



# **PIABC LEVEL 3 DIPLOMA IN POLYMER PROCESSING**

Qualification Number: 603/2403/X

## **Qualification Specification**

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## EXECUTIVE SUMMARY

This regulated qualification PIABC Level 3 Diploma in Polymer Processing (QN: 603/2403/X) has been designed for learners working in the polymer processing and related sectors. It covers knowledge of thermoplastic processing; technologies, methods and processes; polymer materials and their processing behaviour; engineering principles; health and safety; the environment; and quality and process management.

Learners then may choose one of five pathways which focus on specific processes within polymer processing (e.g. thermoplastic extrusion, injection moulding, preform blow moulding, parison blow moulding and thermoplastic materials processing).

To achieve the qualification, learners need to successfully gain the 84 credits.

Programmes leading to the qualification can be organised and delivered by providers who have gained centre and qualification approval from PIABC. To achieve this they need to complete the PIABC centre and qualification approval procedures available from PIABC's website ([www.piabc.org.uk](http://www.piabc.org.uk)). In completing the documentation and the approval visit, centres need to demonstrate their ability to deliver high quality education leading to the qualification. The actual style of delivery is up to the centre but could include taught sessions, tutor support, distance learning, work books, mentor support or any other method that the centre considers appropriate. In choosing their delivery method centres are expected to employ robust quality assurance processes. PIABC will appoint its own External Quality Assurers to ensure the effective operation of these processes and the maintenance of standards of quality.

There is no necessity for any formal entry requirement to this course beyond the basic literacy and numeracy expected from anyone entering the business world. But it is intended that this qualification is for those learners who will have worked in a polymer processing environment for approximately 3 to 9 months prior to starting.

Overall, it is expected that courses leading to the qualification will take a minimum of 418 guided learning hours. Learners will also be expected to carry out additional reading and other work to complete each unit and prepare for assessment, up to a total qualification time of approximately 859 hours.

The PIABC Level 3 Diploma in Polymer Processing (QN: 603/2403/X) can be used to provide the theoretical knowledge as required by the Apprenticeship Standard – Science Manufacturing Technician. The qualification does not contribute to the grading of the apprenticeship award.

## AIM

This national qualification is primarily knowledge based and aims to provide industry specific knowledge appropriate for the day to day activities in a polymer processing environment, developing a sound understanding of the different types of processes and how they are processed and their uses. Those achieving the qualification will be able to apply this knowledge to identify a range of product, material and processing issues and communicate technically with others.

PIABC Level 3 Diploma in Polymer Processing (QN: 603/2403/X) is intended for those learners who will have worked in a polymer processing environment for approximately 3 to 9 months prior to starting.

It can also provide a very useful complementary qualification for apprenticeship programmes, or the preparation to progress to higher levels of study.

## OUTCOMES

1. Provide and enhance the skills competency, knowledge and job satisfaction of learners - providing them with a means of progression to higher level job roles and qualifications.
2. Provide employers with an open and transparent basis for judging the suitability of learners for employment and promotion.
3. Facilitate job movement throughout the polymer processing industry and related sectors.

Specific outcomes for the qualification are listed under the individual unit description.

## TARGET GROUP

This Level 3 qualification is appropriate for those wanting to enhance their employment and progression opportunities in the polymer processing industry and related sectors:

There are two broad target groups:

1. People within the polymer processing industry who want to extend their knowledge and skills to gain a recognised qualification.
2. People within the polymer processing industry who want to operate more professionally and effectively.

Due to the diverse nature of the polymer processing industry, it is difficult to define the target groups in terms of precise job functions. Typically, learners are likely to be in positions where they are responsible for functions such as setting up and troubleshooting a new product or process

<b>Job role</b>	<b>Type of company</b>
Process/Condition Setter	Polymer Processing
Production Technician	Polymer Processing
Process Team Leader	Polymer Processing
Product Development Technician	Polymer Processing
Production/Technical Manager	Polymer Processing
Polymer Engineer	Polymer Processing
Process Trouble-shooter	Polymer Processing

## **ENTRY REQUIREMENTS**

There are no entry qualifications or age limits required for this qualification. But the PIABC Level 3 Diploma in Polymer Processing (QN: 603/2403/X) is intended for those learners who will have worked in a polymer processing environment for approximately 3 to 9 months prior to starting.

Assessment for this qualification is open to any learner who has the potential to reach the standards laid down for level 3 qualifications. As a guide those with the following are likely to indicate the potential to succeed: Level 2 qualifications, a minimum of 5 GCSEs at Grade D-G (or equivalent), or experience that indicates ability to succeed. An initial assessment of past experience and current skills, knowledge and understanding should be carried out prior to commencement, to determine suitability for this qualification.

Aids or appliances, which are designed to alleviate disability, may be used during assessment, providing they do not compromise the standard required.

## **PROGRESSION**

The PIABC Level 3 Diploma in Polymer Processing (QN: 603/2403/X) can be used to provide the theoretical knowledge as required by the Apprenticeship Standard – Science Manufacturing Technician. The qualification does not contribute to the grading of the apprenticeship award.

Success in this qualification prepares learners for progression within the polymer processing industry to a position where they can assume some level of responsibility.

## QUALIFICATION STRUCTURE

Six mandatory units, plus 2 optional units from 1 of the 5 pathways is required: 58 credits from the mandatory group and 26 credits from 1 of the 5 optional pathways.

PIABC Unit Ref.	Ofqual Unit Ref.	Unit Title	Level	GLH* (e.g. direct tutor contact)	Total Unit Time (hrs)	Credit
<b>MANDATORY UNITS (58 Credits Required)</b>						
PM1	T/616/4116	Polymer Processing - Health and Safety and the Environment	2	36	63	6
PM2	A/616/4117	Polymer Processing - Engineering Principles	3	61	119	12
PM3	F/616/4118	Principles of Polymer Materials and their Processing Behaviour	3	56	120	12
PM4	J/616/4119	Polymer Processing - Technologies, Methods and Processes	3	54	114	11
PM5	A/616/4120	Principles of Quality and Process Management used in Polymer Processing	3	36	83	8
PM6	F/616/4121	Personnel Employment, Communications and People Skills	2	46	94	9
<b>OPTIONAL UNITS (26 Credits Required)</b>						
<b>Pathway 1 – Thermoplastic Extrusion</b>						
PA1	J/616/4122	Principles of Thermoplastic Extrusion	3	72	134	13
PA2	L/616/4123	Processing Thermoplastics by Extrusion	3	57	132	13
<b>Pathway 2 – Injection Moulding</b>						
PB1	R/616/4124	Principles of Thermoplastic Injection Moulding	3	72	134	13
PB2	Y/616/4125	Processing Thermoplastics by Injection Moulding	3	57	132	13
<b>Pathway 3 – Preform Blow Moulding</b>						
PC1	D/616/4126	Principles of Thermoplastic Preform Blow Moulding	3	72	134	13
PC2	H/616/4127	Processing Thermoplastics by Preform Blow Moulding	3	57	132	13
<b>Pathway 4 – Parison Blow Moulding</b>						
PD1	K/616/4128	Principles of Thermoplastic Parison Blow Moulding	3	72	134	13
PD2	M/616/4129	Processing Thermoplastics by Parison Blow Moulding	3	57	132	13
<b>Pathway 5 – Thermoplastic Materials Processing</b>						
PE1	H/616/4130	Principles of Thermoplastic Materials Processing	3	72	134	13
PE2	K/616/4131	Processing of Thermoplastics by a Production Technique	3	57	132	13
<b>Qualification Level</b>			<b>3</b>			
<b>Total Guided Learning Hours</b>				<b>418</b>		
<b>Total Qualification Time</b>					<b>859</b>	
<b>Total Credit</b>						<b>84</b>

GLH\* = Guided Learning Hours

## QUALIFICATION LEVEL

This is a Level 3 qualification.

Learners may have direct responsibility for others, or may have responsibilities within a team.

The assessments for this qualification are based on the learning outcomes and assessment criteria set in a way that demonstrates that the learner can show that they have the knowledge and skills associated with a level 3 qualification.

It will prepare the learner to operate as a competent team member and will greatly assist them in their career development.

When work for this qualification is assessed, it is important to realise that evidence will be sought which demonstrates these features below.

### LEVEL 3 DESCRIPTOR

#### Summary

The descriptors set out the generic knowledge and skills associated with the typical holder of a qualification at Level 3. The level descriptors are framed as outcomes and each category starts with a stem statement (“the holder can...”) which then links into the outcomes associated with each level of the framework.

#### Knowledge descriptor (the holder...)

- Has factual, procedural and theoretical knowledge and understanding of a subject or field of work to complete tasks and address problems that while well-defined, may be complex and non-routine.
- Can interpret and evaluate relevant information and ideas.
- Is aware of the nature of the area of study or work.
- Is aware of different perspectives or approaches within the area of study or work.

#### Skills descriptor (the holder...)

- Identify, select and use appropriate cognitive and practical skills, methods and procedures to address problems that while well-defined, may be complex and non-routine.
- Use appropriate investigation to inform actions.
- Review how effective methods and actions have been.

*Source: Qualification and Component Levels - Requirements and Guidance for All Awarding Organisations and All Qualifications. Version: Ofqual/15/5774. Ofqual 2015.*

## PROGRAMME ORGANISATION

Programmes leading to the PIABC Level 3 Diploma in Polymer Processing can be organised and delivered by providers who have gained centre and qualification approval from PIABC. To achieve this they need to complete the PIABC centre and qualification approval procedures available from [www.piabc.org.uk](http://www.piabc.org.uk). In completing the documentation and the approval visit, centres need to demonstrate their ability to deliver high quality education leading to the qualification. Centres are expected to employ robust quality assurance processes. PIABC will appoint its own External Quality Assurers to ensure the effective operation of these processes and the maintenance of standards of quality.

It is anticipated that the qualification will require a total qualification time of 859 hours. This includes 355 self study hours and 418 taught hours for satisfactory completion.

The organisation of the qualification is at the discretion of the centre and will take into account the aims, aspirations and experience of the learners.

Centres are encouraged to choose the most suitable curriculum model for their learners. Whilst the sequential delivery of parts of the unit is a possibility and may provide the most straightforward way of determining completion, it may be that some degree of integration of elements will occur, or that other methods of delivery are more appropriate to meet the needs of learners. It should be noted however that the whole unit and all the learning outcomes will be assessed.

Centres must ensure that adequate arrangements are in place for supporting learners. This could be either through separate tutorial sessions or through the use of time within structured study sessions. Centres using on-line or other forms of open learning must ensure that appropriate tutorial support is provided for learners.

The employer's engagement in learning and assessment opportunities will be paramount in securing timely achievement and a participative role should be encouraged.

In relevant circumstances, centres are recommended to provide information and guidance to their learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training in polymer process industry and associate sectors.

## GUIDANCE ON LEARNING AND TEACHING STRATEGY, METHODS AND ASSESSMENT

Polymer processing is a practical subject, based on theoretical principles. As far as possible, it is important that the course is taught by relating the underlying theory to practical examples and applications. Two factors which will help in this regard are:

1. The use of staff with direct experience in the polymer processing industry. This must, of course, be balanced against a sound understanding of the theoretical principles, as anecdotal experience alone is unlikely to meet the requirements of the course.

2. Practical and commercial examples that underpin a more theoretical understanding should be used to show the link between theory and practice. DVD illustrations of processes could also be used as part of the teaching regime. A further and invaluable source of information is the Internet and there are many web sites which demonstrate important aspects of timber processing and use. Learners should be encouraged to research this material.
3. Practical experience of workplace operations dealing with polymer processing and the individual learner's chosen pathway. It is essential that Learners are able to, and can demonstrate their skills and knowledge in their own work environment with its production pressures

Learners employed in the polymer processing industry will come to the qualification with varying levels of existing knowledge and/or practical experience of some parts of the Learning Outcomes. Training needs should be identified and gaps in knowledge and competency should be filled with a planned delivery of an individual learning plan. This should be utilised in preparing for teaching and assessment. The sharing of knowledge which has the potential to lead to a high level of understanding should be encouraged by the use of staff with direct experience in the polymer process industry - particularly in the individual learner's chosen pathway. This must, of course, be balanced against a sound understanding of the theoretical understanding.

Where the skills assessment is to be carried out in a "production environment" this environment must not be simulated. The assessment should take account of production pressure within a natural work place.

The relationship between theory and practice is a theme that should be reflected in the assessments for the programme. Therefore in structured learning and individual work, learners should be aware of the requirement to develop a theoretical understanding to their practical work and a practical application to their theoretical understanding.

Those developing learning programmes should expect to achieve all the learning outcomes. It may be useful to have workbooks for use either at home or in the workplace.

## QUALIFICATION DESCRIPTION

This qualification follows the PIABC principles for designing units and qualifications and contains the features listed as follows:

- Unit reference number, title, guided learning hours, grading structure and assessment guidance.
- Each unit consist of:
  - Learning Outcomes that show what the learners will be able to understand, know or demonstrate.
  - Assessment Criteria that show what the learners can do or produce in order to show that they have met the learning outcome.
- To successfully complete, learners must meet all the learning outcomes and gain an overall pass for each unit.

# UNIT CONTENT

## MANDATORY UNITS

### POLYMER PROCESSING - HEALTH AND SAFETY AND THE ENVIRONMENT

PIABC Unit No: PM1

Unit Reference No: T/616/4116

Unit Level: 2

Guided Learning Hours: 36

Total Unit Time (Hours): 63

Unit Credits: 6

#### Overview

This knowledge based unit introduces the learner to the importance of health, safety and environmental issues within a polymer processing sector.

It covers the importance of statutory environmental regulations and individual organisational requirements including energy efficiency, sustainability, and record keeping.

It also covers the importance of statutory health and safety regulations and individual organisational requirements including the principles that underpin good safety, the management and the control of safety systems, employers and employees responsibilities, sources of health and safety literature, etc.

The unit covers the importance of safe working practices and procedures including the importance of; safe systems of work, standard operating procedures and permits to work, hazards associated with the polymer processing sector, risk assessment with regard to potential health and safety hazards, the use of personal protective equipment, operation of lifting equipment, the use of safe manual handling and common safety signage used in a polymer processing environment.

Accident and emergency procedures are considered together with the description of dangerous occurrence and hazardous malfunction including electric shock, asphyxiation, fire prevention, provision of first aid and how to use different types of emergency response equipment and procedures within polymer processing.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Understand compliance with statutory environmental regulations and organisational requirements	1.1	Identify the hazards to the environment that can arise from polymer processing operations and how to recognise them
		1.2	Describe the Environmental Management Systems Standard ISO 14001 and how it relates to the polymer processing industry
		1.3	Describe the implementation of environmental legislation as it applies to the polymer processing industry
		1.4	Explain the benefits of processing polymers in an energy effective way, including the use of reused polymers
		1.5	Identify environmental signage and notices and explain their purpose
		1.6	State the primary principles of sustainability
		1.7	Summarise the environmental monitoring records that may be required within the polymer processing industry
2.	Understand compliance with statutory health and safety regulations and organisational requirements	2.1	Describe the health and safety regulations applicable to polymer processing operations
		2.2	Describe the principles that underpin good safety and health performance
		2.3	Explain employers' responsibilities to maintain health and safety
		2.4	Describe employee and bystander health and safety requirements
		2.5	Explain how the management of health and safety regulations are implemented
		2.6	Explain the procedures and legal requirements for reporting accidents
		2.7	Explain the sources of health and safety literature/advice and how to access it, including polymer processing codes of practice and safety guidance

		2.8	List the benefits and characteristics of an effective health and safety management system
		2.9	Describe why health and safety performance should be monitored
3.	Understand safe working practices and procedures in a polymer production environment	3.1	Explain the significance of safe systems of work, standard operating procedures and permits to work
		3.2	Identify the hazards associated with the polymer processing sector and the risks they pose
		3.3	Describe how to carry out a risk assessment with regard to potential health and safety hazards in a polymer production environment
		3.4	Identify the personal protective equipment that is appropriate to different tasks when polymer processing, and how to use and maintain it
		3.5	State the requirements of the Lifting Operations and Lifting Equipment Regulations (LOLER)
		3.6	Explain the purpose and methods of use of lifting gear accessories
		3.7	Explain the principles of safe manual handling and describe the Manual Handling Operations Regulations
		3.8	Explain the different classes and types of safety signage used in a polymer processing environment and explain their purpose
4.	Understand how to implement accident and emergency procedures	4.1	State what is meant by a dangerous occurrence and hazardous malfunction, give examples from the polymer processing sector
		4.2	Explain the need for the provision of first aid treatment
		4.3	Explain precautions to be taken to avoid electric shock
		4.4	Explain the appropriate emergency action to be taken in cases of electric shock
		4.5	Explain the causes of asphyxiation and the appropriate emergency action to be taken

		4.6	Describe methods of fire prevention
		4.7	Identify when and how to use different types of emergency response equipment within polymer processing
		4.8	Explain what the effects of emergency shutdown are on staff and the company
		4.9	Explain why incidents should be investigated and what should be covered

### **Assessment and Grading**

This unit is assessed by completing assignments which are set, internally assessed and internally quality assured by the centre.

The assignments should be designed for a holistic approach to the assessment and confirm learners have a full contextualised understanding of all the assessment criteria.

Assignments must also incorporate the health, safety and environmental systems and procedures used within the learner's production environment.

Centre assignments and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to pass all the assessment criteria.

## **POLYMER PROCESSING - ENGINEERING PRINCIPLES**

PIABC Unit No: PM2

Unit Reference No: A/616/4117

Unit Level: 3

Guided Learning Hours: 61

Total Unit Time (Hours): 119

Unit Credits: 12

### **Overview**

This knowledge based unit introduces the learner to engineering concepts utilised in polymer processing operations. It includes the principles of document control, interpretation of engineering information, including drawings, dimension and labelling, databases, spreadsheet, CAD systems and the application of engineering polymer processing calculations.

The unit focuses on the requirements of the mechanical equipment design, concepts and operational support services used in polymer processing including mechanical joining and connection techniques, clamping, locking and holding methods, seals and gaskets, process cooling and heating systems together with power transmission systems.

It covers the principles and function of pneumatics, hydraulics, electronics and electrical systems together with the operation of components, interpretation of circuits and drawings, the use of pipe work, seals and connections found in the polymer processing sector; it also emphasises the potential hazards and precautions required.

Maintenance practices, faulty finding techniques and process trouble shooting approaches are covered, ensuring the learner can define faults, symptoms, breakdowns and potential causes, thereby use fault finding techniques and process trouble shooting approaches with polymer processing techniques.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Know how to interpret polymer engineering information and related processing calculations	1.1	Describe notation used on various standard engineering drawings and piping layouts associated with polymer processing equipment
		1.2	Interpret drawings, dimensioning and labelling
		1.3	Describe the use of CAD systems to produce engineering drawings
		1.4	Explain the use of databases and spreadsheets to display and analyse information
		1.5	Explain the basic principles of document control
		1.6	Describe how to extract information from drawings
		1.7	Summarise the use and application of engineering polymer processing calculations
2.	Understand the requirements and operation of support services and mechanical equipment used in polymer processing	2.1	Summarise the types of services required to operate a polymer processing plant
		2.2	Summarise the design and application of polymer process cooling and heating systems and their capabilities
		2.3	Describe a polymer processing equipment/line sectional design concepts and highlight their advantages
		2.4	Describe the use and application of mechanical components used in polymer processing equipment
		2.5	Describe the operation and use of mechanical power transmission systems used when processing polymers
		2.6	Explain the application and safe operation of lifting equipment

		2.7	Describe the operation of service and maintenance workshop equipment used within the polymer processing environment
3.	Understand the need and operation of different mechanical joining and connection techniques used with polymer processing equipment	3.1	Describe the range of clamping, locking and holding methods used within polymer processing equipment, list their advantages and limitations for one type of polymer process
		3.2	Describe permanent joining techniques used with polymer processing equipment and list their advantages and limitations
		3.3	Summarise the range of seals and gaskets used with polymer processing equipment
		3.4	Summarise the range of mechanical fastening devices used within polymer processing equipment and give examples of their applications
4.	Understand the function of pneumatic and hydraulic systems and components used in polymer processing	4.1	Summarise hydraulics and pneumatics principles
		4.2	Describe the potential hazards and associated precautions connected with the use of hydraulic and pneumatic systems
		4.3	Describe the operation of hydraulic and pneumatic components used in polymer processing equipment for a particular process
		4.4	Describe the design and how to interpret hydraulic and pneumatic circuits used with polymer processing
		4.5	Summarise the types of pneumatic and hydraulic pipe work, seals and connections used with polymer processing equipment
5.	Understand the function of electrical and electronic systems and components used in polymer processing	5.1	Describe the potential hazards and associated precautions connected with the use of electrical systems
		5.2	Summarise electrical and electromagnetic principles
		5.3	Describe the operation of electrical and electronic components used in polymer processing equipment
		5.4	Describe how to interpret simple electrical and electronic drawings used with polymer processing
		5.5	Summarise the different non-permanent electrical components connections used with polymer processing equipment

6.0	Understand polymer processing equipment maintenance practices, faulty finding techniques and process trouble shooting approaches	6.1	Describe potential hazards and risks relating to the maintenance and servicing of polymer processing equipment
		6.2	Summarise the maintenance and service procedures carried out on a typical polymer process
		6.3	Explain the advantages and limitations of both scheduled and breakdown maintenance planning for specific types of polymer processing equipment
		6.4	Describe potential hazards and risks associated with equipment fault finding techniques and process trouble shooting
		6.5	Summarise how to collect information on faults, symptoms and potential causes
		6.6	Define faults, symptoms, breakdowns and potential causes
		6.7	Describe different equipment fault finding techniques used with polymer processing, explain their advantages and limitations
		6.8	Describe different process trouble shooting approaches used with polymer processing, explain their advantages and limitations

### Assessment and Grading

This unit is assessed by completing assignments which are set, internally assessed and internally quality assured by the centre.

The assignments should be designed for a holistic approach to the assessment and confirm learners have a full contextualised understanding of all the assessment criteria.

Assignments must also incorporate the engineering procedures and equipment used within the learner's production environment.

Centre assignments and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to pass all the assessment criteria.

## PRINCIPLES OF POLYMER MATERIALS AND THEIR PROCESSING BEHAVIOUR

PIABC Unit No: PM3

Unit Reference No: F/616/4118

Unit Level: 3

Guided Learning Hours: 56

Total Unit Time (Hours): 120

Unit Credits: 12

### **Overview**

This knowledge based unit introduces the learner to the wide range of polymer processing materials, including thermosetting polymers, thermoplastics and composites.

It includes how polymers are polymerised, common terminology used and trade names, as well as families or groups of polymers.

The unit introduces polymer chemistry at a basic level, to illustrate how and why certain plastics behave in the ways they do.

It also includes how additives are used, how the different families of thermoplastic polymer materials flow and behave during processing, their properties and applications and includes reused polymers.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Understand the classifications of polymer materials and the associated expressions and terms used	1.1	Classify and describe polymers, elastomers, plastics and composites type materials
		1.2	Summarise the polymerisation process for polymer materials
		1.3	Explain simple chemical terms used with polymer materials
		1.4	Explain the production and application of biodegradable plastics
		1.5	Explain how regrind and reprocessed polymers are used, and their applications
		1.6	Identify commodity and engineering type plastics, their abbreviation and common trade names
2.	Understand the properties and application of different classes of polymers to include commodity and high performance thermoplastic materials	2.1	Summarise the properties, processing and application of composites
		2.2	Summarise the properties, processing and application of thermosets
		2.3	Describe the main differences between the types or families of thermoplastic materials
		2.4	Evaluate the physical properties of a range of thermoplastic materials
		2.5	Describe the processing behaviour and properties of thermoplastic materials
		2.6	Summarise the key applications of the different families of thermoplastic materials
		2.7	Describe the benefits of co-polymer, alloys and blends to enhance product properties, list common applications

3.	Understand the processing behaviour of polymeric materials	3.1 3.2 3.3 3.4 3.5 3.6	<p>3.1 Explain how material processing information and data sheets can be used to set processing parameters and predict product properties</p> <p>3.2 Summarise the key physical and chemical terms used to describe material properties e.g. tensile, yield, etc.</p> <p>3.3 Summarise Newtonian and Non-Newtonian flow behaviours of plastics materials</p> <p>3.4 Summarise the thermal and flow behaviour of thermoplastic materials during processing</p> <p>3.5 Describe hydroscopic thermoplastic materials, how they flow and their final properties</p> <p>3.6 Describe the terms and concepts of viscosity, shear stress, shear rate, specific heat, and thermal stability</p>
4.	Understand how the physical structure and the layout of molecules influences thermoplastic product properties	4.1 4.2 4.3 4.4 4.5	<p>4.1 Describe the polymer terms and concepts of, degree of crystallinity, glass transition and melting points</p> <p>4.2 Summarise the factors that determine glass transition temperature (T<sub>g</sub>) in polymers</p> <p>4.3 Explain how polymer material properties can be affected by the degree of crystallinity</p> <p>4.4 Summarise how different polymer materials crystallise during processing</p> <p>4.5 Explain the factors that determine the amount of crystallinity in a product</p>
5.	Understand why different types of additives are used with thermoplastic materials	5.1 5.2 5.3 5.4	<p>5.1 Evaluate the benefits and limitations of the different types of additives which enhance product performance</p> <p>5.2 Evaluate the benefits and limitations of the different types of additives which enhance processing performance</p> <p>5.3 Summarise the methods and processes of incorporating additives to polymer materials</p> <p>5.4 Evaluate cost comparisons of common additives</p>

		5.5	Describe any secondary consequences of using additives with thermoplastic materials
		5.6	Evaluate the different types and formats of colorants used with thermoplastics
6.0	Understand how re-used polymers can affect the processing conditions and final product properties	6.1	Explain the key differences between regrind, re-pelletised and re-processed materials
		6.2	Summarise the issues of using different types of re-used polymer, including its source and mixing ratios
		6.3	Describe the points to consider when processing regrind, re-pelletised and re-processed polymer materials
		6.4	Explain the product properties that can be influenced when regrind, re-pelletised and re-processed polymers are used

### **Assessment and Grading**

This unit is assessed by completing assignments which are set, internally assessed and internally quality assured by the centre.

The assignments should be designed for a holistic approach to the assessment and confirm learners have a full contextualised understanding of all the assessment criteria.

Assignments must incorporate the materials used and preparation procedures within the learner's production environment.

Centre assignments and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to pass all the assessment criteria.

## **POLYMER PROCESSING - TECHNOLOGIES, METHODS AND PROCESSES**

PIABC Unit No: PM4

Unit Reference No: J/616/4119

Unit Level: 3

Guided Learning Hours: 54

Total Unit Time (Hours): 114

Unit Credits: 11

### **Overview**

This knowledge based unit introduces the learner to the processing behaviours of a range of thermosetting and thermoplastic materials when undergoing different manufacturing process techniques, it also looks at the thermoplastic material processing tests and how processing characteristics affect both the processing capability and product properties.

It evaluates different methods of shaping and processing polymer composites, thermosets and thermoplastics, it reviews batch and continuous polymer process techniques, the prime equipment, support equipment and forming equipment. It also evaluates the set up and running resources and costs required for different types of polymer process techniques.

The unit investigates the need and techniques for a range of polymer materials to be prepared prior to processing including pre-heating, adding colourants and additives for a range of processes.

It also looks at the range of post processing techniques, including thermoset and thermoplastic products e.g. cooling operations, post curing, printing/decorating techniques, product moving and handling techniques, finishing techniques; all used for both “batch” and “continuous” type production.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Understand polymer material processing behaviour and the related testing methods used	1.1	Summarise the main behaviour of thermoset materials when they are subjected to the different manufacturing processes
		1.2	Summarise the behaviour of thermoplastic materials when they are subjected to the different manufacturing processes
		1.3	Describe how the viscosity and processing characteristics affect both the processing and product properties
		1.4	Describe the main viscosity, flow and thermal test procedures carried out on thermoplastic materials
		1.5	Summarise the international, national and company material processing testing standards used with thermoplastic materials
2.	Understand the engineering and thermal requirements for processing polymers	2.1	Describe the different methods of shaping and processing polymer composites
		2.2	Describe batch polymer process techniques, including the main process and ancillary equipment, the processing and forming cycles, explain the advantages and limitations of these batch processing techniques
		2.3	Describe continuous polymer process techniques, their forming and downstream processing requirements, explain the advantages and limitations of these continuous processing techniques
		2.4	Summarise the set up and running resources and costs required for typical types of polymer processing, including equipment, formers, ancillary/support equipment and services
		2.5	Summarise the heat and pressure needs for processing thermoplastic and thermosetting materials using different processing techniques
		2.6	Describe the crosslinking performance of thermosetting materials and the processing sequences required, include thermosets and polymer composites

3.	Understand the polymer shaping processes and the types of forming and shaping tools used	3.1	Summarise the different types of thermoplastic continuous formers or dies and analyse the advantages and limitations of manufacturing, operating and maintaining them
		3.2	Evaluate the design advantages and limitations of different types of thermoplastic continuous formers or dies
		3.3	Summarise the different types of thermoplastic forming tools and analyse the advantages and limitations of manufacturing, operating and maintaining them
		3.4	Evaluate the design advantages and limitations of different types of thermoplastic forming tools
4.	Understand the need for polymer material preparation requirements prior to processing	4.1	Summarise the pre-processing needs for the range of polymer materials
		4.2	Describe how additives are mixed with thermoplastic materials, summarise the additives, techniques and equipment used
		4.3	Describe how colourants are added to thermoplastic materials, summarise the techniques and equipment used
		4.4	Describe how different thermoplastic materials are pre-heated, explain benefits and restrictions of the pre-heating techniques
		4.5	Describe how and why thermosetting materials maybe pre-heated prior to processing
5.	Understand the benefits of different polymer production post processing techniques	5.1	Summarise the post processing techniques used in thermoplastic production
		5.2	Summarise the post processing techniques used in thermosetting production
		5.3	Explain different post processing thermoplastic cooling operations, describe their advantages and limitations
		5.4	Describe the different printing/decorating techniques associated with different processes
		5.5	Summarise post processing moving and handling techniques for different thermoplastic processes, including the advantages and limitations of automated systems
		5.6	Summarise common thermoplastic finishing techniques used for both “batch” and “continuous” type production operations

**Assessment and Grading**

This unit is assessed by completing assignments which are set, internally assessed and internally quality assured by the centre.

The assignments should be designed for a holistic approach to the assessment and confirm learners have a full contextualised understanding of all the assessment criteria.

Assignments must incorporate the materials used and preparation procedures within the learner's production environment.

Centre assignments and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to pass all the assessment criteria.

## PRINCIPLES OF QUALITY AND PROCESS MANAGEMENT USED IN POLYMER PROCESSING

PIABC Unit No: PM5

Unit Reference No: A/616/4120

Unit Level: 3

Guided Learning Hours: 36

Total Unit Time (Hours): 83

Unit Credits: 8

### Overview

This knowledge based unit introduces the learner to the concepts of quality management principles including quality assurance, inspection and quality control, fitness for purpose, standard operating procedures, the need for validating and calibrating test and measuring equipment, sampling, auditable records and the roles and responsibilities within a polymer processing quality regime.

It informs the learner of quality improvement and management systems, including the methods and benefits of lean manufacturing. It also covers the range and benefits of the various national and international quality certification standard schemes used in the polymer processing industry and the benefit to processors, suppliers, customers and end users.

This unit covers the need to recognise and manage potential quality issues, the importance of managing documentation including quality and inspection records and how to collect and analyse information. It also reviews fault finding processes including; identifying product faults, process faults, symptoms, causes and solutions.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Understand quality principles with regard to the processing of polymers	1.1	Describe what is meant by the term quality assurance and explain the principles
		1.2	Describe what is meant by the terms inspection and quality control, explain their principles
		1.3	Explain the use of standards in determining the fitness for purpose of material and equipment used in production processing
		1.4	Explain the importance of standard operating procedures
		1.5	State the benefits and limitations to an organisation of setting up a quality assurance scheme, include costs and culture
		1.6	Explain the need for validating and calibrating test and measuring equipment
		1.7	Explain the need for appropriate sampling and auditable records
		1.8	Explain the need for the inspection of materials and components, and the importance of correct documentation
		1.9	Summarise the roles and responsibilities within general quality systems
		1.10	Explain the need to inform a responsible person of the variation from the stated standard
		1.11	Summarise the benefits of decreasing non-compliant products
2.	Understand the various quality improvement and management systems employed in polymer processing production	2.1	Summarise the key quality management principles and describe their benefits and limitations
		2.2	Identify the principal tools used in lean manufacturing and explain their advantages and limitations

		2.3	Explain the responsibilities of individuals when involved in quality management improvement techniques
		2.4	Summarise why organisations should look to continually improve
3.	Understand the range and benefits of the various quality certification schemes used in the polymer processing industry	3.1	Summarise advantages and limitations of company, industry/national and international quality standards
		3.2	List the different standards that are used in a typical polymer processing facility including; equipment, material, safety, product
		3.3	Explain how quality standards benefit suppliers, processors, customers and end users
4.	Understand how to recognise and manage potential quality issues	4.1	Explain the purpose of the ISO 9000 and similar series of standards
		4.2	Explain the importance of quality and inspection records and accurate up to date production information e.g. setting sheets, first off/last reports and tool sampling reports
		4.3	Explain the fault finding terms; product fault, process fault, symptoms, causes, solution
		4.4	Explain how to collect and analyse information against agreed standards of performance
		4.5	Explain the need to document all actions agreed upon and taken
		4.6	Describe how to make recommendations to re-work, adjust or scrap products that do not meet required standards
		4.7	Explain how quality related information should be disseminated

### Assessment and Grading

This unit is assessed by completing assignments which are set, internally assessed and internally quality assured by the centre.

The assignments should be designed for a holistic approach to the assessment and confirm learners have a full contextualised understanding of all the assessment criteria.

Assignments must incorporate the quality systems and procedures used within the learner's production environment.

Centre assignments and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to pass all the assessment criteria.

## PERSONNEL EMPLOYMENT, COMMUNICATIONS AND PEOPLE SKILLS

PIABC Unit No: PM6

Unit Reference No: F/616/4121

Unit Level: 2

Guided Learning Hours: 46

Total Unit Time (Hours): 94

Unit Credits: 9

### Overview

This unit introduces the learner to the significance of employment rights and responsibilities within a polymer processing sector. It covers legislation, codes of practice, company policies, company procedures and work instructions in the following areas: - health & safety, environmental, employment rights, contracts of employment, job descriptions, working time directive, equality act, equal pay, parental leave.

It also looks at company policies and procedures for sickness, holidays, grievances, bullying, safeguarding, discrimination, data protection, disciplinary, equal opportunities, etc.

This unit covers the importance and benefits of working effectively with colleagues and describes organisational structures and responsibilities, the importance of developing positive and constructive working relationships and how to deal with conflict.

The following aspects of effective communication within an organisation are explored: - the advantages and limitations of the different forms of communications, data protection, document control, and how to make recommendations with production issues.

Learners will plan an investigation into a processing issue e.g. quality non-compliance reports, damage reports, process improvements and adjustments, scrap analysis, etc. by investigating and collecting information, analysing and evaluating information against agreed standards, producing a report and disseminating to colleagues.

The learner will also develop and complete process operating procedures, setting sheets or similar documents.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Understand your employment rights and responsibilities	1.1	Explain the differences between legislation, codes of practice, company policies, company procedures and work instructions
		1.2	Summarise the health & safety legislation that applies to a polymer processing workplace
		1.3	Explain what personal responsibilities are with regard to health, safety and the environment in the working area
		1.4	Describe the Employment Rights Act, contracts of employment and job descriptions
		1.5	Summarise other employment legislation that affects employees e.g. working time directive, equality act, equal pay, parental leave, TUPE
		1.6	Describe company policies and procedures for grievances, bullying, discrimination, data protection, confidentiality, disciplinary and equal opportunities
2.	Know how to work effectively with colleagues	2.1	Describe the departmental organisational structure that you work in and who you are responsible to
		2.2	Summarise the importance of developing positive working relationships
		2.3	Explain ways of establishing positive relationships
		2.4	Describe how to use different styles of approach with colleagues in different situations
		2.5	Describe the ways of dealing with disagreements and conflicts
		2.6	Describe how improvements can benefit self and the organisation and how they are identified and managed in your company
		2.7	Explain individual's responsibilities for the safety and welfare of visitors to the work area

3.	Know how to communicate effectively within an organisation	3.1 3.2 3.3 3.4 3.5	Summarise the importance of effective communications within a polymer processing company List the advantages and limitations of the different forms of communications used in a manufacturing company Explain document control and reporting procedures within a company Describe the various ways to present the information showing the benefits to be gained Describe how to make recommendations to re-work, adjust or scrap products that do not meet required standards
4.	Be able to evaluate information, develop procedures, produce a report and give feedback to colleagues.	4.1 4.2 4.3 4.4 4.5 4.6	Plan how to complete an investigation in an agreed timescale, including communicating to the relevant audience using an appropriate method Collect all applicable information and documentation regarding the investigation Analyse and evaluate information against agreed standards e.g. quality non-compliance reports, tests/inspections, damage reports, process improvements and adjustments, scrap analysis, etc. Produce a report in the company's style, addressing all the key aspects Present the report to colleagues in an appropriate, clear and effective manner Develop and complete process operating procedures, setting sheets or similar documents ensuring all information is clearly available

### Assessment and Grading

This unit is assessed by completing assignments which are set, internally assessed and internally quality assured by the centre.

The assignments should be designed for a holistic approach to the assessment and confirm learners have a full contextualised understanding of all the assessment criteria.

The assignment for learning outcome 4 must be based on and within a production environment with typical production pressures; this production environment must not be simulated.

Centre assignments and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to pass all the assessment criteria.

## OPTIONAL UNITS

### PATHWAY 1 - THERMOPLASTIC EXTRUSION

#### PRINCIPLES OF THERMOPLASTIC EXTRUSION

PIABC Unit No: PA1

Unit Reference No: J/616/4122

Unit Level: 3

Guided Learning Hours: 72

Total Unit Time (Hours): 134

Unit Credits: 13

#### Overview

This knowledge based unit introduces the learner to the process of extruding thermoplastic materials using different types or forms of extrudate (e.g. profile, pipe, sheet, film, strand, etc.).

It investigates the needs and behaviour of a range of thermoplastic extrusion materials during each stage of the process and looks at how process conditions affect the process and product, focusing on equipment function, design features, operational requirements and support services required for various extrusion processes.

The unit covers the design features of thermoplastic extruders and die designs available including; plasticising screws, head and die designs and configurations, methods of controlling extruder heating, multilayer extruder head and die designs, etc. It also covers the function and design of downstream and ancillary equipment; principles of controlling and handling the extrudate, material feeders, various range of downstream equipment available, the range of secondary operations available, etc.

The unit introduces the learner to the concepts and requirements to start, control and optimise a specific type of thermoplastic extrusion line. This includes typical systems and techniques for configuring the extrusion line, potential safety hazards and how they are managed, process considerations and parameters for a range of extrusion materials used with the extrusion process, how productivity and quality of the extrudate can be affected by the interaction of the range of process controls, etc.

It also investigates how to recognise and overcome thermoplastic extrusion processing and product faults by considering different strategies of fault finding, identifying extrusion process and product faults, their symptoms, possible causes relating them to the processing conditions and considering possible processing solutions.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Understand the potential safety hazards and how they are managed when processing polymer products by extrusion	1.1	Summarise the potential hazards when extruding thermoplastic materials
		1.2	Describe the statutory safety requirements for extruders and related equipment
		1.3	Describe the safety features incorporated into the equipment
		1.4	Explain the inspections that must be carried out to meet minimum statutory safety requirements on an extrusion line
2.	Understand the equipment functions and operational requirements for thermoplastic extrusion processes	2.1	Summarise the main thermoplastic extrusion processes and explain the key equipment design features including multi screw configurations
		2.2	Describe the behaviour of the thermoplastic materials during each phase of the extrusion process for a range of materials/grades
		2.3	Analyse the processing and production benefits and limitations of the various extrusion processes
		2.4	Describe the support services required for various extrusion processes
		2.5	Summarise how the extrusion product properties can be altered by adjusting the extrusion process
3.	Understand the design features of a thermoplastic extruder and the range of dies used	3.1	Summarise the main design aspects of extruder plasticising screws
		3.2	Summarise the various extruder process control options available
		3.3	Describe the various designs and methods of controlling extruder heating
		3.4	Summarise the main design aspects of an extruder head and die configuration with regard to the different thermoplastic products and materials used

		3.5	Describe the advantages and limitations of various head and die designs and configurations
		3.6	Explain the key features and advantages of a multilayer extruder head and die
4.	Understand the function and design of downstream and ancillary equipment used in the thermoplastic extrusion process	4.1	Describe the purpose and design options available of various material feeders
		4.2	Describe the purpose and design options available of the various range of extruder downstream equipment
		4.3	Summarise the principles of controlling the extrudate with the various downstream equipment
		4.4	List the range of extrusion secondary operations available, describe their operation and benefits
5.	Understand how to start, control and optimise a thermoplastic extrusion line	5.1	Describe typical systems and techniques for configuring an extrusion line
		5.2	Describe an extrusion line start up procedure highlighting key issues regarding safety and production efficiency
		5.3	Describe why, when and how the extrusion process may need purging
		5.4	Explain thermoplastic material flow characteristics whilst they are being extruded
		5.5	List the flow and cooling features for a range of extrusion materials
		5.6	List the process considerations and parameters for a range of extrusion thermoplastic materials
		5.7	List the extruder line controls and how they influence the properties of the final product
		5.8	Describe how the productivity and quality of the extrudate can be affected by the interaction of the range of extrusion line controls

6.	Understand how to recognise and overcome thermoplastic extrusion processing and product faults	6.1	Explain the different strategies for carrying out extrusion fault finding, describe their effectiveness and any limitations
		6.2	List common thermoplastic polymer extrusion process and product faults and their symptoms with regard to different extrusion products
		6.3	Describe the possible causes of common product faults and relate them to the processing conditions
		6.4	Describe the possible processing solutions for common extrusion processing and product faults

### Assessment and Grading

This unit is assessed by learners completing a centre devised and managed multi-choice end test that addresses all the criteria.

Test papers must sample each assessment criteria.

The question bank should contain at least three questions for each assessment criteria; each of which should cover a feature of the specific assessment criteria. The question bank will be monitored and evaluated to ensure a consistent standard is maintained across all assessment criteria and test papers.

The test will be internally assessed and internally quality assured by the centre.

Centre multi-choice end tests and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to achieve a pass mark of 80%.

## PROCESSING THERMOPLASTICS BY EXTRUSION

PIABC Unit No: PA2

Unit Reference No: L/616/4122

Unit Level: 3

Guided Learning Hours: 57

Total Unit Time (Hours): 132

Unit Credits: 13

### Overview

This skills based unit will enable the learner to configure, start up, commission, optimise and fault find one type of thermoplastic extrusion process safely and effectively (e.g. profile, pipe, sheet, film, strand, etc.).

It covers the configuring of the extruder, die, apart from when the die is only removed for maintenance or repair, and ancillary equipment to meet production requirements and includes; preparing the extruder head, die, ancillary equipment and services, aligning and attaching the die and any ancillaries to the extruder, arranging and connecting downstream equipment. Safely and effectively feeding the extrudate through the line, stabilising the process by making suitable process adjustments, optimising the processes and production output by using appropriate process capability studies, analysing the results and determining an effective plan for improvements.

The learner will also recommend any modifications to the die, downstream equipment or material specification to optimise and improve the process.

The unit will enable learners to resolve thermoplastic extrusion processing and product problems by being able to confirm any non-compliance, identify symptoms, gather information and identify likely causes, analyse all the evidence collected, determine a solution and carry out a suitable plan to sustain a product within specification.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Configure a thermoplastic processing extruder, forming tool and ancillary equipment to meet production requirements	1.1	Verify the extruder, forming tool and ancillary equipment requirements will meet the product and processing specification
		1.2	Ensure the equipment and work area is safe and serviceable
		1.3	Arrange and prepare the appropriate extruder head, die, ancillary equipment and services prior to configuration
		1.4	Set production controls to allow for equipment configuration
		1.5	Determine and confirm any lifting and moving equipment, hand tools and equipment are serviceable and available
		1.6	Move, align and attach the die and any ancillaries to the extruder
		1.7	Configure and connect downstream equipment
		1.8	Perform installation/alignment checks to the extrusion line
		1.9	Follow safe systems of work and operational procedures
		1.10	Perform extruder equipment safety checks
		1.11	Verify the extrusion line is configured and prepared for production
2.	Commission a thermoplastic extrusion processing line and shut down the line after production	2.1	Verify the product and production requirements
		2.2	Confirm the extrusion line is ready for commissioning

		2.3	Set production controls to allow for a safe and effective start up, taking into account the polymer material specification and line set up.
		2.4	Confirm the material meets any preparation requirements
		2.5	Purge the extruder and ensure the extrudate is ready for production
		2.6	Feed the extrudate through the line safely and effectively and stabilise the process
		2.7	Incorporate the downstream equipment
		2.8	Adjust process settings to produce sample products to production specification safely and efficiently
		2.9	Close down the process following safe systems of work
		2.10	Leave the equipment and area safe and serviceable
3.	Optimise the extrusion processes and production output	3.1	Verify the extrusion line is within the production specification
		3.2	Observe the process and identify possible aspects or adjustments to enhance the process
		3.3	Perform appropriate process capability studies
		3.4	Analyse the results and determine an effective plan for improvements
		3.5	Adjust process settings to optimise the process, ensuring the product continues to meet the specification safely and efficiently
		3.6	Recommend any modifications to the die, downstream equipment or material specification to optimise the process
		3.7	Confirm the optimised production can be maintained

4.	Resolve thermoplastic extrusion processing and product problems	4.1	Verify the product and processing specification
		4.2	Confirm the non-compliance and identify symptoms
		4.3	Gather information and identify likely causes
		4.4	Analyse the evidence collected and determine appropriate solutions
		4.5	Design and perform a plan to rectify the problem, allowing for the effect of any adjustments generating secondary problems
		4.6	Resolve processing and product faults safely and effectively
		4.7	Recommend any modifications to the die, equipment, material or processing specification

### Assessment and Grading

This unit is assessed by both the following methods to confirm competence over time and to ensure a consistent skills standard is achieved across all the centre's assessment sites:

- A. The assessor will observe the learner, over time, successfully completing all the assessment criteria within a production environment.
- B. The learners complete a final centre devised practical skills end test in a production environment. The test will cover the configuring, commissioning, optimising and product/process fault-finding; all the assessment criteria will be addressed.

The end test must be monitored and evaluated by the centre to ensure a consistent skills standard is maintained across all assessment sites, irrespective of the types of equipment, processes and materials used.

The production environment in both methods of assessment must not be simulated. Both the observation and skill tests are assessed and internally quality assured by the centre.

The ongoing observations and the centre practical skills end test and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to successfully achieve both methods of assessment.

## PATHWAY 2 - INJECTION MOULDING

### PRINCIPLES OF THERMOPLASTIC INJECTION MOULDING

PIABC Unit No: PB1

Unit Reference No: R/616/4124

Unit Level: 3

Guided Learning Hours: 72

Total Unit Time (Hours): 134

Unit Credits: 13

#### Overview

This knowledge based unit introduces the learner to the process of injection moulding thermoplastic materials.

It investigates the needs and behaviour of a range of injection moulding thermoplastic materials during each stage of the process and looks at how process conditions affect the process and product, focusing on equipment function, design features, operational requirements and support services required.

The unit covers the design features of injection moulding machines and designs of the range of moulds available including: - plasticising screws, nozzles, machine drive and control systems, the functions and features of a range of mould tools, hot and insulated runners, including their feed systems, gates and controls, pre-processing and downstream equipment and the range of secondary operations available.

The unit introduces the learner into the concepts and requirements to start, control and optimise an injection moulding machine including typical systems and techniques for configuring the production set-up. It covers the potential safety hazards and how they are managed, process considerations and parameters for a range of injection moulding materials, how productivity and quality can be affected by the interaction of the range of process controls, etc.

It also investigates how to recognise and overcome thermoplastic injection moulding processing and product faults by considering different strategies of fault finding, identifying injection moulding process and product faults, their symptoms, possible causes relating them to the processing conditions and considering possible processing solutions.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Understand the potential safety risks/hazards when processing polymer products by injection moulding	1.1	Summarise the potential hazards when injection moulding thermoplastic materials
		1.2	Describe the statutory safety requirements for injection moulding machines and related equipment
		1.3	Describe the safety features incorporated into the equipment
		1.4	Explain the inspections that must be carried out to meet minimum statutory safety requirements on an injection moulding machine
2.	Understand the equipment functions and operational requirements for thermoplastic injection processes	2.1	Describe the behaviour of the thermoplastic materials during each phase of the injection moulding process
		2.2	Describe the design and mechanical requirements of an injection moulding machine to meet the processing needs
		2.3	Describe the design and mechanical requirements of mould tools to meet the processing needs
		2.4	Describe the support services required for the injection moulding process
		2.5	Summarise how the moulded product properties can be altered by adjusting the injection process options
3.	Understand the design features of a thermoplastic injection moulding machines and the range of mould tools used	3.1	Describe how injection moulding machine clamping units and injection units are specified
		3.2	Summarise the main design aspects of a range of plasticising screws with regard to thermoplastic materials being processed
		3.3	Summarise the main design aspects of a range of machine nozzles with regard to the moulds and materials being used
		3.4	Describe the various designs and methods of controlling machine and mould heating and cooling with regard to the materials and product design

		3.5	Summarise the range of machine drive and control systems available, describe their advantages and limitations
		3.6	Summarise the various injection moulding process control options available
		3.7	Describe the functions of the mould tool during the injection moulding cycle
		3.8	Describe the construction and key design features of a mould tool including the properties of the metals and other materials used
		3.9	Explain the features of standard, hot and insulated runners moulds' including their feed systems, gates and controls, summarise their benefits and limitations
		3.10	Describe the operation of different multi daylight moulds and summarise their advantages and limitations
		3.11	Explain how to calculate the projected area for different types of injection moulds
		3.12	Explain how to calculate mould clamping force with reference to the specific injection pressure
		3.13	Summarise the different mould ejection systems used for different products and processing designs, evaluate their benefits and limitations
4.	Understand the function and design of ancillary equipment used with thermoplastic injection moulding	4.1	Describe the purpose and design options available of the various range of moulding machine ancillary and support equipment
		4.2	Compare the purpose and design options available of various material feeders and dryers with regard the materials being processed
		4.3	Describe the purpose and design options available of the various range of injection moulding downstream equipment
		4.4	List the range of injection moulding secondary operations available, describe their operation and benefits

5.	Understand how to start, control and optimise a thermoplastic injection moulding process	5.1 5.2 5.3 5.4 5.5 5.6 5.7 5.8 5.9	Describe typical practices for configuring an injection moulding process Describe a typical injection moulding start up procedure highlighting key issues regarding safety and production efficiency Describe why, when and how an injection moulding machine may need purging Explain how to calculate cycle times and production rates for different types of material and mould/product designs Explain thermoplastic materials flow characteristics whilst they are being injection moulded List the flow and cooling features for different families of thermoplastic materials, include typical process temperatures and pressures involved List the injection moulding process considerations and parameters for a range of thermoplastic materials List the Injection moulding process controls and how they influence the properties of the final product Describe how profiling the different process controls can benefit the product and moulding process
6.	Understand how to recognise and overcome thermoplastic injection moulding processing and product faults	6.1 6.2 6.3 6.4	Explain the different strategies for carrying out injection moulding fault finding, describe their effectiveness and any limitations List common injection moulding processing and product faults and their symptoms Describe the possible causes of common product faults and relate them to the processing conditions Describe the possible processing solutions for common injection moulding processing and product faults

**Assessment and Grading**

This unit is assessed by learners completing a centre devised and managed multi-choice end test that addresses all the criteria.

Test papers must sample each assessment criteria.

The question bank should contain at least three questions for each assessment criteria; each of which should cover a feature of the specific assessment criteria. The question bank will be monitored and evaluated to ensure a consistent standard is maintained across all assessment criteria and test papers.

The test will be internally assessed and internally quality assured by the centre.

Centre multi-choice end tests and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to achieve a pass mark of 80%.

## PROCESSING THERMOPLASTICS BY INJECTION MOULDING

PIABC Unit No: PB2

Unit Reference No: Y/616/4125

Unit Level: 3

Guided Learning Hours: 57

Total Unit Time (Hours): 132

Unit Credits: 13

### Overview

This skills based unit will enable the learner to configure, start up, commission, optimise and fault find an injection moulding process safely and effectively.

It covers the configuring of the injection moulding machine, mould and ancillary equipment to meet production requirements and includes; preparing the injection moulding machine, mould, ancillary equipment and services, aligning and installing the mould and any ancillaries, arranging and connecting downstream equipment. Safely and effectively starting the moulding process, stabilising the process by making suitable process adjustments, optimise the processes and production output by using appropriate process capability studies, analysing the results and determining an effective plan for improvements.

The learner will also recommend any modifications to the mould, downstream equipment or material specification to optimise and improve the process.

The unit will enable learners to resolve thermoplastic injection moulding processing and product problems by being able to confirm any non-compliance, identify symptoms, gather information and identify likely causes, analyse all the evidence collected, determine a solution and carry out a suitable plan to sustain a product within specification.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Configure a thermoplastic processing injection moulding machine, mould and ancillary equipment to meet production requirements	1.1	Verify the moulding machine, mould tool and ancillary equipment requirements will meet the product and processing specification
		1.2	Ensure the equipment and work area is safe and serviceable
		1.3	Arrange and prepare the mould, ancillary equipment and service connections prior to configuration
		1.4	Set production controls to allow for equipment configuration
		1.5	Determine and confirm any lifting and moving equipment, hand tools and equipment are serviceable and available
		1.6	Move, align and attach the mould and any ancillaries to the moulding machine
		1.7	Configure and connect downstream equipment
		1.8	Perform mould installation/alignment checks safely and effectively
		1.9	Follow safe systems of work and operational procedures
		1.10	Perform moulding machine and any ancillary equipment safety checks
		1.11	Verify the moulding machine set-up is configured and prepared for production
2.	Commission the injection moulding process and shut down after production	2.1	Confirm the product and production requirements
		2.2	Confirm the machine set up is ready for commissioning

		2.3	Set production controls to allow for a safe and effective start up, taking into account the polymer material specification and mould geometry
		2.4	Confirm the polymer meets any preparation requirements
		2.5	Purge the machine and ensure the material is ready for production
		2.6	Start the process safely and effectively and stabilise the operation
		2.7	Incorporate the downstream equipment
		2.8	Adjust process settings to produce sample products to production specification safely and efficiently
		2.9	Close down the process following safe systems of work
		2.10	Leave the equipment and area safe and serviceable
3.	Optimise the injection moulding processes and production output	3.1	Verify the injection moulding process and product are within the production specification
		3.2	Observe the process and identify possible aspects or adjustments to enhance the process
		3.3	Perform appropriate process capability studies
		3.4	Analyse the results and determine an effective plan for improvements
		3.5	Adjust process settings to optimise the process, ensuring the product continues to meet the specification safely and efficiently
		3.6	Recommend any modifications to the mould, downstream/ancillary equipment or material specification to optimise the process
		3.7	Confirm the optimised production can be maintained

4.	Resolve injection moulding processing and product problems	4.1	Verify the product and injection moulding processing specification
		4.2	Confirm the non-compliance and identify symptoms
		4.3	Gather information and identify likely causes
		4.4	Analyse the evidence collected and determine appropriate solutions
		4.5	Design and perform a plan to rectify the problem, allowing for the effect of any adjustments generating secondary problems
		4.6	Resolve processing and product faults safely and effectively
		4.7	Recommend any modifications to the mould, downstream/ancillary equipment, material or processing specification

### Assessment and Grading

This unit is assessed by both the following methods to confirm competence over time and to ensure a consistent skills standard is achieved across all the centre's assessment sites:

- A. The assessor will observe the learner, over time, successfully completing all the assessment criteria within a production environment.
- B. The learners complete a final centre devised practical skills end test in a production environment. The test will cover the configuring, commissioning, optimising and product/process fault-finding; all the assessment criteria will be addressed.

The end test must be monitored and evaluated by the centre to ensure a consistent skills standard is maintained across all assessment sites, irrespective of the types of equipment, processes and materials used.

The production environment in both methods of assessment must not be simulated. Both the observation and skill tests are internally assessed and internally quality assured by the centre.

The ongoing observations and the centre practical skills end test and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to successfully achieve both methods of assessment.

## **PATHWAY 3 – PREFORM BLOW MOULDING**

### **PRINCIPLES OF THERMOPLASTIC PREFORM BLOW MOULDING**

PIABC Unit No: PC1

Unit Reference No: D/616/4126

Unit Level: 3

Guided Learning Hours: 72

Total Unit Time (Hours): 134

Unit Credits: 13

#### **Overview**

This knowledge based unit introduces the learner to the process of preform blow moulding thermoplastic materials.

It investigates the needs and behaviour of a range of preform blow moulding materials during each stage of the process and looks at how process conditions affect the process and product, focusing on equipment function, design features, operational requirements and support services required.

The unit covers the design features of preform blow moulding machines and designs of the range of moulds available including: - machine layout, control systems, the functions and features of a range of mould tools, pre-processing and downstream equipment and the range of secondary operations available.

The unit introduces the learner into the concepts and requirements to start, control and optimise a preform blow moulding machine including typical systems and techniques for configuring the production set-up. It covers the potential safety hazards and how they are managed, process considerations and parameters for a range of preform blow moulding materials, how productivity and quality can be affected by the interaction of the range of process controls, etc.

It also investigates how to recognise and overcome preform blow moulding processing and product faults by considering different strategies of fault finding, preform blow moulding process and product faults, their symptoms, possible causes relating them to the processing conditions and considering possible processing solutions.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Understand the potential safety hazards and how they are managed when processing polymer products by preform blow moulding	1.1	Summarise the potential hazards when preform blow moulding thermoplastic materials
		1.2	Describe the statutory safety requirements for blow moulders and related equipment
		1.3	Describe the safety features incorporated into the equipment
		1.4	Explain the inspections that must be carried out to meet minimum statutory safety requirements on a preform blow moulding machine
2.	Understand the equipment functions and operational requirements for thermoplastic preform blow moulding processes	2.1	Summarise the main thermoplastic preform blow moulding process techniques and explain the key equipment design features
		2.2	Describe the preform blow moulding production cycle and the function of the equipment at each stage
		2.3	Describe the behaviour of the thermoplastic material during each phase of the preform blow moulding process for a range of materials
		2.4	Analyse the processing and production benefits and limitations of the various preform blow moulding processes
		2.5	Describe the different methods of producing preforms
		2.6	Describe the support services required for various preform blow moulding processes
		2.7	Summarise how the preform blow moulding product properties can be altered by adjusting the process conditions

3.	Understand the design features of a thermoplastic preform blow moulder and the range of moulds used	3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8	<p>Summarise the process control options needed for the preform blow moulding cycle</p> <p>Explain the important requirements needed for a preform blow moulding pneumatic system</p> <p>Describe the various designs and methods of controlling the heating and cooling during the process</p> <p>Summarise the advantages and limitations of the different methods of preform, preparation, feed and loading systems with regard to the thermoplastic materials and product geometry</p> <p>Explain the different preform heating options used and their advantages and limitations</p> <p>Describe the purpose and functions of the mould and support equipment at each stage of the moulding cycle</p> <p>Describe the construction and key design features of a mould and support equipment, including the properties of the metals and other materials used</p> <p>Summarise the features, parts and uses of moulds and associated support equipment</p>
4.	Understand the function and design of ancillary equipment used in the thermoplastic preform blow moulding process	4.1 4.2 4.3	<p>Summarise the services and process equipment available to the preform blow moulding machine</p> <p>Describe the purpose of the various range of preform blow moulding downstream equipment available</p> <p>List the range of preform blow moulding secondary operations available, describe their operation and benefits e.g. printing, filling, etc.</p>
5.	Understand how to start, control and optimise a thermoplastic preform blow moulding process	5.1 5.2 5.3 5.4	<p>Describe typical techniques for configuring and setting up a preform blow moulding line</p> <p>Describe a preform blow moulding start up procedure highlighting key issues regarding safety and production efficiency</p> <p>Describe why, when and how the mould may need cleaning or servicing</p> <p>Explain thermoplastic material flow and preform shaping characteristics whilst being blow moulded</p>

		5.5	List the flow and cooling features for a range of preform blow moulding materials
		5.6	List the process considerations and parameters for a range of preform blow moulding materials
		5.7	List the preform blow moulding controls and how they influence the properties of the final product
		5.8	Describe how the productivity and quality of the preform blow moulded product can be affected by the interaction of the range of moulding controls
6.	Understand how to recognise and overcome thermoplastic preform blow moulding processing and product faults	6.1	Explain the different strategies for carrying out preform blow moulding fault finding, describe their effectiveness and any limitations
		6.2	List common preform blow moulding product faults and their symptoms
		6.3	Describe the possible causes of common product faults and relate them to the processing conditions
		6.4	Describe the possible processing solutions for common preform blow moulding processing and product faults

### Assessment and Grading

This unit is assessed by learners completing a centre devised and managed multi-choice end test that addresses all the criteria.

Test papers must sample each assessment criteria.

The question bank should contain at least three questions for each assessment criteria; each of which should cover a feature of the specific assessment criteria. The question bank will be monitored and evaluated to ensure a consistent standard is maintained across all assessment criteria and test papers.

The test will be internally assessed and internally quality assured by the centre.

Centre multi-choice end tests and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to achieve a pass mark of 80%.

## PROCESSING THERMOPLASTICS BY PREFORM BLOW MOULDING

PIABC Unit No: PC2

Unit Reference No: H/616/4127

Unit Level: 3

Guided Learning Hours: 57

Total Unit Time (Hours): 132

Unit Credits: 13

### Overview

This skills based unit will enable the learner to configure, start up, commission, optimise and fault find a preform blow moulding process safely and effectively.

It covers the configuring of a preform blow moulding machine, moulds, apart from when moulds are only removed for maintenance or repair, and ancillary equipment to meet production requirements and includes; preparing a preform blow moulding machine, moulds, ancillary equipment and services, aligning and installing the moulds and any ancillaries, arranging and connecting downstream equipment. Safely and effectively starting the moulding process, stabilising the process by making suitable process adjustments, optimising the processes and production output by using appropriate process capability studies, analysing the results and determining an effective plan for improvements.

The learner will also recommend any modifications to the moulds, downstream equipment or material specification to optimise and improve the process.

The unit will enable learners to resolve preform blow moulding processing and product problems by being able to confirm any non-compliance, identify symptoms, gather information and identify likely causes, analyse all the evidence collected, determine a solution and carry out a suitable plan to sustain a product within specification.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Configure a thermoplastic processing preform blow moulding machine, moulds and ancillary equipment to meet production requirements	1.1	Verify a preform blow moulding machine, moulds and ancillary equipment requirements will meet the product and processing specification
		1.2	Ensure the equipment and work area is safe and serviceable
		1.3	Arrange and prepare a preform blow moulding machine, moulds, ancillary equipment and services prior to configuration
		1.4	Set production controls to allow for equipment configuration
		1.5	Determine and confirm any lifting and moving equipment, hand tools and equipment are serviceable and available
		1.6	Move, align and attach the moulds and moulds support equipment to the machine
		1.7	Configure and connect ancillary equipment
		1.8	Perform installation/alignment checks to the moulds
		1.9	Follow safe systems of work and operational procedures
		1.10	Perform machine and equipment safety checks
		1.11	Verify a preform blow moulding machine is configured and prepared for production
2.	Commission a preform blow moulding process and shut down after production	2.1	Verify the product and production requirements
		2.2	Confirm the machine set up is ready for commissioning

		2.3	Set production controls to allow for a safe and effective start up, taking into account the thermoplastic material specification and the product geometry
		2.4	Confirm the preforms meets any preparation requirements
		2.5	Clean/purge the machine where applicable and ensure the material/preform is ready for production
		2.6	Start the process safely and effectively and stabilise the operation
		2.7	Incorporate the downstream and ancillary equipment
		2.8	Adjust process settings to produce sample preform blow moulded products to production specification safely and efficiently
		2.9	Close down a preform blow moulding process following safe systems of work
		2.10	Leave the equipment and area safe and serviceable
3.	Optimise a preform blow moulding process and production output	3.1	Verify a preform blow moulding process and product are within the production specification
		3.2	Observe the process and identify possible aspects for adjustments to enhance the process
		3.3	Perform appropriate process capability studies
		3.4	Analyse the results and determine an effective plan for improvements
		3.5	Adjust preform blow moulding process settings to optimise the process, ensuring the product continues to meet the specification safely and efficiently
		3.6	Recommend any modifications to the preforms, moulds, ancillary/downstream equipment or material specification to optimise the process
		3.7	Confirm the optimised production can be maintained

4.	Resolve preform blow moulding processing and product problems	4.1	Confirm the product and preform blow moulding processing specification
		4.2	Confirm the non-compliance and identify symptoms
		4.3	Gather information and identify likely causes
		4.4	Analyse the evidence collected and determine appropriate solutions.
		4.5	Design and perform a plan to rectify the problem, allowing for the effect of any adjustments generating secondary problems
		4.6	Resolve processing and product faults safely and effectively
		4.7	Recommend any modifications to the preforms, moulds, ancillary/downstream equipment, material or processing specification

### Assessment and Grading

This unit is assessed by both the following methods to confirm competence over time and to ensure a consistent skills standard is achieved across all the centre's assessment sites:

- A. The assessor will observe the learner, over time, successfully completing all the assessment criteria within a production environment for a thermoplastic preform blow moulding technique.
- B. The learners complete a final centre devised practical skills end test in a production environment for a thermoplastic preform blow moulding technique. The test will cover the configuring, commissioning, optimising and product/process fault-finding; all the assessment criteria will be addressed.

The end test must be monitored and evaluated by the centre to ensure a consistent skills standard is maintained across all assessment sites, irrespective of the types of equipment, processes and materials used.

The production environment in both methods of assessment must not be simulated. Both the observation and skill tests are internally assessed and internally quality assured by the centre.

The ongoing observations and the centre practical skills end test and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to successfully achieve both methods of assessment.

## PATHWAY 4 – PARISON BLOW MOULDING

### PRINCIPLES OF THERMOPLASTIC PARISON BLOW MOULDING

PIABC Unit No: PD1

Unit Reference No: K/616/4128

Unit Level: 3

Guided Learning Hours: 72

Total Unit Time (Hours): 134

Unit Credits: 13

#### Overview

This knowledge based unit introduces the learner to the process of parison blow moulding thermoplastic materials.

It investigates the needs and behaviour of a range of parison blow moulding materials during each stage of the process and looks at how process conditions affect the process and product, focusing on equipment function, design features, operational requirements and support services required for various parison blow moulding processes.

The unit covers the design features of a thermoplastic extruder and die designs available including; plasticising screws, head and parison dies and their configurations, methods of controlling extruder heating, multi-head and parison process control options, blow pins and moulds

It also covers the function and design of downstream and ancillary equipment; principles of controlling and handling the parison and product, material feeders, various range of downstream equipment available, the range of secondary operations available, etc.

The unit introduces the learner into the concepts and requirements to start, control and optimise a specific type of parison blow moulding set-up, including typical systems and techniques for configuring the mould and ancillary equipment to the machine, potential safety hazards and how they are managed, process considerations and parameters for a range of parison blow moulding materials used, how productivity and quality of the parison and product can be affected by the interaction of the range of the process controls, etc.

It also investigates how to recognise and overcome parison blow moulding processing and product faults by considering different strategies of fault finding, identifying process and product faults, their symptoms, and possible causes relating them to the processing conditions and considering possible processing solutions.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Understand the potential safety hazards and how they are managed when processing polymer products by parison blow moulding	1.1	Summarise the potential hazards when parison blow moulding thermoplastic materials
		1.2	Describe the statutory safety requirements for parison blow moulders and related equipment
		1.3	Describe the safety features incorporated into the equipment
		1.4	Explain the inspections that must be carried out to meet minimum statutory safety requirements on a parison blow moulding machine
2.	Understand the equipment functions and operational requirements for thermoplastic parison blow moulding processes	2.1	Summarise the main thermoplastic parison blow moulding process techniques and explain the key equipment design features
		2.2	Describe the parison blow moulding production cycle and the function of the equipment at each stage
		2.3	Describe the behaviour of the thermoplastic material during each phase of the parison blow moulding process for a range of materials
		2.4	Analyse the processing and production benefits and limitations of the various parison blow moulding process designs
		2.5	Summarise how the parison blow moulding product properties can be altered by adjusting the process conditions
3.	Understand the design features of a thermoplastic parison blow moulder and the range of moulds used	3.1	Summarise the main design aspects of a blow moulding plasticising screw with regard to different families of materials
		3.2	Summarise the various extruder, multi-head and parison process control options available
		3.3	Explain the key features and advantages of a multilayer extruder head and die
		3.4	Describe the various designs and methods of controlling the heating and cooling of the extruder, head, parison, blow pin and mould

		3.5	Explain the importance of parison control through the die and the different designs available
		3.6	Describe the construction and key design features of a mould, blow pin, and associated support equipment
		3.7	Summarise the services and process support equipment available to the blow moulding machine
		3.8	Summarise the service and maintenance requirements for moulds, blow pins, extrusion heads and dies
4.	Understand the function and design of downstream and ancillary equipment used in thermoplastic parison blow moulding	4.1	Describe the purpose and design options available of various material feeders
		4.2	Describe the purpose and design options available of the various range of parison blow moulding downstream equipment
		4.3	List the range of parison blow moulding secondary operations available, describe their operation and benefits
5.	Understand how to start, control and optimise a thermoplastic parison blow moulding process	5.1	Describe typical techniques for configuring a parison blow moulding set up
		5.2	Describe a parison blow moulding machine start up procedure highlighting key issues regarding safety and production efficiency
		5.3	Describe why, when and how the parison blow moulding process may need purging
		5.4	Explain thermoplastic materials flow characteristics whilst they are being parison blow moulded
		5.5	List the flow and cooling features for a range of parison blow moulding materials
		5.6	List the process considerations and parameters for a range of parison blow moulding materials
		5.7	List the parison blow moulding controls and how they influence the properties of the final product
		5.8	Describe how the productivity and quality of the parison blow moulding product can be affected by the interaction of controls

6.	Understand how to recognise and overcome thermoplastic parison blow moulding processing and product faults	6.1	List common thermoplastic parison blow moulding product faults and their symptoms
		6.2	Describe the possible causes of common product faults and relate them to the processing conditions
		6.3	Describe the possible processing solutions for common parison blow moulding faults
		6.4	Explain the effective strategies for carrying out parison blow moulding fault finding

**Assessment and Grading**

This unit is assessed by learners completing a centre devised and managed multi-choice end test that addresses all the criteria.

Test papers must sample each assessment criteria.

The question bank should contain at least three questions for each assessment criteria; each of which should cover a feature of the specific assessment criteria. The question bank will be monitored and evaluated to ensure a consistent standard is maintained across all assessment criteria and test papers.

The test will be internally assessed and internally quality assured by the centre.

Centre multi-choice end tests and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to achieve a pass mark of 80%.

## PROCESSING THERMOPLASTICS BY PARISON BLOW MOULDING

PIABC Unit No: PD2

Unit Reference No: M/616/4129

Unit Level: 3

Guided Learning Hours: 57

Total Unit Time (Hours): 132

Unit Credits: 13

### Overview

This skills based unit will enable the learner to configure, start up, commission, optimise and fault find a parison blow moulding set-up safely and effectively.

It covers the configuring of a parison blow moulder, die, pin, apart from when the die and pin are only removed for maintenance or repair, together with moulds and ancillary equipment to meet production requirements and includes; preparing a parison blow moulding machine parison head, moulds, ancillary equipment and services, aligning and attaching the die and any ancillaries to the extruder, arranging and connecting downstream equipment. Safely and effectively starting the process, stabilising the process by making suitable adjustments, optimise the process and production output by using appropriate process capability studies, analysing the results and determining an effective plan for improvements.

The learner will also recommend any modifications to the die, mould, downstream equipment or material specification to optimise and improve the process.

The unit will enable learners to resolve parison blow moulding processing and product problems by being able to confirm any non-compliance, identify symptoms, gather information and identify likely causes, analyse all the evidence collected, determine a solution and carry out a suitable plan to sustain a product within specification.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Configure a thermoplastic parison blow moulding machine, mould and ancillary equipment to meet production requirements	1.1	Verify a parison blow moulding machine, die, mould and ancillary equipment requirements will meet the product and processing specification
		1.2	Ensure the equipment and work area is safe and serviceable
		1.3	Arrange and prepare a parison blow moulding machine, mould, ancillary equipment and services prior to configuration
		1.4	Set production controls to allow for equipment configuration
		1.5	Determine and confirm any lifting and moving equipment, hand tools and equipment are serviceable and available
		1.6	Move, align and attach the mould to the machine
		1.7	Configure and connect ancillary equipment
		1.8	Perform installation/alignment checks to the mould
		1.9	Follow safe systems of work and operational procedures
		1.10	Perform machine and equipment safety checks
		1.11	Verify a parison blow moulding machine is configured and prepared for production
2.	Commission a parison blow moulding process and shut down after production	2.1	Verify the product and production requirements
		2.2	Confirm the machine set up is ready for commissioning

		2.3	Set production controls to allow for a safe and effective start up, taking into account the thermoplastic material specification and product geometry
		2.4	Confirm the material meets any preparation requirements
		2.5	Purge the machine and ensure the material is ready for production
		2.6	Start the process safely and effectively and stabilise the operation
		2.7	Incorporate the downstream and ancillary equipment
		2.8	Adjust process settings to produce sample parison blow moulded products to production specification safely and efficiently
		2.9	Close down a parison blow moulding process following safe systems of work
		2.10	Leave the equipment and area safe and serviceable
3.	Optimise a parison blow moulding process and production output	3.1	Verify a parison blow moulding process and product are within the production specification
		3.2	Observe the process and identify possible aspects for adjustments to enhance the process
		3.3	Perform appropriate process capability studies
		3.4	Analyse the results and determine an effective plan for improvements
		3.5	Adjust a parison blow moulding process settings to optimise the process, ensuring the product continues to meet the specification safely and efficiently
		3.6	Recommend any modifications to the mould, die, ancillary/downstream equipment or material specification to optimise the process
		3.7	Confirm the optimised production can be maintained

4.	Resolve parison blow moulding processing and product problems	4.1	Verify the product and parison blow moulding processing specification
		4.2	Confirm the non-compliance and identify symptoms
		4.3	Gather information and identify likely causes
		4.4	Analyse the evidence collected and determine appropriate solutions.
		4.5	Design and perform a plan to rectify the problem, allowing for the effect of any adjustments generating secondary problems
		4.6	Resolve processing and product faults safely and effectively
		4.7	Recommend any modifications to the mould, die, ancillary/downstream equipment, material or processing specification

### Assessment and Grading

This unit is assessed by both the following methods to confirm competence over time and to ensure a consistent skills standard is achieved across all the centre's assessment sites:

- A. The assessor will observe the learner, over time, successfully completing all the assessment criteria within a production environment for a thermoplastic parison blow moulding technique.
- B. The learners complete a final centre devised practical skills end test in a production environment for a thermoplastic parison blow moulding technique. The test will cover the configuring, commissioning, optimising and product/process fault-finding; all the assessment criteria will be addressed.

The end test must be monitored and evaluated by the centre to ensure a consistent skills standard is maintained across all assessment sites, irrespective of the types of equipment, processes and materials used.

The production environment in both methods of assessment must not be simulated. Both the observation and skill tests are internally assessed and internally quality assured by the centre.

The ongoing observations and the centre practical skills end test and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to successfully achieve both methods of assessment.

## PATHWAY 5 – PARISON BLOW MOULDING

### PRINCIPLES OF THERMOPLASTIC MATERIALS PROCESSING

PIABC Unit No: PE1

Unit Reference No: H/616/4130

Unit Level: 3

Guided Learning Hours: 72

Total Unit Time (Hours): 134

Unit Credits: 13

#### Overview

This knowledge based unit introduces the learner to a thermoplastic processing technique and the materials involved (e.g. rotational moulding, compression moulding, dip moulding, etc.).

It investigates the needs and behaviour of a range of thermoplastic materials used for the processing technique during each stage of the process and looks at how process conditions affect the process and product, focusing on equipment function, forming tool features, operational requirements and support services required for the process.

The unit covers the design features of the thermoplastic processing technique and forming tool designs available including; methods of controlling heating and cooling, etc. It also covers the function and design of support equipment; principles of controlling and handling the product, material feeders, the range of downstream equipment available, the range of secondary operations available, etc.

The unit introduces the learner into the concepts and requirements to start, control and optimise a specific type of thermoplastic processing technique, including typical systems and techniques for configuring the production set-up, potential safety hazards and how they are managed, process considerations and parameters for a range of processing materials used with the technique, how productivity and quality can be affected by the interaction of the range of processing controls, etc.

It also investigates how to recognise and overcome processing and product faults by considering different strategies of fault finding, identifying process and product faults, their symptoms and possible causes relating them to the processing conditions and considering potential processing solutions.

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Understand the potential safety hazards and how they are managed when using a thermoplastics processing technique	1.1	Summarise the potential hazards when processing particular polymer materials
		1.2	Describe the statutory safety requirements for the processing equipment
		1.3	Describe the safety features incorporated into the equipment
		1.4	Explain the inspections that must be carried out to meet minimum statutory safety requirements for processing setup
2.	Understand the equipment functions and operational requirements when using a thermoplastics processing technique	2.1	Summarise a thermoplastic processing technique, explain the key equipment design features
		2.2	Describe the behaviour of the thermoplastic material during each phase of the process for a range of materials used
		2.3	Analyse the processing and production benefits and limitations of the variations in the processing technique
		2.4	Describe the support services required for the processing technique
		2.5	Summarise how the processing and product properties can be altered by adjusting the process variables
3.	Understand the equipment and forming tool design features for a thermoplastic processing technique	3.1	Describe the functions and processing requirements for the equipment and forming tools for the particular processing technique
		3.2	Summarise the main design aspects of the processing equipment and any variations available, highlighting advantages and limitations for the specific processing technique
		3.3	Describe the various designs and methods of heating and cooling with regard to the materials and product design
		3.4	Summarise the construction and key design features of the forming tools including the properties of the metals and other materials used

		3.5	Describe the processing features for the families of thermoplastic materials used in the processing technique
4.	Understand the function and design of downstream and ancillary equipment used with a thermoplastic processing technique	4.1	Describe the support services required for the processing equipment for a specific processing technique
		4.2	Describe the purpose and design options available of various pre-processing equipment for a specific processing technique
		4.3	Describe the purpose and design options available of the various range of downstream equipment for a specific processing technique
		4.4	List the range of secondary operations available for the processing technique describe their operation and benefits
		4.5	Summarise the principles of controlling and integrating the ancillary equipment to enhance the processing capability
5.	Understand how to start, control and optimise a thermoplastic processing technique	5.1	Describe typical techniques for configuring the thermoplastic processing technique
		5.2	Describe the start-up procedure highlighting key issues regarding safety and production efficiency for a thermoplastic processing technique
		5.3	Describe why, when and how the process equipment may need purging or cleaning
		5.4	Explain polymer material flow characteristics whilst they are being processed for a specific technique
		5.5	List the flow and cooling features for a range of materials used in the specific thermoplastic processing technique
		5.6	List the process considerations and parameters for a range of materials used in the specific thermoplastic processing technique
6.	Understand how to recognise and overcome processing and product faults on a thermoplastic processing technique	6.1	Explain the effective strategies for carrying out fault finding on a specific thermoplastic processing technique, describe their effectiveness and any limitations
		6.2	List common polymer product and processing faults, and their symptoms for a thermoplastic processing technique
		6.3	Describe the possible causes of common product faults and relate them to the processing conditions.

		6.4	Describe the possible processing solutions for common thermoplastic processing and product faults
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### **Assessment and Grading**

This unit is assessed by learners completing a centre devised and managed multi-choice end test that addresses all the criteria for a thermoplastic processing technique.

Test papers must sample each assessment criteria.

The question bank should contain at least three questions for each assessment criteria; each of which should cover a feature of the specific assessment criteria. The question bank will be monitored and evaluated to ensure a consistent standard is maintained across all assessment criteria and test papers.

The test will be internally assessed and internally quality assured by the centre.

Centre multi-choice end tests and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to achieve a pass mark of 80%.

## PROCESSING THERMOPLASTICS BY A PRODUCTION TECHNIQUE

PIABC Unit No: PE2

Unit Reference No: K/616/4131

Unit Level: 3

Guided Learning Hours: 57

Total Unit Time (Hours): 132

Unit Credits: 13

### Overview

This skills based unit will enable the learner to configure, start up, commission, optimise and fault find a thermoplastic processing production technique safely and effectively (e.g. rotational moulding, compression moulding, dip moulding, etc.).

It covers the configuring of the machine, former or shaper and ancillary equipment to meet production requirements and includes; preparing the machine, former, ancillary equipment and services, aligning and attaching the former and any ancillaries to the machine, arranging and connecting downstream equipment. Safely and effectively starting the process, stabilising the process by making suitable adjustments, optimising the process and production output by using appropriate process capability studies, analysing the results and determining an effective plan for improvements.

The learner will also recommend any modifications to the former, downstream equipment or material specification to optimise and improve the process.

The unit will enable learners to resolve processing and product problems by being able to confirm any non-compliance, identify symptoms, gather information and identify likely causes, analyse all the evidence collected, determine a solution and carry out a suitable plan to sustain a product within specification

In order to gain this unit the candidates must meet the following learning outcomes by being able to demonstrate that they can carry out the tasks listed in the assessment criteria:

<b>Learning outcomes:</b> what you need to know/ understand		<b>Assessment criteria:</b> what you need to do	
1.	Configure the equipment, forming tool and ancillary equipment for a thermoplastics processing technique to meet production requirements	1.1	Verify the processing machine, forming tool and ancillary equipment requirements will meet the product and processing specification
		1.2	Ensure the equipment and work area is safe and serviceable
		1.3	Arrange and prepare the forming tool ancillary equipment and service connections prior to configuration
		1.4	Set production controls to allow for equipment configuration
		1.5	Determine and confirm any lifting and moving equipment, hand tools and equipment are serviceable and available
		1.6	Move, align and attach the forming tool and any attachments to the machine/equipment
		1.7	Configure and connect downstream and ancillary equipment
		1.8	Perform forming tool and equipment installation/alignment checks safely and effectively
		1.9	Follow safe systems of work and operational procedures
		1.10	Perform machine and any ancillary equipment safety checks
		1.11	Verify the machine set up is configured and prepared for production
2.	Commission a thermoplastics processing technique and shut down after production	2.1	Verify the product and production requirements
		2.2	Confirm the equipment is set up and ready for commissioning

		2.3	Set production controls to allow for a safe and effective start up, taking into account the thermoplastic material specification
		2.4	Confirm the material meets any preparation requirements
		2.5	Purge or clean the equipment and ensure the material is ready for production
		2.6	Start the process safely and effectively and stabilise the operation
		2.7	Incorporate the downstream and ancillary equipment
		2.8	Adjust process settings to produce sample products to production specification safely and efficiently
		2.9	Close down the process following safe systems of work
		2.10	Leave the equipment and area safe and serviceable
3.	Optimise a thermoplastics processing technique and ensure production output	3.1	Verify the thermoplastics processing technique and product are within the production specification
		3.2	Observe the process and identify possible aspects or adjustments to enhance the process
		3.3	Perform appropriate process capability studies
		3.4	Analyse the results and determine an effective plan for improvements
		3.5	Adjust process settings to optimise the process, ensuring the product continues to meet the specification safely and efficiently
		3.6	Recommend any modifications to the equipment, forming tool or material specification to optimise the process
		3.7	Confirm the optimised production can be maintained

4.	Resolve processing and product problems for a thermoplastics processing technique	4.1	Verify the specification for the product processing requirements
		4.2	Confirm the non-compliance and identify symptoms
		4.3	Gather information and identify likely causes
		4.4	Analyse the evidence collected and determine appropriate solutions
		4.5	Design and perform a plan to rectify the problem, allowing for the effect of any adjustments generating secondary problems
		4.6	Resolve processing and product faults safely and effectively
		4.7	Recommend any modifications to the equipment, forming tool, material or processing specification

### Assessment and Grading

This unit is assessed by both the following methods to confirm competence over time and to ensure a consistent skills standard is achieved across all the centre's assessment sites:

- A. The assessor will observe the learner, over time, successfully completing all the assessment criteria within a production environment for a thermoplastic processing technique.
- B. The learners complete a final centre devised practical skills end test for a thermoplastic processing technique in a production environment. The test will cover the configuring, commissioning, optimising and product/process fault-finding; all the assessment criteria will be addressed.

The end test must be monitored and evaluated by the centre to ensure a consistent skills standard is maintained across all assessment sites, irrespective of the types of equipment, processes and materials used.

The production environment in both methods of assessment must not be simulated. Both the observation and skill tests are internally assessed and internally quality assured by the centre.

The ongoing observations and the centre practical skills end test and their management will be externally quality assured by PIABC.

This unit has no grading; learners need to successfully achieve both methods of assessment.

## QUALIFICATION CERTIFICATION

To achieve the full qualification, PIABC Level 3 Diploma in Polymer Processing (QN: 603/2403/X), learners need to successfully gain the 84 credits by completing the six mandatory units, plus two optional units from 1 of the 5 pathways. There is no grading for this qualification.

## GLOSSARY

<b>Term</b>	<b>Definition</b>
Learning Outcome	This describes what a learner needs to know, understand or do as a result of the process of learning.
Assessment Criteria	These are the requirements learners are expected to meet to demonstrate that a learning outcome has been achieved.
Centre	The organisation that is approved by PIABC Limited for the purposes of preparing learners for assessment.