals

British Rubber and Plastics

Materials Foresite

Materials World

Plastics, Rubber and Composites

Websites

www.bpf.co.uk	British Plastics Federation
www.cia.org.uk	Chemical Industries Association
www.cogent-ssc.com	COGENT – Sector Skills Council
www.en.wikipedia.org/wiki/polymers	Polymers
www.expainthatstuff.com/bioplastics.html	Bioplastics
www.iom3.org	The Institute of Materials, Minerals and Mining
www.iom3.org/content/polymersociety	The Polymer Society
www.practicalchemistry.org	Practical experiments on polymers
www.rsc.org.uk	The Royal Society of Chemistry
www.stemnet.org.uk	Network for Science, Technology, Engineering and Maths – Network Ambassadors Scheme

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are …
Independent enquirers	obtaining data and using results to predict properties
Creative thinkers	exploring possibilities of changing additives
Reflective learners	using case studies
Self-managers	planning and completing experiments
Effective participators	undertaking site visits to manufacturers