Unit 47: Plastics Processing

Unit code: H/602/3459

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit enables learners to gain a knowledge of moulding techniques and the techniques used to manufacture products from laminates. Learners will also gain a knowledge of plastics extruder design and extrusion processes and develop an understanding of how film and sheet materials are manufactured and converted into products.

Unit introduction

This unit builds on the concepts of plastics technology and provides an opportunity to develop knowledge of plastics processing methods. This unit also builds on the polymer processing covered in the Basic Polymer Technology unit. Learners will develop an understanding of plastics processing techniques for thermoplastic and thermoset materials. The unit provides opportunities for learners to develop their understanding through practical investigation.

The unit addresses the process engineering principles used in the polymer industry. Learners will gain knowledge of the systems used in typical polymer processing plants such as injection moulding machines, extruders, presses and mills. It is important that operatives and technical staff have an understanding of the concepts and principles in plastics processing enabling them to suggest ways to improve efficiency. For example, finding ways of reducing the use of resources such as water and heating, and the effect of waste on the environment.

Learning outcomes

On completion of this unit a learner should:

1 Know the moulding techniques used for manufacture of plastic products

2 Understand the features of plastics extruder design and extrusion processes

3 Understand the manufacture of film and sheet materials and conversion to products

4 Know the techniques used in the manufacture of products from phenolic, epoxy and polyester laminates.

Unit content

1 Know the moulding techniques used for manufacture of plastic products

Compression moulding: press design; upstroke and downstroke; positive and semi-positive mould design; preparation of moulding materials and performs

Transfer moulding: pot transfer moulds; transfer presses

Injection moulding: machine design (screw and barrel design, nozzles, clamping systems); mould design (runners, gates, ejection systems, cooling systems, single and multi-daylight, hot runner systems, injection moulding variables)

Moulding defects: eg blistering, shrinkage, colour streaks, surface marks, voids, burn marks

Remedies: eg check material dryness, moisture content, shrinkage calculations, temperature profile, mould rigidity

2 Understand the features of plastics extruder design and extrusion processes

Extruder design: screw nomenclature; barrel and feed hopper; breaker plate; die and die swell

Extrusion processes: pipe, wire and film; ancillary equipment; polymers used

3 Understand the manufacture of film and sheet materials and conversion to products

Manufacture of film and sheet material: tubular blown film; cast film; extruded; calendered sheet

Conversion of sheet material to products: thermoforming eg male and female forming, drape, plug assisted, air-slip; fabrication eg welding, bag-making, machining, mechanical fasteners

4 Know the techniques used in the manufacture of products from phenolic, epoxy and polyester laminates

Polymers and fibres: phenolics, epoxies and polyesters; paper; cotton fibre; glass fibre; carbon fibre

Lamination techniques: hand lay-up; spray lay-up; DMC; SMC; pultrusion; filament winding

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 the moulding techniques used for manufacture of plastic products [RL6, EP1]	**M1** explain the factors effecting the choice of mould design and moulding process	**D1** evaluate moulding processes, including hot runner systems
P2 describe moulding defects and remedies [RL6, EP4]		
P3 explain the features of plastics extruders and extrusion processes [RL6]	**M2** explain die design for extrusion processes, including factors effecting die swell	**D2** analyse the production costs of extrusion processes including details of ancillary equipment associated with each process
P4 explain the manufacture of film and sheet materials	**M3** explain the merits and limitations of the sheet manufacturing processes	**D3** evaluate the most appropriate process for the production of different types of sheet material and products
P5 explain the conversion of film and sheet materials to products		
P6 describe the techniques used in the manufacture of products from phenolic, epoxy and polyester laminates [RL6, EP1]	**M4** explain the merits and limitations of product manufacturing processes	**D4** justify the most appropriate laminate processes for different products

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

Essential guidance for tutors

Delivery

The concepts covered by this unit should be delivered through a programme of tuition and practical work in the laboratory. Delivery should be based on a well-structured programme of practical exercises to develop learners' skills and the evidence necessary to meet the unit assessment and grading criteria. Learners should build on the concepts delivered in *Unit 45: Basic Polymer Technology* and *Unit 46: Plastics Materials*. Delivery should also cover the processing of recycled plastics.

If it is appropriate to use facilities other than those in the centre (eg, facilities on employers' or university premises) arrangements to use these facilities should ensure that the necessary formative activities can be undertaken; one-off use of equipment will not meet the outcomes of this unit.

Health and safety should be a recurring theme throughout the delivery and assessment of this unit. Learners must be taught the nature of hazards and where to find appropriate information on them. Learners are not 'competent persons' under the COSHH regulations; they should not, therefore, be expected to carry out full risk analyses for practical work to be undertaken.

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: Moulding Techniques.
Demonstration and learner investigation of different types of moulds.
Case studies on types of moulds.
Visit to plastics manufacturer.
Formative assignment.
Assignment 1: Moulding Techniques (P1, M1, D1)
Formal input: defect and remedies.
Demonstration of types of defects.
Learners investigate defect remedies.
Assignment 2: Defects and Remedies (P2)
Formal input: plastic extruder design.
Demonstration on extruder designs.
Formal input: extrusion processes.
Learners investigate extruder designs and extrusion processes.
Formative assignment.
Assignment 3: Extruder Design and Extrusion Process (P3, M2, D2)
Formal input: Extruder design and extrusion process.
Demonstration of typical film and sheet products.
Visit to processing plant for film and sheet manufacture.

Topic and suggested assignments/activities and/assessment
Formative assignment on film and sheet manufacture case study.
Assignment 4: Film and Sheet Products (P4, P5, M3, D3)
Formal input: phenolic, epoxy and polyester laminates.
Learners produce table of phenolic, epoxy and polyester laminates.
Formal input: lamination techniques.
Learners investigate fibres.
Formative assignment on techniques in laminate manufacture.
Assignment 5: Manufacture of Laminates (P6, M4, D4)
Review of unit and results of assessment.

Assessment

The focus of assessment should be on learners carrying out the required tasks, as well as producing reports as evidence towards meeting the assessment and grading criteria. Throughout this unit, learners need to be aware of issues such as sustainability and the effects of waste products on the environment. Learner presentations, supported by tutor witness testimony, would also form a suitable assessment method. Tutors should observe learners undertaking practical activities and clearly record assessment decisions using an appropriate assessor's observation record, retained for audit purposes.

Safety requirements must be applied to all activities. Learners must work safely and accurately within supplied methods; this must be applied rigorously to all activities.

The pass assessment criteria require practical methods to be followed safely and correctly. Learners should investigate moulding techniques, features of plastic extruders and extrusion techniques as well as the manufacture of film sheets and products from phenolic, epoxy and polyester laminates to meet these criteria. The delivery of the unit should be based on the development of skills in methods relevant to industry.

For the merit criteria, learners need to investigate factors influencing mould design and various manufacturing processes as well as factors affecting die design and swell. This requires delivery of the underlying principles, which may be introduced before or during the practical work, but should be emphasised throughout the formative programme preceding assessed exercises.

For the distinction criteria, learners need to adopt a more evaluative approach to plastics processing, including moulding, extrusion, lamination. It may be appropriate to analyse one activity in detail as a group exercise. Thereafter, these activities may be left to learner independent study, with appropriate guidance from tutors. If group work is undertaken, tutors must ensure that each learner individually produces sufficient evidence to meet the assessment and grading criteria and that assessment decisions are clearly recorded using an appropriate observation sheet.

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	Moulding Techniques	Processing engineer has been asked to produce a report on the moulding techniques being used on the processing plant.	Report. Diagrams.
P2	Defects and Remedies	The quality control process engineer has asked for an investigation into moulding defects and remedies.	Report. Diagrams.
P3, M2, D2	Extruder Design and Extrusion Process	The process engineer has asked for a report on the make of the extruder and the extrusion process.	Report. Diagrams.
P4, P5, M3, D3	Film and Sheet Products	The research polymer scientist has been asked to provide information about how different types of film and sheet materials are manufactured and how they are converted to products.	Research report. Presentation Observation record.
P6, M4, D4	Manufacture of Laminates	As the technical editor of the main polymer magazine you are writing an article on the techniques to manufacture laminates.	Article.

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
Applications of Physical Science	Plastics Materials
Energy and Our Universe	Polymer Process Engineering
Designing and Making Useful Devices in Science	Basic Polymer Technology
Electronics in Action	Scientific Practical Techniques
	Fundamentals of Science
	Energy Changes Sources and Applications
	Electronics for Science Technicians

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.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 ...
Reflective learners	using case studies
Effective participators	undertaking visits to manufacturers