



# **LEVEL 3 DIPLOMA IN POLYMER MANUFACTURING TECHNOLOGIES**

**Centre Qualification Handbook**

**Bespoke Knowledge-based Qualifications**



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## **INTRODUCTION TO THE HANDBOOK**

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This qualification is awarded by PAA\VQ-SET; it is bespoke and offered outside of the Regulated Qualifications Framework (RQF). This qualification is subject to PAA\VQ-SET's quality assurance processes.

This Qualification Handbook has been developed to ensure that PAA\VQ-SET Centres understand the requirements of the qualification. The Handbook contains the following information:

- Qualification Structure
- Process of Assessment
- Glossary
- Qualification Units

This Qualification Handbook has been developed to provide support in the implementation of the qualification as well as giving information to ensure that the assessment and quality assurance is consistent, robust and reliable. The handbook also contains details of the skills and/or knowledge the learner must obtain to achieve the units and qualification.

### Qualification Structure

This section of the handbook summarises the content of the qualification and the skills and/or knowledge learners that achieve it can be expected to gain. It also outlines the units required to achieve the qualification.

### Process of Assessment

The process of assessment outlines how the qualification will be assessed; this may be via an externally set examination, completion of a workbook or assignments, written or practical exercises, or a combination of these.

### Qualification Units

The unit overview summarises the content of the unit and the skills and/or knowledge the learner will have gained on achievement of the unit. The units may also contain additional information in the assessment context which will describe the areas to be covered.

### Qualification Assessment and Support Materials

Centres will be sent the following qualification assessment and support materials:

- Registration Spreadsheet
- Learner Guide
- Qualification Handbook

If the qualification is assessed by external examination and/or Internal Assessments, centres will also receive:

- Mock Examination and Answer Paper
- Internal Assessments and Scoring, if appropriate
- Internal Assessments Results Sheet, as appropriate

## LEVEL 3 DIPLOMA IN POLYMER MANUFACTURING TECHNOLOGIES

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### Qualification Summary

This qualification is designed for individuals working in the Polymer Processing and related sectors. It covers knowledge of Thermoplastic processing, methods and materials; engineering principles and quality assurance and quality control. Learners may then choose to complete units that focus on specific processes within Polymer Processing i.e. Injection Moulding, Parison Blow Moulding or Preform Blow Moulding.

### Achieving the Qualification

To achieve the qualification learners must complete 4 Mandatory Units and both Optional Units from their chosen Pathway.

### Mandatory Units

| Unit No. | Unit Name   |
|----------|---|
| PMT 3.01 | Principles of Polymer and Thermoplastic Materials                 |
| PMT 3.02 | Thermoplastic Processing Technology and Methods                   |
| PMT 3.03 | Engineering Principles used in Thermoplastic Processing           |
| PMT 3.04 | Quality Assurance and Quality Control in Thermoplastic Processing |

### Injection Moulding Pathway

| Unit No. | Unit Name  |
|----------|--|
| PMT 3.05 | Injection Moulding Process - Machines and Mould Tools                    |
| PMT 3.06 | Injection Moulding Processing - Configure, Optimise and Rectify Problems |

### Parison Blow Moulding Pathway

| Unit No. | Unit Name   |
|----------|---|
| PMT 3.09 | Parison Blow Moulding Process - Machines/Equipment and Moulds               |
| PMT 3.10 | Parison Blow Moulding Processing - Configure, Optimise and Rectify Problems |

### Preform Blow Moulding Pathway

| Unit No. | Unit Name   |
|----------|---|
| PMT 3.11 | Preform Blow Moulding Process - Machines/Equipment and Moulds               |
| PMT 3.12 | Preform Blow Moulding Processing - Configure, Optimise and Rectify Problems |

## PROCESS OF ASSESSMENT

The assessment of the Level 3 Diploma in Polymer Manufacturing Technologies will be by Internal Assignments undertaken by the Centre; an external examination set by PAA\VQ-SET and a Practical Assessment skills test.

To achieve the qualification learners must pass the external examination, the Internal Assignments and the Practical Assessment. The qualification is assessed as shown below:

|                       | Unit Number | Internal Assignment | Practical Assessment | External Examination |
|-----------------------|-------------|---------------------|----------------------|----------------------|
| Mandatory Units       | PMT 3.01    | ✓                   |                      | ✓                    |
|                       | PMT 3.02    | ✓                   |                      | ✓                    |
|                       | PMT 3.03    | ✓                   |                      | ✓                    |
|                       | PMT 3.04    | ✓                   |                      | ✓                    |
| Injection Moulding    | PMT 3.05    | ✓                   |                      |                      |
|                       | PMT 3.06    |                     | ✓                    |                      |
| Parison Blow Moulding | PMT 3.09    | ✓                   |                      |                      |
|                       | PMT 3.10    |                     | ✓                    |                      |
| Preform Blow Moulding | PMT 3.11    | ✓                   |                      |                      |
|                       | PMT 3.12    |                     | ✓                    |                      |

### Internal Assignments

The Internal Assignments will cover all 4 Mandatory Units and **ONE** of the Optional Units: PMT3.05, PMT3.09 or PMT3.11 dependant on the learner's chosen Pathway.

The Internal Assignments will be provided by PAA\VQ-SET along with marking criteria and will be externally verified by PAA\VQ-SET.

### Practical Assessment

The Practical Assessment will cover **ONE** of the following Units PMT 3.06, PMT 3.10 or PMT 3.12, dependant on the learners chosen Pathway; and will be externally verified by PAA\VQ-SET.

Practical Assessment guidance will be provided by PAA\VQ-SET.

### External Examination

The External Examination will be set by PAA\VQ-SET and will include questions covering the 4 Mandatory Units.

The questions have been developed by subject experts from the sector and directly relate to the Learning Outcomes and Assessment Criteria for the units contained in this Qualification Handbook.

Examinations will be conducted in accordance with PAA\VQ-SET's requirements to maintain national standards and rigorous quality assurance. Examinations will be held on pre-defined dates as shown on PAA\VQ-SET'S Examination timetable. PAA\VQ-SET, will mark and moderate all examination papers returned by the Examination Centres and Centres will be notified of the results.

Centres will be externally verified by PAA\VQ-SET to ensure that examinations, assignments and the Practical Assessment have been conducted at the required standard.

Should a learner not pass all the required units from a qualification they will receive a unit certificate for the units they have achieved and will need to register to re-sit the failed units. Once all units have been achieved a certificate for the full qualification can be issued.

PAA\VQ-SET will also provide a mock examination paper, and answer paper, to enable learners to prepare and revise for the external examination.

Further information regarding PAA\VQ-SET's requirements for Externally Examined Knowledge-based qualifications can be found in the Centre Portfolio.

## GLOSSARY

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| Term                                 | Definition  |
|--------------------------------------|---|
| <b>Access Arrangements</b>           | Arrangements that are approved in advance of an examination or assessment to allow achievement to be demonstrated by learners with a disability, special learning needs (including where the learner's first language is not English, Welsh or Irish) or to avoid unlawful discrimination |
| <b>Appeal</b>                        | The process through which an awarding organisation may be challenged on the outcome of an enquiry about results or, where appropriate, other procedural decisions affecting a centre or an individual learner   |
| <b>Assessment</b>                    | The process of making judgements about the extent to which a learner's work meets the requirements of a unit, or any additional assessment requirements of a qualification  |
| <b>Assessor</b>                      | A person who assesses a learner's work  |
| <b>Learning Time</b>                 | The amount of time a learner at the level of the unit is expected to take, on average, to complete the unit to the standard required  |
| <b>Mandatory Units</b>               | Units that must be achieved for the qualification to be awarded   |
| <b>Optional Unit</b>                 | A unit that a learner may choose to complete to achieve the required number of units for award of the qualification   |
| <b>Pathway</b>                       | A route to the achievement of a qualification that requires particular units to be achieved and is identified by an endorsement to a qualification title  |
| <b>Qualification</b>                 | An award made to a Learner for the achievement of the required units or other components for that qualification   |
| <b>Qualification Level</b>           | An indication of the relative demand, complexity and/or depth of achievement, and/or the autonomy of the learner, represented by a qualification  |
| <b>Standardisation Of Assessment</b> | A process to ensure that assessment leading to the award of qualifications is applied consistently by individuals, centres and awarding organisations   |

## **LEVEL 3 DIPLOMA IN POLYMER MANUFACTURING TECHNOLOGIES**

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### **CONTENT OF THE QUALIFICATION**

#### **MANDATORY UNITS**

**UNIT PMT 3.01                    PRINCIPLES OF POLYMER AND THERMOPLASTIC MATERIALS**

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#### **Unit Overview**

This unit covers the knowledge of polymer and thermoplastic materials in the polymer manufacturing industries.

#### **Assessment Context**

The following terms have a specific meaning in this unit:

Common polymer chemical terms to include: atoms, chains, bonding of elements, monomers, polymers

Production and application of biodegradable plastics to include: corn and starch based polymers

Describe the differences between types of plastics materials to include: virgin, regrind, reprocessed and recycled

Key physical properties of thermoplastic materials to include: comparative cost of common commodity and high performance plastic materials

Key processing properties and characteristics to include: degradation of common commodity and high performance and engineering type plastic materials

Main applications of a range of thermoplastic materials to include: common commodity and high performance plastic materials.

Common trade names and abbreviations of Polymer materials used in Engineering

Colorant forms to include dry, master batch, liquid, and compounded

Flow behaviours including Bingham, Pseudo plastic, Dilatent flow and Thixotropic

## Learning Outcome and Assessment Criteria

| Learning outcomes<br>The learner will:  | Assessment criteria<br>The learner can:  |
|---|--|
| 1. Know the classifications and common terminology used for polymers  | 1.1. State polymer, elastomer, plastics and composite type materials<br>1.2. Define thermoplastics, thermoset, copolymers, elasticity and plasticity<br>1.3. Explain common polymer chemical terms<br>1.4. Describe the polymerisation process for plastic materials<br>1.5. Explain the production and application of biodegradable plastics<br>1.6. Identify commodity plastics, their abbreviation and common trade names<br>1.7. Identify engineering type polymer materials<br>1.8. Describe the main differences between types of plastic materials  |
| 2. Know the properties and usage of commodity and high performance thermoplastic materials                        | 2.1. Describe the key physical properties of thermoplastic materials<br>2.2. Describe the key processing properties and characteristics of thermoplastic materials<br>2.3. State the main applications of a range of thermoplastic materials   |
| 3. Know the different types of additives, their benefits and limitations when used within thermoplastic materials | 3.1. Explain why different types of additives are used in polymeric materials<br>3.2. Describe the different methods of incorporating additives to polymeric materials<br>3.3. State common additives which enhance product performance<br>3.4. Describe cost comparisons of common additives<br>3.5. Explain the benefits and limitations of product performance additives<br>3.6. State common additives which benefit processing performance<br>3.7. Explain the benefits and limitations of processing type additives<br>3.8. Explain the side effects of additives on thermoplastic materials<br>3.9. State the types of colorant forms<br>3.10. Explain the benefits of co-polymer, alloys and blends applications to enhance product properties |

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|---|---|
| <p>4. Understand the flow and thermal behaviour of polymeric materials</p>      | <p>4.1. Describe Newtonian flow behaviours</p> <p>4.2. Describe Non-Newtonian flow behaviour of plastic materials</p> <p>4.3. Explain the terms and concepts of viscosity, shear stress and shear rate</p> <p>4.4. Describe common flow/viscosity indexes and the differences between them</p> <p>4.5. Describe the terms specific heat, and thermal stability</p> <p>4.6. Explain the relevance of viscosity temperature graphs</p> <p>4.7. Explain the flow behaviour and final product properties of hydroscopic thermoplastic materials</p> |
| <p>5. Understand morphology in relation to thermoplastic product properties</p> | <p>5.1. Define polymer morphology, crystallinity, glass transition and melting points</p> <p>5.2. State the factors that determine Glass Transition Temperature (T<sub>g</sub>) in polymers</p> <p>5.3. Explain the factors that determine the amount of crystallinity in a product</p> <p>5.4. Describe how different plastic materials crystallise</p> <p>5.5. Explain the causes of crystallinity in plastic materials</p> <p>5.6. Describe how crystallinity affects the properties of plastic materials</p>                                |

**Unit Overview**

This unit provides learners with an understanding of the engineering and thermal principals required to process polymeric materials into products. Learners will develop an understanding of the different processing techniques (including for both thermoplastics and thermosets), the design requirements for forming and shaping, pre and post forming requirements and techniques, together with an understanding of processing and product testing procedures.

**Assessment Context**

The following terms have a specific meaning in this unit:

Mould tools to include injection, compression, thermoforming, rotational, blow moulding Processes

Post forming automated handling techniques for different processes to include automated packaging

**Learning Outcome and Assessment Criteria**

| <b>Learning outcomes</b><br><b>The learner will:</b>  | <b>Assessment criteria</b><br><b>The learner can:</b>  |
|---|--|
| 1. Understand the engineering and thermal requirements for processing thermoplastic materials                 | 1.1. Describe the heat and pressure requirements for processing thermoplastic materials<br>1.2. Explain the curing mechanism cycle when processing thermosets<br>1.3. Describe the composite shaping process<br>1.4. Describe continuous polymer process techniques, their forming and downstream processing requirements<br>1.5. Explain the advantages and limitations of continuous polymer process techniques<br>1.6. Describe the commonly used batch polymer process techniques for the forming and processing cycle<br>1.7. Explain the advantages and limitations of the commonly used batch polymer process techniques<br>1.8. Explain the initial set up and running costs of common types of processing equipment, mould/formers, and ancillary equipment |
| 2. Understand the tools and moulds for thermoplastic shaping processes  | 2.1. Explain the design advantages and limitations of different types of mould tools<br>2.2. Explain the design advantages and limitations of different types of continuous formers/dies<br>2.3. Describe the advantages and limitations of making, operating and maintaining different types of mould tools<br>2.4. Describe the advantages and limitations of making, operating and maintaining different types of continuous formers/dies   |
| 3. Understand the pre-processing requirements for polymer manufacturing processes for thermoplastic materials | 3.1. Describe pre-processing requirements for different polymeric materials<br>3.2. Explain how to pre-heat thermoplastic materials for different processing techniques<br>3.3. Describe methods of colouring thermoplastic materials<br>3.4. Explain the methods used for incorporating additives<br>3.5. Explain the advantages and limitations of various ways to pre-heat thermoplastic materials  |
| 4. Understand the post processing requirements and techniques for thermoplastic materials                     | 4.1. Explain post formed cooling operations<br>4.2. Describe the benefits and limitations of post formed cooling operations<br>4.3. State the post forming automated handling techniques for different processes<br>4.4. Describe printing/decorating techniques associated with different processes<br>4.5. Describe assembly and finishing techniques for both “batch” and “continuous” type production products   |

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|  | 4.6. Explain the “added value” benefits and limitations of post processing activities   |
| 5. Understand standard testing methods for thermoplastic processing and products | 5.1. List the international, national and company testing standards<br>5.2. Describe the main flow and thermal test procedures carried out on polymeric materials<br>5.3. Describe the physical testing procedures carried out on thermoplastic products<br>5.4. Explain how flowability and processing characteristics affect product properties |

**Unit Overview**

This unit provides learners with an understanding of the engineering operation, mechanical systems and components used in plastic processing, including electrical systems and components, pneumatic and hydraulic systems and components, routine servicing and maintenance of equipment and fault finding techniques.

**Assessment Context**

The following terms have a specific meaning in this unit:

Mechanical power transmission systems to include shafts and toggles, belt drives, cams, levers, gearing and couplings

Workshop equipment to include lathes, grinders and milling machines

Mechanical components will include bearings, guide pins/bushes, springs

Lifting equipment to include hoists, cranes, jacks, rollers, slings and shackles

Permanent joining techniques to include welding and brazing techniques

Cooling systems to include chillers, cooling towers, water treatments, flow, volume, pressure and their cooling capacities

Principals of electricity including ohms law, single and three phase, AC, DC, power and electro magnetism

Electrical components will include fuses, switches, solenoids, transformers, timers, motors, heaters and thermocouples

Electronic components will include resistors, diodes, capacitors, transistors, control relays

Pneumatic components to include compressors, filters, driers, valves and cylinders

Pneumatic circuits to include flow rates/volume, reducers and associated pipe-work

Hydraulic components to include pumps, valves and cylinders

Hazards associated with maintenance and the servicing of equipment to include permits to work procedures

## Learning Outcome and Assessment Criteria

| <b>Learning outcomes</b><br><b>The learner will:</b>   | <b>Assessment criteria</b><br><b>The learner can:</b>  |
|--|--|
| 1. Understand the operation of mechanical systems and components used in thermoplastic processing              | 1.1. Describe the structural and modular designs used in thermoplastic processing machines<br>1.2. Describe the typical factory services required to operate a plastic processing plant<br>1.3. Describe the operation of mechanical power transmission systems<br>1.4. Describe the operation of maintenance workshop equipment<br>1.5. Explain the application and safe operation of lifting equipment<br>1.6. Explain the use and application of mechanical components<br>1.7. Describe the requirements and design of typical cooling systems and their cooling capacities |
| 2. Understand the use and operation of joining techniques used in thermoplastic processing                     | 2.1. Describe the types of mechanical fastening devices available and their applications<br>2.2. Describe the range of screws and bolts available and their applications<br>2.3. Explain the types of mechanical locking devices and techniques used with plastic processing equipment<br>2.4. Describe permanent joining techniques<br>2.5. Explain the benefits and limitations of permanent joining techniques<br>2.6. State the different mechanical seals and gaskets used with plastic processing equipment  |
| 3. Understand the operation of electrical systems and components used in thermoplastic processing              | 3.1. State the principles of electricity<br>3.2. Explain the hazards and safety precautions associated with electricity<br>3.3. Describe the operation of common electrical components<br>3.4. Describe the operation of common electronic components<br>3.5. State the different electrical plugs/sockets and connections used with plastic processing equipment<br>3.6. Explain how to read simple electrical drawings and identify the key components   |
| 4. Understand the operation of pneumatic and hydraulic systems and components used in thermoplastic processing | 4.1. State the principals of pneumatics<br>4.2. Explain the hazards and safety precautions associated with the use of pneumatics<br>4.3. Describe the operation of common pneumatic components<br>4.4. Explain the design of typical pneumatic circuits<br>4.5. Explain how to read simple pneumatic drawings and identify the key components  |

|  |   |
|--|---|
|  | <ul style="list-style-type: none"> <li>4.6. Explain the principals of hydraulics</li> <li>4.7. Describe the hazards and safety precautions associated with use of hydraulics</li> <li>4.8. Describe the operation of common hydraulic components</li> <li>4.9. Explain how to read simple hydraulic drawings and identify the key components</li> <li>4.10. Describe the types of pipe work, seals and connections used with pneumatic and hydraulic systems for plastic processing equipment</li> </ul>  |
| <p>5. Understand routine maintenance and servicing routines used in thermoplastic processing</p> | <ul style="list-style-type: none"> <li>5.1. Explain the advantages and limitations of routine service schedules for different types of plastic processing equipment</li> <li>5.2. Explain the hazards associated with maintenance and the servicing of equipment</li> <li>5.3. Describe typical mechanical maintenance procedures for plastic processing equipment</li> <li>5.4. Describe typical pneumatic and hydraulic maintenance procedures carried out with plastic processing equipment</li> </ul> |
| <p>6. Understand how to carryout equipment faulty finding techniques</p>                         | <ul style="list-style-type: none"> <li>6.1. Explain how to define a fault</li> <li>6.2. Explain different fault finding techniques and their advantages</li> <li>6.3. Describe the hazards associated with fault finding techniques</li> <li>6.4. Describe how to collect information on faults and identify causes</li> </ul>  |

**Unit Overview**

This unit provides learners with an understanding of quality arrangements when processing plastic materials; including quality assurance and quality control; the benefits of different quality accreditation systems; the different quality management and improvement schemes used in plastic processing.

**Assessment Context**

The following terms have a specific meaning in this unit:

Quality Management Tools to include Statistical Process Control (SPC), Six Sigma, statistical Design of Experiments (DOE)

Lean Manufacturing methods to include Single Minute Exchange of Dies (SMED), Five 'S' and Kaizen

## Learning Outcome and Assessment Criteria

| <b>Learning outcomes</b><br><b>The learner will:</b>   | <b>Assessment criteria</b><br><b>The learner can:</b>   |
|--|---|
| 1. Understand the quality arrangements when processing thermoplastic materials                                   | <ul style="list-style-type: none"><li>1.1. Define the term 'quality' with regard to the customer and supplier; both internal and external</li><li>1.2. Explain the benefits of reducing non-compliant products</li><li>1.3. Describe the roles and responsibilities within quality systems</li><li>1.4. Explain the potential value and cost to a company when investing in quality systems</li><li>1.5. Explain the importance of standard operating procedures</li></ul>              |
| 2. Understand quality assurance and quality control used in thermoplastic processing                             | <ul style="list-style-type: none"><li>2.1. Define quality assurance and describe the benefits</li><li>2.2. Define quality control and describe the benefits</li><li>2.3. Describe quality improvement</li><li>2.4. Explain how quality assurance principles are applied to a process and the product</li><li>2.5. Describe when quality control would be appropriate in thermoplastic processing</li><li>2.6. Explain the need for appropriate sampling and auditable records</li></ul> |
| 3. Understand the needs and benefits of different quality accreditation systems used in thermoplastic processing | <ul style="list-style-type: none"><li>3.1. Describe the need for quality standards</li><li>3.2. List national and international quality standards, including examples employed in thermoplastic processing</li><li>3.3. Explain the purpose of industry and company quality standards, their benefits and limitations</li><li>3.4. Explain how quality standards benefit the supply chain</li></ul>   |
| 4. Understand the different quality management and improvement schemes used in thermoplastic processing          | <ul style="list-style-type: none"><li>4.1. Explain the need for an organisation to continually improve</li><li>4.2. Explain the main management improvement techniques and their benefits</li><li>4.3. Describe the concept of total quality management and identify example models and tools used in the plastic processing industry</li><li>4.4. Describe the concept of lean manufacturing and the methods used</li></ul>  |

**Unit Overview**

This unit provides learners with an understanding of the equipment required to injection mould different thermoplastic materials into moulded products.

Learners will develop knowledge of the variations in machine construction and type together with mould tool design and controls to enable different thermoplastic materials to be moulded into quality products, including the use of different moulding techniques.

Learners will also gain an understanding of the need for different types of ancillary equipment and their function relative to the moulding process.

**Assessment Context**

The following terms have a specific meaning in this unit:

Moulds to include use of 'two plate' and 'multi plate'

Power/drive/control systems to include hydraulic, mechanical and electrical

Machine operation to include valves, motors, pumps, timers, transducers and switches

Downstream equipment to include robotics and product handling equipment

Mould profiling to include injection speeds, pressures settings, back pressures and screw speed

**Learning Outcome and Assessment Criteria**

| <b>Learning outcomes</b><br><b>The learner will:</b>   | <b>Assessment criteria</b><br><b>The learner can:</b>  |
|--|--|
| 1. Understand the design and operational features of a mould tool used in the injection moulding process | 1.1. Describe the functions of the mould tool during the injection moulding cycle<br>1.2. Describe the construction of a mould tool<br>1.3. Describe the moulding cycle<br>1.4. State the characteristics of moulds<br>1.5. Calculate the available projected area for an injection mould tool<br>1.6. Explain the different types of feed systems used for injection mould tools<br>1.7. Explain the aspects of standard, hot and insulated runners and gates and their controls<br>1.8. Describe common mould cooling systems<br>1.9. Explain mould ejection systems |
| 2. Understand machine design features  | 2.1. Identify the requirements of the moulding machine<br>2.2. Explain power/drive/control systems<br>2.3. Calculate machine clamping forces<br>2.4. Describe the principles of screw and nozzle designs<br>2.5. Explain the injection unit “specification”<br>2.6. Calculate machine injection pressures<br>2.7. Explain the methods and controls for machine heating and cooling<br>2.8. Describe how the moulding machine operates<br>2.9. Explain the setting control options  |
| 3. Know the different types of ancillary equipment used in the injection moulding process                | 3.1. Explain the functions of material feed and drying units<br>3.2. Describe machine/process support equipment used in the injection moulding process<br>3.3. Describe downstream equipment used in the injection moulding process<br>3.4. Describe the functions of secondary operations in the injection moulding process   |
| 4. Know the different injection moulding techniques used with various mould tools and materials          | 4.1. Explain basic heating, flow and cooling characteristics of polymers<br>4.2. Describe start up, shut down and purge procedures<br>4.3. Describe the material flow characteristics during the different injection moulding stages<br>4.4. State process parameters and barrel temperatures for common materials<br>4.5. Explain the benefits of profiling<br>4.6. Calculate cycle times and production rates for different moulding techniques  |

|  |   |
|--|---|
| 5. Know how to identify and overcome injection moulding faults | 5.1. Describe processing faults, their cause and solution for the injection moulding process<br>5.2. Explain how to control the quality of the product  |
| 6. Know the safety requirements for injection moulding         | 6.1. Explain the safety features and safety checks for injection moulding machines and tools<br>6.2. State the legal requirements for injection moulding machines and tools and ancillary equipment |

**Unit Overview**

This unit enables learners to gain skills in the injection moulding process, moulding techniques and process optimisation. Learners will gain skills in formatting and commissioning mould tools and ancillary equipment, setting and adjusting moulding parameters to overcome problems and optimise the process.

**Assessment Guidance and Evidence Requirements**

The learner should provide evidence to meet the requirements of the Assessment Criteria.

- The use of simulation is not acceptable in the assessment of this unit

**Assessment Context**

The following terms have a specific meaning in this unit:

Verify the injection moulding process is ready for production start-up to include support equipment and services

Production set up to be within agreed normal production time scales and conditions

Mould tool alignment to include ejection, heating and cooling connections

Production start-up to include associated support equipment and services

Improvement recommendations to consider choice of moulding machine, downstream equipment, materials and product specification; further considerations may include cycle times, product weight, material usage, equipment performance, power consumption and environmental factors

**Learning Outcome and Assessment Criteria**

| <b>Learning outcomes</b><br><b>The learner will:</b>                     | <b>Assessment criteria</b><br><b>The learner can:</b>   |
|--|---|
| 1. Install and set mould tools in production injection moulding machines | 1.1. Confirm moulding machine and mould tool specifications<br>1.2. Prepare mould tool alignment<br>1.3. Check lifting and moving equipment<br>1.4. Use appropriate hand tools and equipment<br>1.5. Prepare the machine for the mould tool<br>1.6. Manoeuvre and lift the mould tool to the machine<br>1.7. Align and clamp the mould into the machine<br>1.8. Align and connect service connections and any ancillary equipment<br>1.9. Adjust machine settings to provide mould movement and operation<br>1.10. Carry out mould protection checks<br>1.11. Carry out machine safety checks<br>1.12. Confirm the installation is ready for production<br>1.13. Comply with safe systems of work |
| 2. Prepare, start-up and close down injection moulding machines          | 2.1. Verify the moulding machine is ready for production start-up<br>2.2. Ensure the polymer material meets the specification<br>2.3. Select and input suitable process parameters to start the process<br>2.4. Purge and confirm the material is ready for production<br>2.5. Start the moulding process and produce sample mouldings<br>2.6. Integrate mould conditioning units and product and material handling equipment<br>2.7. Operate and control the process safely and efficiently<br>2.8. Shut down the process following safe systems of work   |
| 3. Identify and overcome processing and product problems                 | 3.1. Identify the necessary product and processing quality standard and output requirements<br>3.2. Identify product and processing faults<br>3.3. Collect evidence/symptoms and identify possible remedies<br>3.4. Plan to overcome the problems taking account of processing variables<br>3.5. Take account of the effect of adjusting certain parameters on component quality<br>3.6. Overcome processing and product faults<br>3.7. Make recommendations to improve the mould, materials or product specification   |

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| 4. Optimise the injection moulding process | <ul style="list-style-type: none"><li>4.1. Confirm the process and product meet the minimum specified quality standard and output requirements</li><li>4.2. Review the process parameters and identify any potential areas of improvement</li><li>4.3. Carry out simple process capability studies</li><li>4.4. Make suitable adjustments to improve the process parameters</li><li>4.5. Ensure the optimised cycle is sustainable</li><li>4.6. Identify and report any areas for improvement in the injection moulding process</li></ul> |
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Unit Overview

This unit provides learners with a general understanding of the equipment required to extrusion blow mould different thermoplastic materials into moulded products. Learners will develop specific knowledge for a Parison blow moulding process including the variations in machine construction and type together with mould tool design and controls to enable different thermoplastic materials to be moulded into quality products, including the use of different moulding techniques. Learners will also gain an understanding of the need for different types of ancillary equipment and their function relative to the moulding process.

This unit requires a detailed explanation for **one type** of Parison blow moulding process.

Assessment Context

The following terms have a specific meaning in this unit:

Machine design principals to include extruder screw for different materials and products including Compression ratio, length/diameter (L/D) ratio and screw heads

Parison die design to include weight/strength ratios, die swell and material flow rate.

Parison mould construction to include surface finish, cooling, materials used and construction techniques

Mould characteristics to include mould parts, uses of moulds, associated blowing equipment, machine clamping, Parison cutters, blow pins, de-flash, ejection, base weld and calibration

Pneumatic system for a blow moulding process to include air quality, capacity and control

Ancillary equipment to include material feeders, blenders and drying units

Process support equipment to include temperature control units and associated connections

Downstream equipment to include product handling equipment and testing

**Learning Outcome and Assessment Criteria**

| <b>Learning outcomes</b><br><b>The learner will:</b>   | <b>Assessment criteria</b><br><b>The learner can:</b>  |
|--|--|
| 1. Understand the principles of the Parison blow moulding process  | 1.1. Describe the common blow moulding techniques and processes used for plastic materials<br>1.2. Explain the benefits and limitations of the various blow moulding processes<br>1.3. Explain the benefits and limitations of the various blow moulding products<br>1.4. State the cycle of the Parison blow moulding process<br>1.5. Describe the behaviour of the plastic material during the processing cycle for a Parison blow moulding process<br>1.6. Describe the purpose of the mould in a Parison blow moulding process |
| 2. Understand extruder design features for the Parison blow moulding process                               | 2.1. Describe the requirements of the machine with respect to the production of a Parison<br>2.2. Describe the key design aspects of an extruder screw for different materials/products<br>2.3. Explain the methods of extruder heating and cooling<br>2.4. Explain the methods for control of extruder heating and cooling<br>2.5. Describe the main extruder control feedback systems  |
| 3. Understand the different extrusion head and Parison design features of a Parison blow moulding process  | 3.1. Describe the main design features of an extruder head for the production of a Parison<br>3.2. Explain the advantages and disadvantages of common extruder heads<br>3.3. Describe the principals of multi head blow moulders<br>3.4. Describe the principals of Parison control through the die  |
| 4. Understand the different mould tool designs and operational features of a Parison blow moulding process | 4.1. Describe the different functions of the mould tool in the moulding cycle<br>4.2. Describe the design aspects for the construction of a mould<br>4.3. Explain the main characteristics and uses of moulds and associated blow moulding equipment<br>4.4. Describe the care and maintenance requirements for blow moulding moulds   |
| 5. Understand machine controls and functions for a Parison blow moulding process                           | 5.1. Explain the control requirements of the Parison blow moulding machine with respect to the moulding cycle<br>5.2. Describe the key functions of a pneumatic system for a blow moulding process   |
| 6. Know the safety requirements for a Parison blow moulding process  | 6.1. Explain the safety features and safety checks for extrusion blow moulding machines and ancillary equipment<br>6.2. State the legal requirements for extrusion blow moulding machines and ancillary equipment  |

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| <p>7. Know the types of ancillary equipment used in the extrusion blow moulding process</p>                               | <p>7.1. Explain the function of ancillary equipment used in a Parison blow moulding process</p> <p>7.2. Describe the machine/process support equipment used in a Parison blow moulding process</p> <p>7.3. Identify downstream equipment used in a Parison blow moulding process</p> <p>7.4. Identify secondary operations and their functions in a Parison blow moulding process</p>   |
| <p>8. Know how to control the process and identify and overcome processing faults for a Parison blow moulding process</p> | <p>8.1. Describe basic heating, flow and cooling characteristics of plastic materials during the Parison blow moulding process</p> <p>8.2. State typical process parameters and temperatures for common materials used in Parison blow moulding</p> <p>8.3. Describe start up, shut down and purge procedures</p> <p>8.4. Explain the flow and grade characteristics of thermoplastic materials used in Parison blow moulding</p> <p>8.5. Describe processing faults, their possible cause and solution</p> <p>8.6. Describe cycle times and production rates</p> |

**Unit Overview**

This unit enables learners to gain skills in the Parison blow moulding process, moulding techniques and process optimisation. Learners will gain skills in formatting and commissioning mould tools and ancillary equipment, setting and adjusting moulding parameters to overcome problems and optimise the process.

**Assessment Guidance and Evidence Requirements**

The learner should provide evidence to meet the requirements of the Assessment Criteria.

- The use of simulation is not acceptable in the assessment of this unit

**Assessment Context**

The following terms have a specific meaning in this unit:

Verify the moulding process is ready for production start-up to include support equipment and services

Production set up to be within agreed normal production time scales and conditions

Mould tool alignment to include blow pin, heating and cooling connections

Allied equipment to include neck calibration, blow pin, cutter and de-flash

Ancillary equipment to include blenders, conveyors and leak testing

Moulding process improvements to include choice of moulding machine, mould, and material and product specification

Improvement recommendations to consider choice of moulding machine, downstream equipment, materials and product specification; further considerations may include cycle times, product weight, material usage, equipment performance, power consumption and environmental factors

## Learning Outcome and Assessment Criteria

| <b>Learning outcomes</b><br><b>The learner will:</b>                              | <b>Assessment criteria</b><br><b>The learner can:</b>   |
|---|---|
| 1. Install and set mould tools in a production type Parison blow moulding machine | 1.1. Confirm moulding machine, mould tool specifications and material requirements<br>1.2. Identify and prepare any appropriate mould tool alignment<br>1.3. Identify and check appropriate lifting and moving equipment<br>1.4. Identify and use appropriate hand tools and equipment<br>1.5. Prepare the machine for the mould tool change<br>1.6. Manoeuvre and lift the mould tool to the machine<br>1.7. Follow safe systems of work<br>1.8. Align and clamp the mould into the machine<br>1.9. Align and connect allied equipment<br>1.10. Align and connect ancillary equipment<br>1.11. Adjust machine settings as required by organisational procedures<br>1.12. Carry out mould protection checks<br>1.13. Carry out machine safety checks<br>1.14. Confirm the installation is ready for production set up |
| 2. Prepare, start-up and close down a Parison moulding machine                    | 2.1. Verify the moulding machine is ready for production start-up<br>2.2. Ensure the plastic material meets the specification<br>2.3. Select, and input suitable process parameters to start the process<br>2.4. Purge and confirm the material is ready for production<br>2.5. Start the moulding process and produce sample mouldings<br>2.6. Integrate Parison programming, mould conditioning units and product and material handling equipment<br>2.7. Operate and control the process safely and efficiently<br>2.8. Shut down the process following safe systems of work   |
| 3. Identify and overcome processing and product problems                          | 3.1. Identify the necessary product and processing quality standard and output requirements from the specification<br>3.2. Identify product and processing faults<br>3.3. Collect evidence/symptoms and identify possible remedies<br>3.4. Overcome product problems<br>3.5. Take account of the effect of adjusting certain parameters on component quality<br>3.6. Overcome processing and product faults   |

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|   | 3.7. Make recommendations to improve the mould, materials or product specification   |
| 4. Optimise the Parison blow moulding process | 4.1. Confirm the process and product meet the minimum output requirements<br>4.2. Review the process parameters and identify any areas of improvement<br>4.3. Carry out simple process capability studies<br>4.4. Make suitable adjustments to the process parameters<br>4.5. Ensure the optimised cycle is sustainable<br>4.6. Identify and report any areas for improvement in the Parison blow moulding process |

Unit Overview

This unit provides learners with a general understanding of the equipment required to blow mould different thermoplastic materials into moulded products. It includes the variations in machine construction and type, together with mould tool design and controls to enable different thermoplastic materials to be moulded into quality products, including the use of different moulding techniques. Learners will also gain an understanding of the need for different types of ancillary equipment and their function relative to the moulding process.

This unit requires a detailed explanation for **one type** of preform blow moulding process that can be injection blow moulding or injection stretch blow moulding machines. To include the variations in machine construction, mould tool design and controls to enable different thermoplastic materials to be moulded into quality products.

Assessment Context

The following terms have a specific meaning in this unit:

Pneumatic systems to include air quality, capacity and control

Ancillary equipment to include material feeders, blenders and drying units

Process support equipment to include temperature control units and associated connections

Secondary operations to include functions of product handling equipment labelling, filling, stacking and testing

## Learning Outcome and Assessment Criteria

| Learning outcomes<br>The learner will:   | Assessment criteria<br>The learner can:   |
|--|---|
| 1. Understand the requirements of the preform blow moulding process  | 1.1. Describe the main preform blow moulding techniques and processes used with plastic materials<br>1.2. Explain the benefits and limitations of the different types of preform blow moulding processes<br>1.3. Describe the production of a preform<br>1.4. Explain the key design considerations for various preforms<br>1.5. Explain the advantages and limitations of different preform manufacturing processes<br>1.6. Describe the design features of a preform blow moulding process<br>1.7. Describe the cycle and functions of each stage for the preform blow moulding process<br>1.8. Describe the behaviour of the plastic material through the cycle of a preform blow moulding process<br>1.9. Explain the requirements of the machine and mould for the preform blow moulding process |
| 2. Understand the different preform preheating and loading designs and functions for the preform blow moulding process | 2.1. Explain the different preform heating options used and their advantages and limitations<br>2.2. Describe the preheating conditions for preform materials<br>2.3. Explain the design and operation of a preform heating process<br>2.4. Describe preform feed and loading options<br>2.5. Explain the advantages and limitations of preform feed and loading<br>2.6. Describe the preheating and handling process and product faults  |
| 3. Understand the different mould tool designs and operational features of the preform blow moulding process           | 3.1. Explain the different functions of the mould tool during the moulding cycle<br>3.2. Describe the key design aspects of the construction of a mould<br>3.3. Explain the main characteristics, parts and uses of moulds and associated blow moulding equipment<br>3.4. Describe the care and maintenance requirements for preform moulds   |
| 4. Understand the range of machine controls and functions for the preform blow moulding process                        | 4.1. State the control requirements of the machine for the preform blow moulding cycle<br>4.2. Describe the key requirements of a pneumatic system for a preform blow moulding process<br>4.3. Explain the different methods of controlling machine heating and cooling   |

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| 5. Know the safety requirements for the preform blow moulding process                       | 5.1. Explain the safety features and safety checks for preform blow moulding<br>5.2. State the legal requirements for preform blow moulding machines and ancillary equipment   |
| 6. Know the different types of ancillary equipment used in preform blow moulding operations | 6.1. State the downstream equipment used in preform blow moulding operations<br>6.2. Explain the functions and options of ancillary equipment available for different materials<br>6.3. Describe machine/process support equipment<br>6.4. Describe the secondary operations associated with preform blow moulding operations and their main function  |
| 7. Know how to control the preform blow moulding process                                    | 7.1. Describe heating, flow and cooling characteristics of plastic materials during the preform blow moulding process<br>7.2. Describe typical process parameters and temperatures for common plastic materials used<br>7.3. Describe typical start up, shut down and any purge procedures<br>7.4. Explain the flow and grade characteristics of plastic materials used in preform blow moulding |
| 8. Know how to identify and overcome processing faults                                      | 8.1. Describe preform blow moulding processing faults, their cause and solution<br>8.2. Describe how to control the quality of the product   |

**Unit Overview**

This unit enables learners to gain skills in the preform blow moulding process, moulding techniques and process optimisation. Learners will gain skills in formatting and commissioning mould tools and ancillary equipment, setting and adjusting moulding parameters to overcome problems and optimise the process.

**Assessment Guidance and Evidence Requirements**

The learner should provide evidence to meet the requirements of the Assessment Criteria.

- The use of simulation is not acceptable in the assessment of this unit

**Assessment Context**

The following terms have a specific meaning in this unit:

Verify the moulding process is ready for production start-up to include: support equipment and services

Production set up to be within agreed normal production time scales and conditions

Mould tool alignment to include ancillary equipment, services and connections

Allied equipment to include preform/bottle conveyors and feeders

Improvement recommendations to consider choice of moulding machine, downstream equipment, materials and product specification; further considerations may include cycle times, product weight, material usage, equipment performance, power consumption and environmental factors

## Learning Outcome and Assessment Criteria

| Learning outcomes<br>The learner will:  | Assessment criteria<br>The learner can:   |
|---|---|
| 1. Install and set mould tools in a production type preform blow moulding machine | 1.1. Confirm moulding machine, mould tool specifications and material requirements<br>1.2. Identify and prepare mould tool alignment<br>1.3. Identify and check appropriate lifting and moving equipment<br>1.4. Identify and use appropriate hand tools and equipment<br>1.5. Prepare the machine for the mould tool change<br>1.6. Manoeuvre and lift the mould tool to the machine<br>1.7. Follow safe systems of work<br>1.8. Align and clamp the mould into the machine<br>1.9. Install, align and connect allied equipment<br>1.10. Align and connect ancillary equipment<br>1.11. Adjust machine settings to provide mould movement and operation<br>1.12. Carry out mould protection checks<br>1.13. Carry out machine safety checks<br>1.14. Confirm the installation is ready for production set up |
| 2. Prepare, start-up and close down a preform moulding machine                    | 2.1. Verify the machine is ready for production start-up<br>2.2. Ensure the plastic material/preform meets the specification<br>2.3. Select and input suitable process parameters to start the process<br>2.4. Purge and confirm the material is ready for production<br>2.5. Start the moulding process and produce sample mouldings<br>2.6. Integrate the preform conditioning, mould conditioning units and product and preform handling equipment<br>2.7. Operate and control the process safely and efficiently<br>2.8. Shut down the process following safe systems of work   |
| 3. Identify and overcome processing and product problems                          | 3.1. Identify the necessary product and processing quality standard and output requirements from the specification<br>3.2. Identify product and processing faults<br>3.3. Collect evidence/symptoms and identify possible remedies<br>3.4. Determine a plan to overcome problems<br>3.5. Take account of the effect of adjusting certain parameters on component quality<br>3.6. Overcome processing and product faults   |

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|  | 3.7. Make recommendations to improve the mould, materials/preforms or product specification  |
| 4. Optimise the preform moulding process | <ul style="list-style-type: none"><li>4.1. Confirm the process and product meet the minimum specified quality standard and output requirements</li><li>4.2. Review the process parameters and identify any potential areas of quality improvement</li><li>4.3. Carry out simple process capability studies</li><li>4.4. Make suitable adjustments to improve performance</li><li>4.5. Ensure the optimised cycle/output rate is sustainable</li><li>4.6. Identify and report any areas for improvement in the preform moulding process</li></ul> |

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