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AUTOMOTIVE PARTS PRODUCTION MACHINE OPERATOR

LEARNER GUIDE

National Vocational Certificate Level 4

Version 1 - October, 2019

NAVTTC

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- **Learning Elements:**
  - This is the main content of your learner's guide with detail of the knowledge and skills (practical activities, projects, assignments, practices etc.) you will require to achieve learning outcomes stated in the curriculum
  - This section will include examples, photographs and illustrations relating to each learning outcome
- **Summary of modules**:
  - This contains the summary of the modules that make up your learner's guide
- **Frequently asked questions**:
  - These have been added to provide further explanation and clarity on some of the difficult concepts and areas. This further helps you in preparing for your assessment.
- **Multiple choice questions for self-test**:

These are provided as an exercise at the end of your learner's guide to help you in preparing for your assessment.

AUTOMOTIVE PARTS PRODUCTION MACHINE OPERATOR

Module-7
LEARNER GUIDE
National Vocational Certificate Level 4

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Modules

Module 7: 0716001046 Conduct moulding and extrusion operations

Objective of the module: This module covers the specific skills and knowledge related to the plastic and rubber parts manufacturing operation on moulding and extrusion machines, material handling, inspection techniques and maintenance of machines and workplace.

Duration: 290 hours **Theory:** 58 hours **Practical:** 232 hours

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1: Prepare for moulding and extrusion	**The trainee will be able to:** Arrange material as per drawing or process sheet. Select the tools and equipment. Set machine as per job specification.	Knowledge and Understanding of material preparation as per drawing or process sheet. Knowledge and Understanding of material (Plastic, Rubber, PU, Extrusion) Knowledge and Understanding about how to select the tools and equipment. Knowledge and Understanding about how to	PPEs Moulds (Injection, Compression, Blow, Rubber Injection, Extrusion and PU) Dryer Air compressor

		set machine as per job specification.	Water chiller Heater Adjustable Spanner Pipe Wrench Mixer (for Rubber Compounding) Dryer Combination Spanner Set Socket Set with handle Screw Driver Set Allen Key Set Plier Set Hammer Mallet (Soft Hammer) First aid box
LU2: **Conduct pre-operational checks on**	**The trainee will be able to:** Inspect all electrical connections. Check all mechanical fitting and joints.	Knowledge and Understanding about how to check electrical connections Knowledge and Understanding about how to check mechanical fitting and joints.	PPEs Maintenance tools kit Air compressor

machine	Check operation of emergency switches. Check and maintain correct machine lubricant level. Check chillier temperature. Check function by operate machine manually.	Knowledge and understanding about how to check emergency switches. Knowledge and understanding about how to check machine lubricant, temperature and pressures. Knowledge and understanding about operation of machine.	Water chiller Heater Adjustable Spanner Pipe Wrench Combination Spanner Set Socket Set with handle Screw Driver Set Allen Key Set Plier Set Tongue & Groove Plier Hammer Mallet (Soft Hammer) First aid box
LU3.Prepare moulds (Injection, Compression, blow, rubber injection,PU)	**The trainee will be able to:** Place the mould on machine (Moulding/Extrusion). Align the mould on machine. Operate machine manually and match the	Knowledge and understanding about types of Mould. Understanding how to lift mould(Injection, Compression, blow, rubber injection, PU) Understanding how to clamp mould.	PPEs Plastic injection moulding machine Extrusion machine Moulds (Injection, Compression, Blow,

	upper and lower mould. Clamp the mould. Install the cooling water lines on mould. Set the parameters. Perform the trial of mould to verify the operation.	Knowledge and understanding about how to set the parameters. Knowledge and understanding about how to perform the trial of mould/die, to verify the operation.	Rubber Injection, Extrusion and PU) Rubber compression moulding machine Blow moulding machine Rubber injection moulding machine Polurethane moulding machine Air compressor Water chiller Heater Lifter Hoist with stand Adjustable Spanner Pipe Wrench Combination Spanner Set Socket Set with handle Screw Driver Set Allen Key Set Measurement Tape

			Plier Set Tongue & Groove Plier Hammer Mallet (Soft Hammer) First aid box
LU4: **Prepare die**	**The trainee will be able to:** Place the die on machine with lifting equipment. Align the die on machine. Operate machine manually and match the upper and lower dies. Clamp the die. Set parameters Perform the trial of die to verify the operation.	Knowledge and understanding about how to lift die. Knowledge and understanding about alignment of die. Knowledge and understanding about Die Clamping Knowledge and understanding about parameters setting Knowledge and understanding about how to trial of die/mould to verify the operation.	PPEs Plastic injection moulding machine Extrusion machine Moulds (Injection, Compression, Blow, Rubber Injection, Extrusion and PU) Rubber compression moulding machine Blow moulding machine Rubber injection moulding machine Polurethane moulding machine Maintenance tools kit Air compressor

			Water chiller Heater Lifter Hoist with stand Adjustable Spanner Pipe Wrench Combination Spanner Set Socket Set with handle Screw Driver Set Allen Key Set Tool Trolley Measurement Tape Micrometer Vernier Caliper Plier Set Blower Tongue & Groove Plier Hammer Mallet (Soft Hammer)

			First aid box	
LU5: **Operate injection moulding machine**	**The trainee will be able to:** Set all parameters. Proceed with operation. Monitor operation to ensure compliance with job requirements.	Knowledge and understanding about machine selection. Knowledge and understanding about parameters setting. Knowledge and understanding about injection moulding operation. Knowledge and understanding about monitoring operation. Knowledge and understanding about quality of plastic parts Knowledge and explaining about different parts of moulding machine Knowledge and explaining fits and limits system.	PPEs Plastic injection moulding machine Dryer Maintenance tools kit Air compressor Water chiller Heater Lifter Vernier Caliper Blower Mallet (Soft Hammer) First aid box	
LU6: **Operate rubber compression moulding machine**	**The trainee will be able to:** Perform degassing on mould. Set all parameters. Proceed with operation. Monitor operation to ensure compliance with job requirements.	Knowledge and understanding about machine selection. Knowledge and understanding about parameters setting. Knowledge and understanding about degassing on mould. Knowledge and understanding about rubber compression mounding operation. Knowledge and understanding about	PPEs Rubber compression moulding machine Mixer (for Rubber Compounding) Air compressor Water chiller Heater	.

		monitoring operation. Knowledge and understanding about quality of rubber compression mounding parts. Knowledge of define different parts about moulding machine Knowledge and explaining about fits and limits system.	Vernier Caliper Blower Mallet (Soft Hammer) First aid box	
LU7: **Operate blow moulding machine**	**The trainee will be able to:** Set all Parameters. Proceed with operation. Monitor operation to ensure compliance with job requirements.	Knowledge and understanding about machine selection. Knowledge and Understanding about parameters setting. Knowledge and understanding about blow mounding operation. Knowledge and understanding about monitoring operation. Knowledge and understanding about quality of Blow mounding parts. Knowledge and explaining about different parts of moulding machine. Knowledge and understanding about fits and limits system.	Blow moulding machine Dryer Air compressor Water chiller Heater Vernier Caliper Blower Mallet (Soft Hammer) First aid box	
LU8: **Operate rubber injection moulding machine**	**The trainee will be able to:** Perform degassing on mould. Set all parameters. Proceed with operation.	Knowledge and understanding about machine selection. Knowledge and understanding about parameters setting. Knowledge and understanding about	Rubber injection moulding machine Mixer (for Rubber Compounding) Air compressor	

	Monitor operation to ensure compliance with job requirements.	degassing on mould. Knowledge and understanding about rubber injection moulding operation. Knowledge and understanding about how to monitor operation. Knowledge and understanding about quality of injection moulding parts Knowledge and explaining different parts of moulding machine. Knowledge and explaining about fits and limits system.	Water chiller Heater Vernier Caliper Blower Mallet (Soft Hammer) First aid box
LU9: **Operate Polyurethane moulding mchine**	**The trainee will be able to:** Mix the raw material polyurethane part A (Polyols) in the drum of mixing machine. Mix the raw material polyurethane part B (Isocyanates) in the drum of mixing machine. Fill the tank of polyurethane machine part A (Polyols) by using the pump. Fill the tank of polyurethane machine part B (isocyanates) by using the pump. Fasten the machine tank cover to avoid the moisture. Circulate the water on machine tank to maintain the required temperature of raw	Knowledge and understanding about machine selection. Knowledge and understanding about parameters setting. Knowledge and understanding about material mixing Knowledge and understanding about PU moulding operation. Knowledge and understanding about monitoring operation. Knowledge and understanding about quality of PU moulding parts Knowledge and understanding about PU process. Knowledge and understanding about different	PPEs Polyurethane moulding machine Maintenance tools kit Air compressor Water chiller Heater Mallet (Soft Hammer) First aid box

	material. Set the water temperature according to the weather condition. Set all parameters (Ratio A & B). Operate the material circulating pump A (Polyols) and B (Isocyanates) on operating position. Fill the de-flashing tank by hand and ensure safety. Set the die on platform. Proceed with operation. Monitor operation to ensure compliance with job requirements.	parts of moulding machine Knowledge and understanding about behavior of Environment on process.	
LU10: **Operate extrusion machine**	**The trainee will be able to:** Set all parameters. Fix the nozzle in extruder according to job material. Fill the water tank. Set the cutting distance of material as per requirement. Proceed with operation. Monitor operation to ensure compliance	Knowledge and understanding about machine selection. Knowledge and understanding about machine and parameters setting. Knowledge and understanding about extrusion moulding operation. Knowledge and understanding about monitor operation. Knowledge and understanding about quality checks of extrusion moulding parts. Knowledge and understanding about different parts of moulding machine.	PPEs Extrusion machine Dryer Maintenance tools kit Air compressor Water chiller Heater Vernier Caliper Mallet (Soft Hammer)

	with job requirements.	Knowledge and explaining about fits, limits and Hole and Shaft system	First aid box
LU11: **Inspect final product**	**The trainee will be able to:** Perform visual inspection of defects. Check dimensionally. Check by go nogo gauge. Complete inspection report.	Knowledge and understanding about visual inspection. Knowledge and understanding about how to Check dimensionally. Knowledge and understanding about how to check with the gauges. Knowledge and understanding about how to make inspection report.	Measurement Tape Micrometer Vernier Caliper GO no-go Gauges Inspection reports Printers Papers computer
LU12: **Perform workplace cleaning and maintenance**	**The trainee will be able to:** Maintain all check sheets and work instructions on the machine. Maintain the tools and equipment. Keep tools and equipment at appropriate place. Perform cleaning of machine, mould/die and floor. Apply anti-rust spray/cleaning agent. Perform lubrication.	Knowledge and understanding about how maintain all check sheets and work instructions on the machine. Knowledge and understanding about how to maintain the tools and equipment. Knowledge and understanding about how to keep tools and equipment at their appropriate place. Knowledge and understanding about lubricants and lubrication. Knowledge and understanding about how to perform cleaning of machine, mould/die and	PPEs Maintenance tools kit Adjustable Spanner Pipe Wrench Combination Spanner Set Socket Set with handle Screw Driver Set Allen Key Set

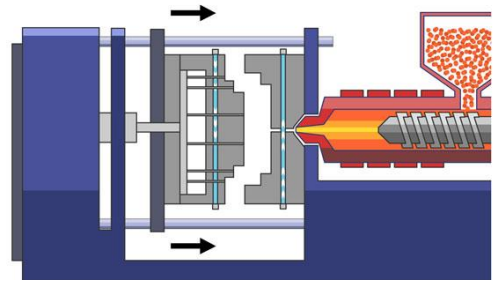
	Transfer wastage material into the wastage area. Return excess material to store.	floor. Knowledge and understanding about how to apply anti-rust spray/cleaning agent. Knowledge and understanding about how to handle waste/excess material.	Tool Trolley Plier Set Blower Tongue & Groove Plier Hammer cotton Mallet (Soft Hammer) First aid box

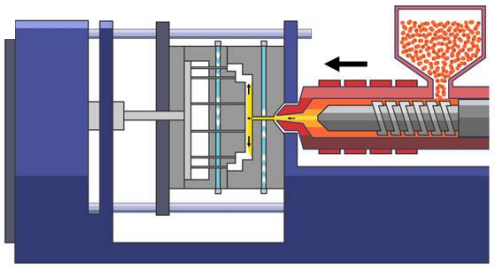
Examples and illustrations

Injection Moulding Process:

The various stages of the **injection moulding process** are carefully considered when analyzing part design, tool creation and efficient production of moulded plastic products. There are a lot of factors and configurations which we won't touch on here but the basic process is the same. Let's start with the basics.

Injection Moulding Process:





STEP 1: THE MOULD CLOSES

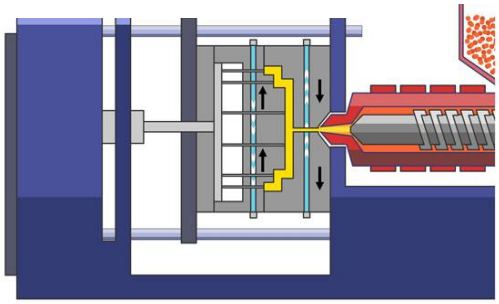
The Injection Moulding cycle timer begins when the mould closes.*

*Note: In some cases, as with the use of robots, the cycle runs "part to part" which means the cycle begins and ends when the robot receives a new part or the new part touches the conveyor belt.

STEP 2: INJECTION

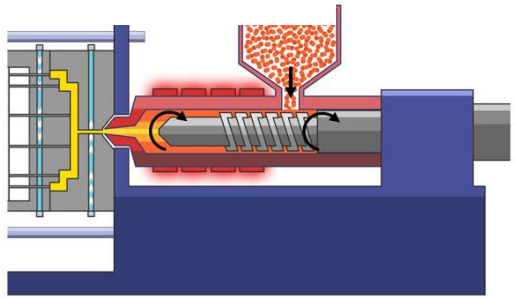
The heated plastic is injected into the mould. As the melt enters the mould, the displaced air escapes through vents in the injection pins and along the parting line. Runner, gate and vent design are important to insure the mould is properly filled.

STEP 3: COOLING



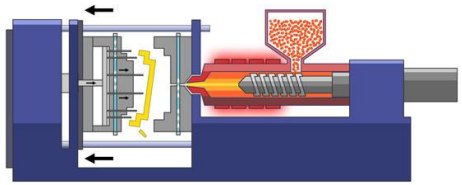
Once the mould is filled the part is allowed to cool for the exact amount of time needed to harden the material. Cooling time is dependent on the type of resin used and the thickness of the part. Each mould is designed with internal cooling or heating lines where water is cycled through the mould to maintain a constant temperature.

STEP 4: PLASTICIZING THE RESIN



While the part cools, the barrel screw retracts and draws new plastic resin into the barrel from the material hopper. The heater bands maintain the needed barrel temperature for the type of resin being used.

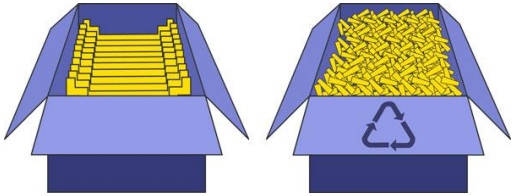
STEP 5: EJECTION



The mould opens and the ejector rod moves the ejector pins forward.

The part falls and is captured in a bin located below the mould.

STEP 6: REMOVING THE RUNNER AND PACKAGING



Although the injection moulding machine's cycle ends on Step 5, the process continues. Periodically the machine operators, or robots separate the usable parts from the left over runner.* The runner is the pathway that the plastic takes to fill the mould cavity. In many cases the runners are ground and recycled to reduce costs and environmental impact. The usable parts are then weighed, counted and packaged for

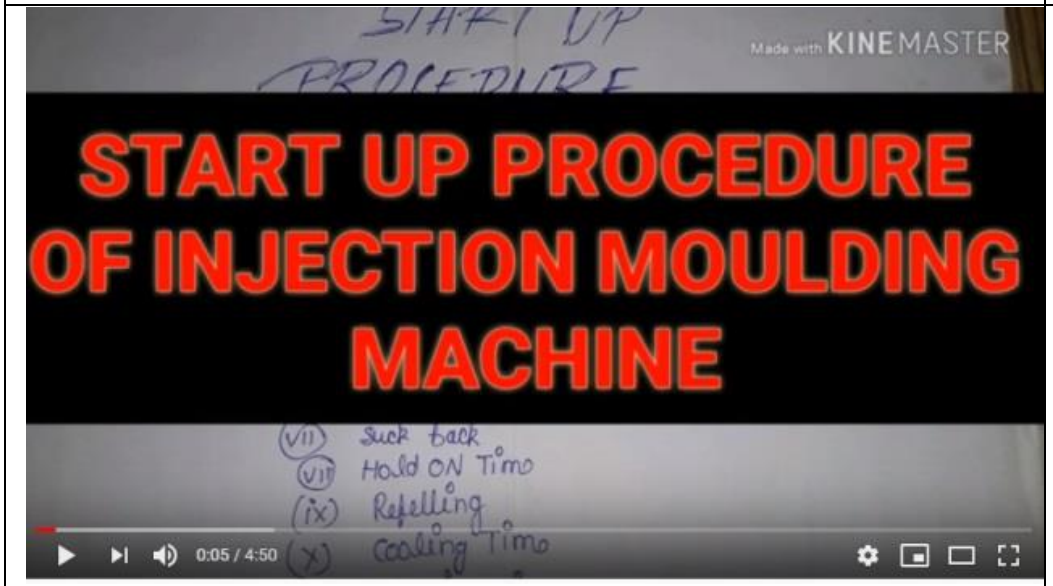
assembly or shipping.

*Note: Moulds with hot runner systems may not have a runner or waste because the pathway is maintained at a constant heat.

Reference:

https://www.aireplastics.com/basic-injection-moulding-process/

Videos:

	Topic	Hyperlink
	Startup procedure of injection moulding machine	https://www.youtube.com/watch?v=h14eFRjdlgw

	The Principle of Injection Moulding.	https://www.youtube.com/watch?v=b1U9W4iNDiQ

The Compression Moulding Process

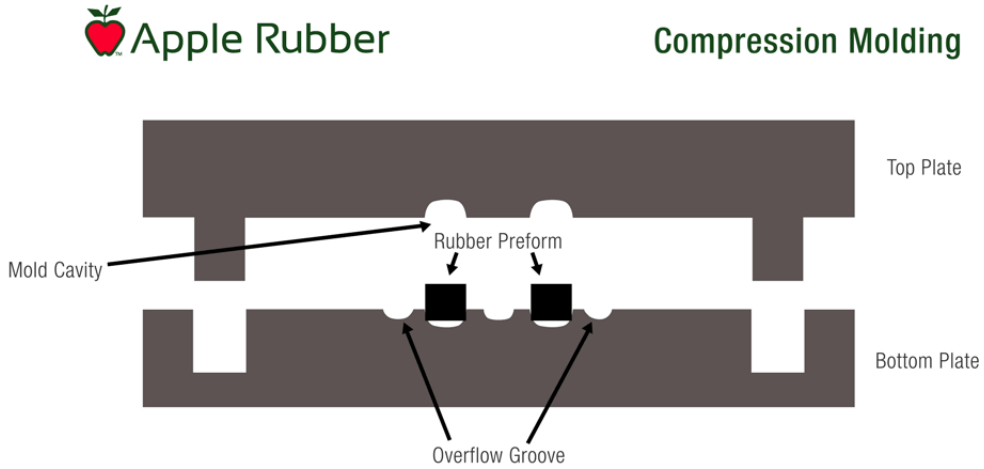
Compression moulding involves several steps:

1. An uncured rubber compound is formed to the proper shape and size based on the finished part configuration. This uncured rubber shape is termed a pre form — it is prepared to be formed, or moulded. Every mould will have a different shape and size pre form that works best. When the optimal pre form has been determined, it is important to have a tolerance on both its size and shape to ensure the part forms correctly. Too much material is wasteful and can cause flash to become too thick, while too little material can cause voids in the part.
2. The pre form is placed into the cavity of a heated mould. The mould is then closed. Heat and pressure are applied in a compression moulding press. Presses used in production utilize a programmable logic controller to monitor and control critical parameters like temperature, pressure and time to ensure moulding takes place within a prescribed tolerance window.
3. The mould is then opened. The cured rubber part is removed along with its flash.

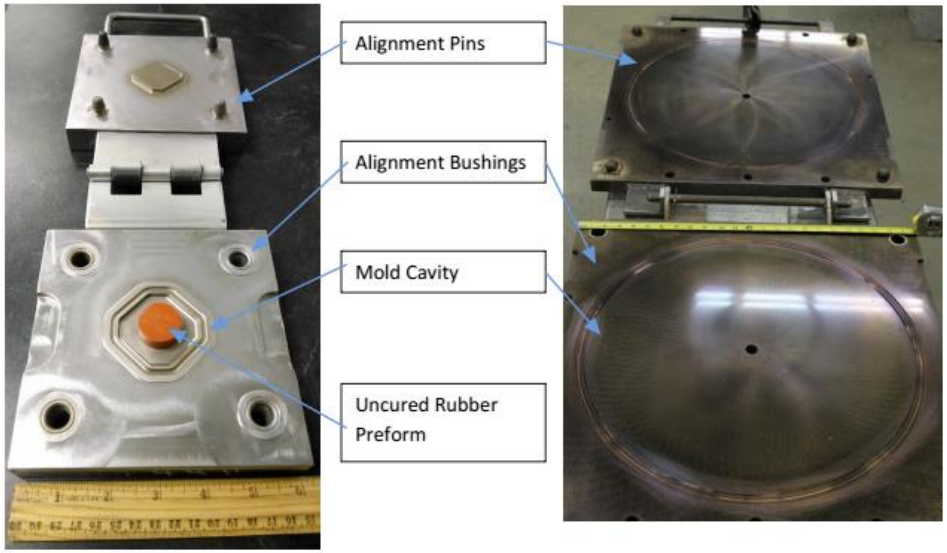
4. The part is then moved through the manufacturing operation to undergo post-moulding processing, which can include de-flashing, post curing, automated inspection and packaging.

Reference:

https://www.applerubber.com/hot-topics-for-engineers/understanding-compression-moulding/

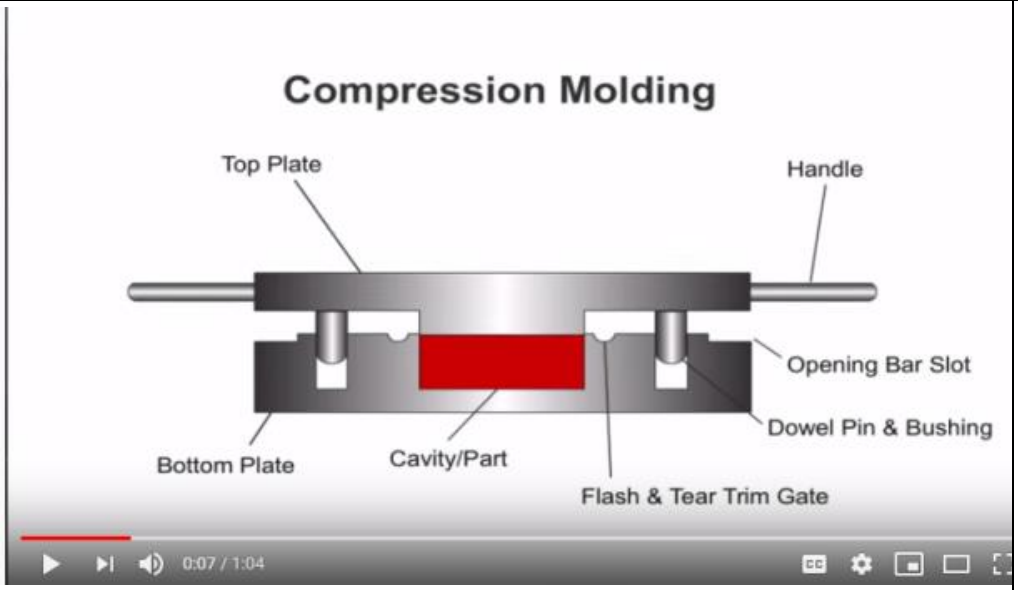


https://www.applerubber.com/hot-topics-for-engineers/understanding-compression-moulding/



https://www.applerubber.com/hot-topics-for-engineers/understanding-compression-moulding/

Videos:

	Topic	Hyperlink
	What is Rubber Compression Moulding?	https://www.youtube.com/watch?v=sceetLZDyz0

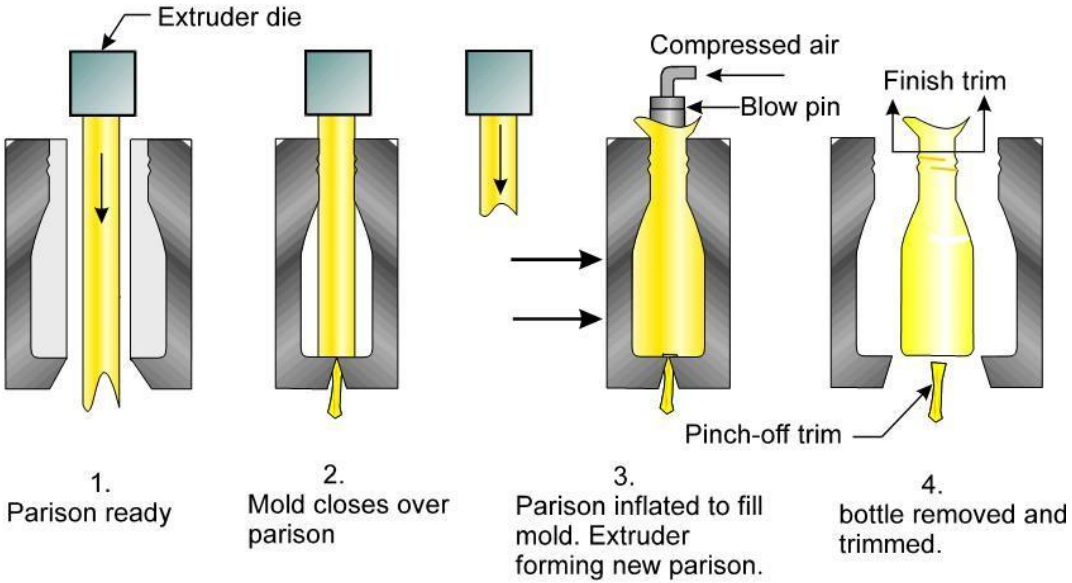
	Rubber Moulding Process	https://www.youtube.com/watch?v=W68YdDKnFDA

Blow Moulding Process:

- The first step involves mixing, melting and pushing plastic (extrusion) to form it into a tube called a parison that will be used to make the part.
- A mould is used to make the part shape you desire. The mould has two halves that are closed around the molten parison.
- Air is blown into the inside of the parison to expand the molten plastic against the mould surface.
- The mould is cooled to set the plastic to the new shape of the mould.
- The moulded plastic part is removed from the mould, separated from excess parison material called flash, and finished. (Most finishing steps can be completed in-mould but some involve secondary operations.)

Reference:

https://www.custom-pak.com/design/blow-moulding-design-guide/



https://engineeringinsider.org/what-is-blow-moulding/

Videos:

	Topic	Hyperlink
	The blow moulding process	https://www.youtube.com/watch?v=8W6P5KU5ONQ
	Blow Moulding Process	https://www.youtube.com/watch?v=2bay2JDHKGY

PU Moulding Process:

Material preparation

- The liquid chemicals are delivered either by railroad tanker cars or tank trucks and pumped into large holding tanks. From there, the chemicals are pumped into smaller heated mixing tanks, and are kept separate if they react with each other. For continuous manufacture of foam such as slab stock, more than two monomer streams are typically used.

Dispensing and mixing

- Continuous dispensing (also called open pouring or free-rise) is used in the production of rigid and flexible low-density foams. A specific amount of each chemical, measured by metered pumps, is fed from the mixing tanks into a mixing head, where the blending of the chemicals take place. The reactive components are poured onto a moving surface or conveyor belt, where the foam rises and cures to form slab stock.

Cutting and curing

- As the foam moves toward the end of the conveyor belt, it is automatically cut by a horizontal bandsaw into smaller pieces, usually 12 ft (3.66 m) long sections. After cutting, the foam sections are cured at room temperature for 12 hours or more. They are not stacked since they are not firm enough to withstand any weight. After curing, a second automatic bandsaw cuts the sections into the desired thickness. Other shapes can also be cut.

Reference:

http://www.madehow.com/Volume-5/Foam-Rubber.html

http://www.madehow.com/Volume-5/Foam-Rubber.html

Workplace Housekeeping - Basic Guide

Why should we pay attention to housekeeping at work?

Effective housekeeping can help control or eliminate workplace hazards. Poor housekeeping practices frequently contribute to incidents. If the sight of paper, debris, clutter and spills is accepted as normal, then other more serious hazards may be taken for granted.

Housekeeping is not just cleanliness. It includes keeping work areas neat and orderly, maintaining halls and floors free of slip and trip hazards, and removing of waste materials (e.g., paper, cardboard) and other fire hazards from work areas. It also requires paying attention to important details such as the layout of the whole workplace, aisle marking, the adequacy of storage facilities, and maintenance. Good housekeeping is also a basic part of incident and fire prevention.

Effective housekeeping is an ongoing operation: it is not a one-time or hit-and-miss cleanup done occasionally. Periodic "panic" cleanups are costly and ineffective in reducing incidents

What is the purpose of workplace housekeeping?

Poor housekeeping can be a cause of incidents, such as:

- tripping over loose objects on floors, stairs and platforms
- being hit by falling objects
- slipping on greasy, wet or dirty surfaces
- striking against projecting, poorly stacked items or misplaced material
- cutting, puncturing, or tearing the skin of hands or other parts of the body on projecting nails, wire or steel strapping

To avoid these hazards, a workplace must "maintain" order throughout a workday. Although this effort requires a great deal of management and planning, the benefits are many.

What are some benefits of good housekeeping practices?

Effective housekeeping results in:

- reduced handling to ease the flow of materials
- fewer tripping and slipping incidents in clutter-free and spill-free work areas
- decreased fire hazards
- lower worker exposures to hazardous products (e.g. dusts, vapours)
- better control of tools and materials, including inventory and supplies
- more efficient equipment cleanup and maintenance
- better hygienic conditions leading to improved health
- more effective use of space
- reduced property damage by improving preventive maintenance
- less janitorial work

- improved morale
- improved productivity (tools and materials will be easy to find)

How do I plan a good housekeeping program?

A good housekeeping program plans and manages the orderly storage and movement of materials from point of entry to exit. It includes a material flow plan to ensure minimal handling. The plan also makes sure that work areas are not used as storage areas by having workers move materials to and from work areas as needed. Part of the plan could include investing in extra bins and more frequent disposal.

The costs of this investment could be offset by the elimination of repeated handling of the same material and more effective use of the workers' time. Often, ineffective or insufficient storage planning results in materials being handled many times and being stored in hazardous ways. Knowing the workplace layout and the movement of materials throughout it will help when planning work procedures.

Worker training is an essential part of any good housekeeping program. Workers need to know how to work safely with the products they use. They also need to know how to protect other workers such as by posting signs (e.g., "Wet - Slippery Floor") and reporting any unusual conditions.

Housekeeping order is "maintained" not "achieved." Cleaning and organization must be done regularly, not just at the end of the shift. Integrating housekeeping into jobs can help ensure this is done. A good housekeeping program identifies and assigns responsibilities for the following:

- clean up during the shift
- day-to-day cleanup
- waste disposal
- removal of unused materials
- inspection to ensure cleanup is complete

Do not forget out-of-the-way places such as shelves, basements, sheds, and boiler rooms that would otherwise be overlooked.

The final step to any housekeeping program is inspection. It is the only way to check for deficiencies in the program so that changes can be made. Examples of checklists include inspecting offices and manufacturing facilities.

What are the elements of an effective housekeeping program?

Maintenance

The maintenance of buildings and equipment may be the most important element of good housekeeping. Maintenance involves keeping buildings, equipment and machinery in safe, efficient working order and in good repair. It includes maintaining sanitary facilities and regularly painting and cleaning walls. Broken windows, damaged doors, defective plumbing and broken floor surfaces can make a workplace look neglected; these conditions can cause incidents and affect work practices. So it is important to replace or fix broken or damaged items as quickly as possible. A good maintenance program provides for the inspection, maintenance, upkeep and repair of tools, equipment, machines and processes.

Dust and Dirt Removal

Enclosures and exhaust ventilation systems may fail to collect dust, dirt and chips adequately. Vacuum cleaners are suitable for removing light dust and dirt that is not otherwise hazardous. Industrial models have special fittings for cleaning walls, ceilings, ledges, machinery, and other hard-to-reach places where dust and dirt may accumulate.

Special-purpose vacuums are useful for removing hazardous products. For example, vacuum cleaners fitted with HEPA (high efficiency particulate air) filters may be used to capture fine particles of asbestos or fiber glass.

Dampening (wetting) floors or using sweeping compounds before sweeping reduces the amount of airborne dust. The dust and grime that collect in places like shelves, piping, conduits, light fixtures, reflectors, windows, cupboards and lockers may require manual cleaning.

Compressed air should not be used for removing dust, dirt or chips from equipment or work surfaces.

Employee Facilities

Employee facilities need to be adequate, clean and well maintained. Lockers may be necessary for storing employees' personal belongings. Washroom facilities require cleaning once or more each shift. They also need to have a good supply of soap, towels plus disinfectants, if needed.

If workers are using hazardous products, employee facilities should provide special precautions as needed such as showers, washing facilities and change rooms. Some facilities may require two locker rooms with showers between. Using such double locker rooms allows workers to

shower off workplace contaminants and reduces the chance of contaminating their "street clothes" by keeping their work clothes separated from the clothing that they wear home.

Smoking, eating or drinking in the work area should be prohibited where hazardous products are handled. The eating area should be separate from the work area and should be cleaned properly each shift.

Surfaces

Floors: Poor floor conditions are a leading cause of incidents so cleaning up spilled oil and other liquids at once is important. Allowing chips, shavings and dust to accumulate can also cause incidents. Trapping chips, shavings and dust before they reach the floor or cleaning them up regularly can prevent their accumulation. Areas that cannot be cleaned continuously, such as entrance ways, should have anti-slip flooring. Keeping floors in good order also means replacing any worn, ripped, or damaged flooring that poses a tripping hazard.

Walls: Light-colored walls reflect light while dirty or dark-colored walls absorb light. Contrasting colors warn of physical hazards and mark obstructions such as pillars. Paint can highlight railings, guards and other safety equipment, but should never be used as a substitute for guarding. The program should outline the regulations and standards for colors.

Maintain Light Fixtures

Dirty light fixtures reduce essential light levels. Clean light fixtures can improve lighting efficiency significantly.

Aisles and Stairways

Aisles should be wide enough to accommodate people and vehicles comfortably and safely. Aisle space allows for the movement of people, products and materials. Warning signs and mirrors can improve sight-lines in blind corners. Arranging aisles properly encourages people to use them so that they do not take shortcuts through hazardous areas.

Keeping aisles and stairways clear is important. They should not be used for temporary "overflow" or "bottleneck" storage. Stairways and aisles also require adequate lighting.

Spill Control

The best way to control spills is to stop them before they happen. Regularly cleaning and maintaining machines and equipment is one way. Another is to use drip pans and guards where possible spills might occur. When spills do occur, it is important to clean them up immediately. Absorbent materials are useful for wiping up greasy, oily or other liquid spills. Used absorbents must be disposed of properly and safely.

Tools and Equipment

Tool housekeeping is very important, whether in the tool room, on the rack, in the yard, or on the bench. Tools require suitable fixtures with marked locations to provide an orderly arrangement. Returning tools promptly after use reduces the chance of it being misplaced or lost. Workers should regularly inspect, clean and repair all tools and take any damaged or worn tools out of service.

Waste Disposal

The regular collection, grading and sorting of scrap contribute to good housekeeping practices. It also makes it possible to separate materials that can be recycled from those going to waste disposal facilities.

Allowing material to build up on the floor wastes time and energy since additional time is required for cleaning it up. Placing scrap containers near where the waste is produced encourages orderly waste disposal and makes collection easier. All waste receptacles should be clearly labelled (e.g., recyclable glass, plastic, scrap metal, etc.).

Storage

Good organization of stored materials is essential for overcoming material storage problems whether on a temporary or permanent basis. There will also be fewer strain injuries if the amount of handling is reduced, especially if less manual material handling is required. The location of the stockpiles should not interfere with work but they should still be readily available when required. Stored materials should allow at least one meter (or about three feet) of clear space under sprinkler heads.

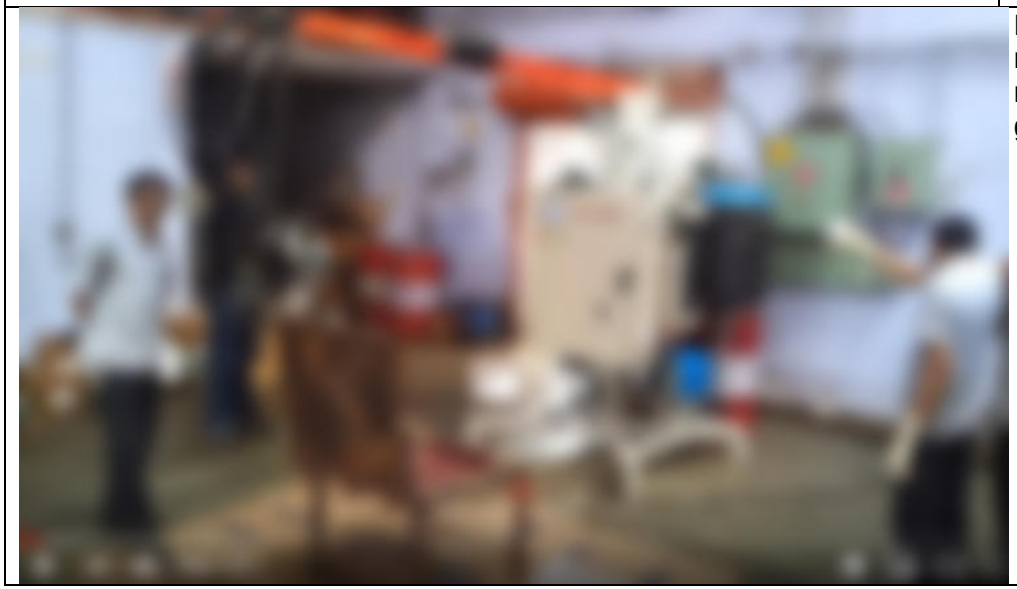
Stacking cartons and drums on a firm foundation and cross tying them, where necessary, reduces the chance of their movement. Stored materials should not obstruct aisles, stairs, exits, fire equipment, emergency eyewash fountains, emergency showers, or first aid stations. All storage areas should be clearly marked.

Flammable, combustible, toxic and other hazardous materials should be stored in approved containers in designated areas that are appropriate for the different hazards that they pose. Storage of materials should meet all requirements specified in the fire codes and the regulations of environmental and occupational health and safety agencies in your jurisdiction.

Reference:

https://www.ccohs.ca/oshanswers/hsprograms/house.html

Videos:

	Topic	Hyperlink
	PU foam moulded seat manufacturing process	https://www.youtube.com/watch?v=KWUNBwc3X_Y

	Tractor PU Foam Seating	https://www.youtube.com/watch?v=vxX6g4bJkI0

Rubber Extrusion Process:

Rubber extrusion don't differs so much of plastic extrusion. Basically, the main difference is the curing process or vulcanization of the rubber during the extrusion process.

As plastic extrusion, in rubber extrusion process the rubber is forced through a die of the desired cross-section under pressure from an extruder. Then, the rubber part normally must be vulcanized before it is usable.

The processes of vulcanization or curing takes place at the last step of the extrusion process. This aids the rubber extruded profiles to maintain its shape and acquire necessary physical properties.

Exist different types of rubber extrusion processes:

- **Continuous in-line cure extrusion:** The rubber material travels through a curing tunnel that raises the product to the appropriate vulcanizing temperature.
- **Off-line cure extrusion:** The warm rubber is driven through the die and then exposed to high-pressure steam in order to achieve the appropriate vulcanizing temperature.

Rubber extrusion advantages

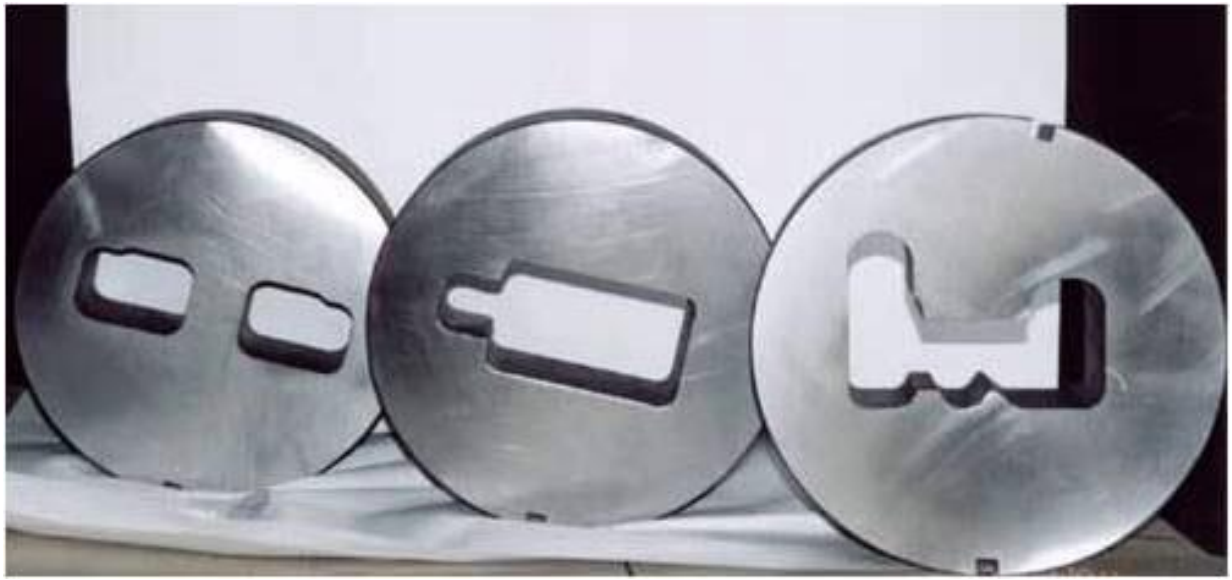
- Huge variety of shapes.
- Economical process.
- Flexible and lightweight products.

- Minimal wasted material.
- Highly efficient process.

Reference:

http://www.gestiondecompras.com/en/products/rubber-and-rubber-metal/rubber-extrusion

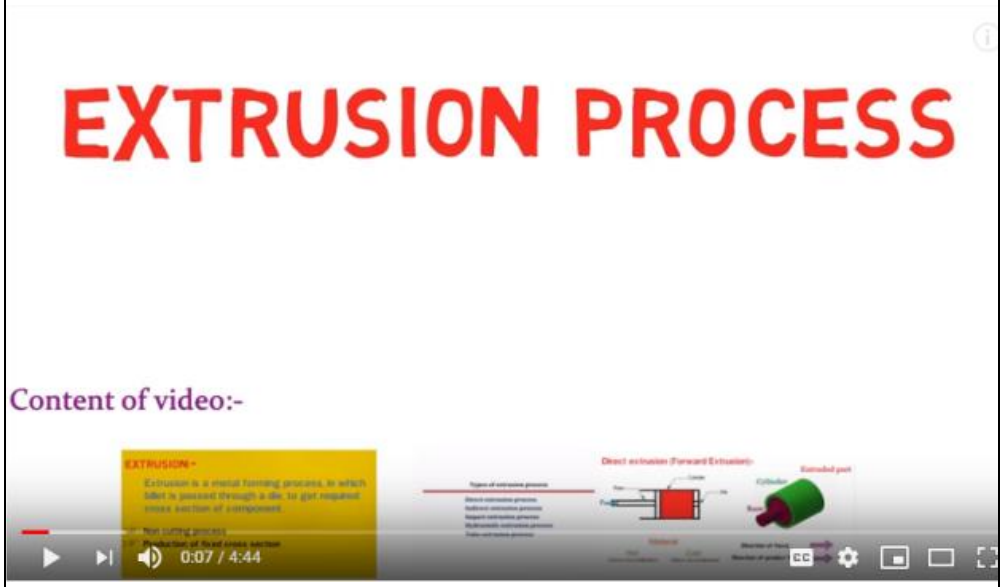
http://www.gestiondecompras.com/en/products/rubber-and-rubber-metal/rubber-extrusion



https://www.timcorubber.com/rubber-resources/rubber-extrusion-process/

Videos:

	Topic	Hyperlink
	EPDM rubber extrusion Vulcanization production line	https://www.youtube.com/watch?v=B_fUt9tSL2I

	Extrusion process and its types	https://www.youtube.com/watch?v=743fHkOvOkA

AUTOMOTIVE PARTS PRODUCTION MACHINE OPERATOR

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	Quality Control Procedures for Rubber & Plastic Extrusion	https://www.youtube.com/watch?v=o_XWQTzZVB0

Module 8: 0716001047 Perform hot forging operations

Objective of the module: This module covers the specific skills and knowledge related to the process of hot forging parts manufacturing operation on hot forging and press forging machines, material handling, inspection techniques and maintain of machines and workplace.

Duration: 100 hours **Theory:** 20 hours **Practical:** 80 hours

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
Prepare for hot press forging	Arrange material as per drawing or process sheet. Select tools and equipment. Set the machine as per job specification.	process sheet. Knowledge and understanding about material Knowledge and understanding about how to select the tools and equipment. Knowledge and understanding about how to set machine as per job specification.	Hot forging Press machine (hydraulic/pneumatic) Combination spanner set Socket Set with handle Screw driver set Allen key set Plier set Hammer Chisel First aid box
LU2. **Conduct pre-operational checks on machine**	**The trainee will be able to:** Inspect all electrical connection. Check all mechanical fitting and joints. Check operation of emergency switches. Check air connections. Check the control panel button. Check and maintain oil tank lubrication. Check the manual stroke for proper ram	Knowledge and understanding how to check electrical connections Knowledge and understanding about how to check electrical connections. Knowledge and understanding about how to check mechanical fitting and joints. Knowledge and understanding about how to check emergency switches. Knowledge and understanding about how to check machine lubricant, temperature and	PPEs PPEs Gas burner Tool kit trolley Adjustable spanner Combination spanner set Socket Set with handle Screw driver set

	working.	pressures Knowledge and understanding about how to operate machine manually.	Allen key set Plier set Hammer Chisel First aid box
LU3. **Prepare mould/ die**	**The trainee will be able to:** Install mould/die with lifting equipment. Set all parameters. Turn on gas burner for pre-heating mould/die. Maintain the idle temperature of mould/die.	Knowledge and understanding about how to lift die/Mould. Knowledge and understanding about alignment of die/mould. Knowledge and understanding about how to Clamp Die/Mould. Knowledge and understanding about parameters setting. Knowledge and understanding about preheating of die/mould. Knowledge and understanding about idle temperature of die/mould.	PPEs Hot forging Press machine (hydraulic/pneumatic) Mould/die set Manual toggle Mould/die setter on machine Mould/die lifting crane Gas burner Shakels Eye bolt Tool kit trolley Adjustable spanner Combination spanner set Socket Set with handle

			Screw driver set Allen key set Hammer Chisel First aid box
LU4. Operate machine	**The trainee will be able to:** Release the mult/blank from induction heater. Adjust mult/blank on mould/die. Proceed with operation. Monitor operation to ensure compliance with job requirements.	Knowledge and understanding about machine selection. Knowledge and understanding about machine setting and parameters setting. Knowledge and understanding about induction heater Knowledge and understanding about operation. Knowledge and understanding about monitoring operation. Knowledge and understanding about Mult/Blank and their Calculation. Knowledge and understanding about quality checks of forging parts. Knowledge and understanding about different parts of forging press machine.	PPEs Hot forging Press machine (hydraulic/pneumatic) Allen key set Measurement tape Vernier Caliper Hammer Chisel First aid box
LU5.	**The trainee will be able to:**	Knowledge and understanding about visual	PPEs

Inspect final product	Perform visual inspection of defects. Check dimensionally. Inspect the part for non-filling. Complete inspection report.	inspection. Knowledge and understanding about how to Check dimensionally. Knowledge and understanding about how to check with the help of gauges. Knowledge and understanding about how to make inspection report.	Measurement tape Vernier Caliper First aid box
LU. 6 **Perform workplace cleaning and maintenance**	**The trainee will be able to:** Maintain all check sheets and work instruction on machine. Perform cleaning of die, machine and floor. Apply anti-rust spray/cleaning agent. Perform lubrication on slides and die. Maintain tools and equipment. Keep tools and equipment at appropriate place. Transfer wastage material in to the wastage area. Return excess material to store.	Knowledge and understanding about how to maintain all check sheets and work instructions on the machine. Knowledge and understanding about how to maintain tools and equipments Knowledge and understanding about how to Keep tools and equipment at appropriate place. Knowledge and understanding about lubricants and lubrication. Knowledge and understanding about Perform cleaning of machine, mould/die and floor. Knowledge and understanding about how to apply anti-rust spray/cleaning agent Knowledge and understanding about handling waste/excess material	PPEs Tool kit trolley Adjustable spanner Combination spanner set Socket Set with handle Screw driver set Allen key set Measurement tape Vernier Caliper Plier set Hammer Chisel cotton First aid box

Examples and illustrations

Hot Forging: Main Considerations, Materials and Applications

Forging is classified in hot, warm and cold, according to the temperature at which is performed. Although hot forging remains the oldest known manufacturing technique, the preference for the one or the other process, doesn't depend on their quality but on the required characteristics of the final product and the production cost optimization, in accordance with the size's batch of production. Forging refines the grain structure of the applied materials, mainly metals and alloys and thus improves the mechanical properties of the component making it stronger. Sophisticated hammers and presses are used to deform the material into a desired shape.

How Does Hot Forging Happen?

The hot forging manufacturing process is performed at the highest temperature which does not destroy the metallurgical features of the considered alloy (up to 1250°C for steel, 300 to 460°C for Al-Alloys, 750 to 1040°C for titanium alloys and 700 to 800 °C for Cu-Alloys).

Recrystallization occurs simultaneously with deformation, thus avoiding strain hardening. For this reason, and for best results, the forging temperature must be maintained throughout the entire process above a specific minimal, depending on the alloy. This condition avoids as well

the risk of lack of forge ability, which leads to cracks as the ductility may be seriously reduced at lower temperature. The forging sequence is subsequently limited in time to respect these temperature limits.

If forging is not completed when the lower limit is reached, reheating is required when possible, or the part must be considered as forged, and finished by other means. The required interval of temperature for hot forging process is so important that all tooling are preheated to limit the loss of temperature of the component during the forging step. This had led to design a very accurate and specific process for closed die forging called “isothermal forging”.

During isothermal forging, the tools (actually dies) are kept heated at the required forging temperature. This concept however is applied very differently, depending on the type of the material, thus on the forging temperature itself. The material grade used for the dies must effectively keep the high mechanical properties required to deform the component material at the forging temperature.

Some examples of isothermal forging applied to different materials.

- It is quite mandatory for aluminum forging, as aluminum cools very quickly and forging temperature is rather low: all die grades sustain the required mechanical properties.

- It is possible for copper and titanium alloys, if a sophisticated (and expensive) grade is chosen for the dies.

- It is very difficult for steel alloys, where very few material (such as pure molybdenum) dies stand at 1250 °C the forging stress.

Therefore, isothermal forging is quite unusual for titanium alloys, and very confidential for steel and nickel based alloys (dedicated to the highest difficult turbine disks for jet engines for instance.)
Setforge provides high-quality isothermal forging process for aluminum alloys.
To prevent gas contamination which occurs during the hot forging process (O2, H2 or even N2 contamination) it is possible to protect the component by glass coating or controlled atmosphere (inert gas) within the heating furnace, induction heater and even press laboratory.

Hot forging begins with a forged metal ingot or a cast metal piece which gets “squeezed” in dedicated dies where its grain structure is broken down and homogenized into finer grains for increased yield strength and ductility. Because the metal is hot, it gets easily deformed and allows

manufacturers to create more elaborate shapes than with cold forging. The fact that the metal is plastically deformed above its recrystallization temperature, allows it to retain its deformed shape as it cools. The shaping is followed by cooling, which is of critical importance as cooling hot forged parts too quickly can result in warping.

Hot Forging Benefits

The hot forging process produces the most various shapes compared to other forging processes, and as the dies are not very expensive to produce, it is very well adapted to small batches and shapely components. Actually, other processes (warm and cold forging) are designed for high volume production such as automotive, and fasteners components, with simplier geometry, for which extremely complex dies can be designed, and amortized on a large number of parts produced with.

- Good ductility
- Possibility to manufacture customized parts
- Excellent surface quality
- High formability ratios
- Decreased yield strength and thus less energy required
- Increased diffusion and thus reduced chemical in homogeneity

However, Hot Forging Features 2 Unfavorable Side Effects

The functional areas of the component should be machined before assembly, as surface conditions, dimensional tolerances and residual surface contamination are not suitable to usual mechanical assembly design.

The material yield is higher than other (warm and cold forging) because of the scale produced during the heating, and because of the subsequent machining.

What are The Most Important Things to Consider When Performing Hot Forging?

Cooling

As already mentioned above, cooling should be performed with an extreme care due to the risk of warpage.

Tolerances

Another important thing to consider when choosing hot forging is the less precise dimensional tolerance compared to cold forging.

Flash

Hot forgings can be divided into forgings with and without flash. These with flash possess complex 3D geometries compared to the fleshless ones, generally limited to ax symmetric components or components with cyclic-symmetric geometries.

Dies

The dies used in hot forging are custom-made to match the customer's part designs. The process is performed with drop, power drop or counterblow hammers, hydraulic or screw presses, and other similar machinery to compress the heated metal into the desired part shape.

Since the dies used in hot forging undergo sever thermal cycle and mechanical loading, cracking, plastic deformation, thermal fatigue cracking and wear should be taken into account. To prolong dies' life a good ductility and toughness and enhanced levels of both hot hardness and hot tensile strength are required.

What Are the Best Materials for Hot Forging?

Hot forging can be used to fabricate a broad spectrum of parts, and can be performed with most ferrous and non-ferrous metal alloys as:

- Structural steels

- Aluminum and magnesium wrought alloys
- Free-cutting steels
- Stainless steels
- Titanium alloys
- Molybdenum alloys
- Nickel/cobalt alloys

Most of the steel alloys are almost always hot forged, because as work hardening on hard materials advances, their deformation becomes more and more difficult. Furthermore, it is much more economically interesting to hot forge metals such as steel and then perform a heat treatment.

Hot forging remains the best available manufacturing process for complex shapes, heavy-weight components and high-duty alloys.

Which Industries Can Mostly Benefit from Hot Forging?

The most common hot forged product applications are mainly found in automotive, agricultural, aerospace and construction configurations, which require strength and durability.

The five steps of hot forging are:

1. Heating. Pre-**forged** metal starts with metal blocks called "ingots," which come in a variety of shapes and sizes depending on the part or component to be produced. ...
2. Pre forming. ...
3. Finish **Forging**. ...
4. Cooling. ...
5. Finishing.

Reference:

https://www.farinia.com/forge/hot-forging/the-hot-forging-manufacturing-process-and-its-undoubted-advantages

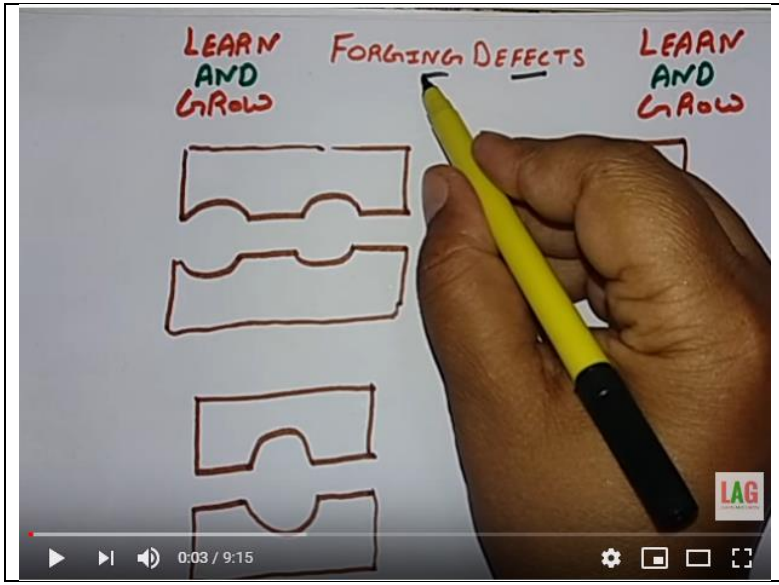
www.rexforge.com › forging-process

Workplace Housekeeping - Basic Guide

Note: please see workplace housekeeping in Module-7 Conduct moulding and extrusion operations

Videos:

	Topic	Hyperlink
	HOT FORGING PRESS	https://www.youtube.com/watch?v=p6vcnYxnlhE

	Forging Defects	https://www.youtube.com/watch?v=_rck2uV8fmE

AUTOMOTIVE PARTS PRODUCTION MACHINE OPERATOR

Module-9
LEARNER GUIDE
National Vocational Certificate Level 4

Version 1 - October, 2019

Module 9: 0716001048 Perform metal die casting operation

Objective of the module: This module covers the specific skills and knowledge related to prepare a machine for die casting process, material handling, formulation/ construction, defects & remedies and maintains machine and workplace.

Duration: 100 hours **Theory:** 20 hours **Practical:** 80 hours

Learning Unit	Learning Outcomes	Learning Elements	Materials Requied
LU1.Prepare for die casting	**The trainee will be able to:** Arrange material as per drawing or process sheet. Select tools and equipment. Prepare the melting furnace (Crucible). Set machine as per job specification.	Knowledge and understanding about how to arrange material as per drawing or process sheet. Knowledge and understanding about material. Knowledge and understanding about how to select the tools and equipment. Knowledge and understanding about how to set machine as per job specification.	PPEs Mould/die set Manual toggle Mould/die setter on machine Mould/die lifting crane Gas burner Shakels Eye bolt Tool kit trolley Adjustable spanner Combination spanner set Socket Set with

			handle Screw driver set Allen key set Plier set Hammer First aid box
LU2.Conduct pre-operational checks on machine	**The trainee will be able to:** Inspect all electrical connection. Check all mechanical fitting and joints. Check operation of emergency switches. Check the plunger Check cooling lines. Check and maintain proper lubrication. Check air pressure. Check water connection	Knowledge and understanding about how to check electrical connections. Knowledge and understanding about how to check mechanical fitting and joints. Knowledge and understanding about how to check emergency switches. Knowledge and understanding about how to check machine lubricant, temperature and pressures Knowledge and understanding about Plunger. Knowledge and understanding about operation of machine.	PPEs Die setting Air compressor Water chiller Heater Lifter Adjustable Spanner Pipe Wrench Combination Spanner Set Socket Set with handle Screw Driver Set Allen Key Set Measurement Tape Plier Set Tongue & Groove Plier

			Hammer First aid box
LU3 Prepare casting mould	**The trainee will be able to:** Lift mould with lifting equipment. Place the mould between the mould platen. Align mould in the centre of platen. Set cutting part size. Connect hydraulic and water connection. Clamp mould with bolts/ hydraulic clamps. Apply releasing spray/ beads.	Knowledge and understanding about how to lifting die/Mould. Knowledge and understanding about Die/Mould Clamping. Knowledge and understanding about alignment of die/mould. Knowledge and understanding about parameters setting. Knowledge and understanding about hydraulic and water connection. Knowledge and understanding about how to perform trial of die/mould to verify the operation.	PPEs Moulds setting Air compressor Water chiller Heater Lifter Hoist with stand Adjustable Spanner Pipe Wrench Combination Spanner Set Socket Set with handle Screw Driver Set Allen Key Set Measurement Tape Plier Set Tongue & Groove Plier Hammer Mallet (Soft Hammer)

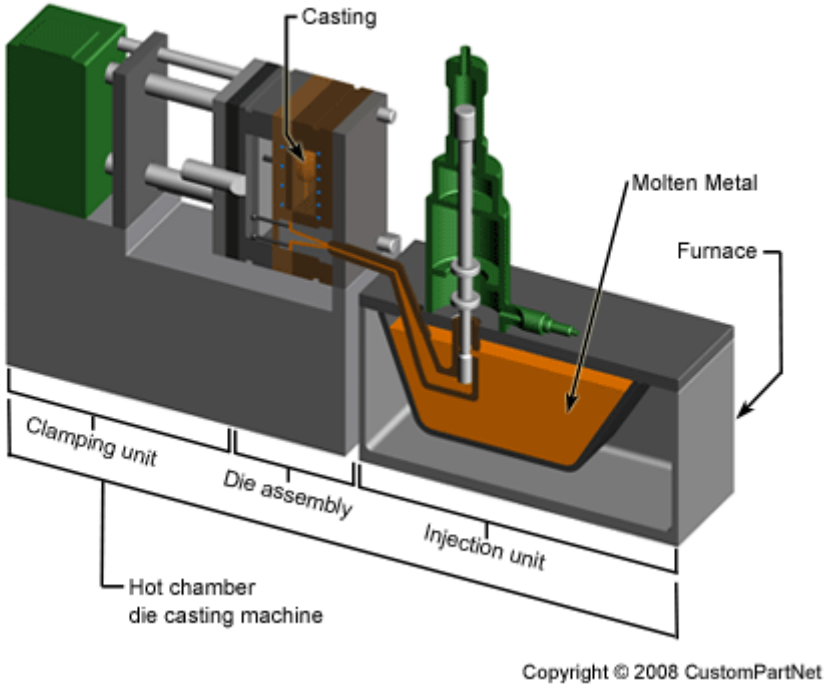
			First aid box
LU4. Operate machine	**The trainee will be able to:** Set all parameters. Lift the material with ladle from the holding furnace. Pour the material in the plunger. Proceed with operation. Monitor operation to ensure compliance with job requirements.	Knowledge and understanding about temperature and melting point of material. Knowledge and understanding about types of casting. Knowledge and understanding about machine selection. Knowledge and understanding about machine and parameters setting. Knowledge and understanding about Furnace. Knowledge and understanding about operation. Knowledge and understanding about how to monitor operation. Knowledge and understanding about different parts of die casting machine	Dryer Maintenance tools kit Air compressor Water chiller Heater Vernier Caliper Mallet (Soft Hammer) First aid box
LU5. **Inspect final product**	**The trainee will be able to:** Perform visual inspection of defects. Check dimensionally. Check part on checking fixture.	Knowledge and understanding about visual inspection. Knowledge and understanding how to Check dimensionally. Knowledge and understanding how to check with the help of gauges / Checking fixture..	PPEs Checking fixture Testing table Measuring equipment

	Complete inspection report.	Knowledge and understanding how to make inspection report.	Measurement tape Vernier caliper First Aid box
LU6. **Perform workplace cleaning and maintenance**	**The trainee will be able to:** Maintain all check sheets and work instruction on machine. Perform cleaning of die, machine and floor Perform lubrication on slides, tie bar and mould. Apply anti rust spray/cleaning agent. Maintain tools and equipment. Keep tools and equipment at appropriate place. Transfer wastage material in to the wastage area. Return excess material to store.	Knowledge and understanding about how to Maintain all check sheets and work instructions on the machine. Knowledge and understanding about how to maintain the tools and equipment. Knowledge and understanding about how to Keep tools and equipment at appropriate place. Knowledge and understanding about lubricants and lubrication. Knowledge and understanding about how to perform cleaning of machine, mould/die and floor. Knowledge and understanding about how to apply anti-rust spray/cleaning agent Knowledge and understanding about how to handle waste/excess material	PPEs Cotton Air compressor Lifter First aid box

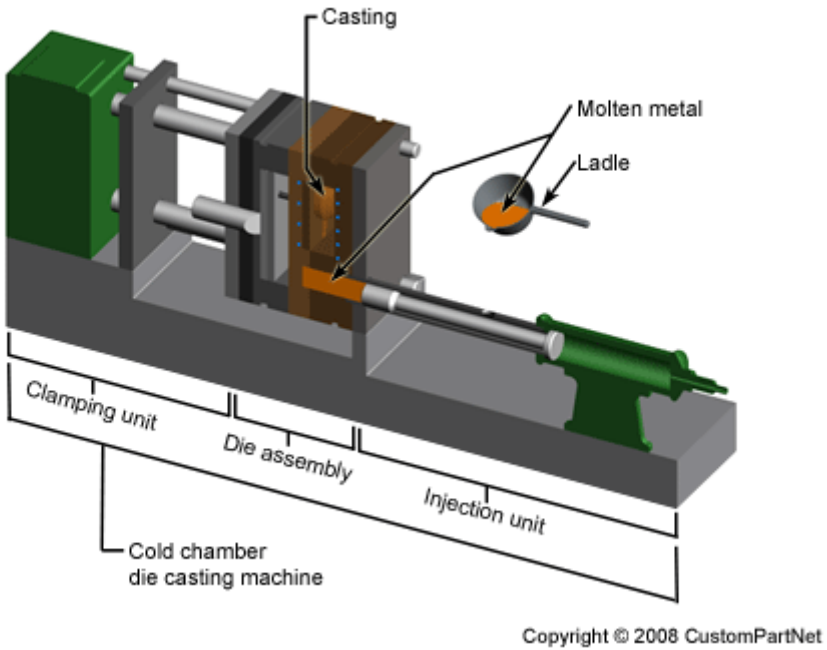
Examples and illustrations

Die Casting:

Die casting is a manufacturing process that can produce geometrically complex metal parts through the use of reusable moulds, called dies. The die casting process involves the use of a furnace, metal, die casting machine, and die. The metal, typically a non-ferrous alloy such as aluminum or zinc, is melted in the furnace and then injected into the dies in the die casting machine. There are two main types of die casting machines - hot chamber machines (used for alloys with low melting temperatures, such as zinc) and cold chamber machines (used for alloys with high melting temperatures, such as aluminum). The differences between these machines will be detailed in the sections on equipment and tooling. However, in both machines, after the molten metal is injected into the dies, it rapidly cools and solidifies into the final part, called the casting. The steps in this process are described in greater detail in the next section.



Die casting hot chamber machine overview



Die casting cold chamber machine overview

The castings that are created in this process can vary greatly in size and weight, ranging from a couple ounces to 100 pounds. One common application of die cast parts are housings - thin-walled enclosures, often requiring many ribs and bosses on the interior. Metal housings for a variety of appliances and equipment are often die cast. Several automobile components are also manufactured using die casting, including pistons, cylinder heads, and engine blocks. Other common die cast parts include propellers, gears, bushings, pumps, and valves.

Process Cycle:

The process cycle for die casting consists of five main stages, which are explained below. The total cycle time is very short, typically between 2 seconds and 1 minute.

1. **Clamping**

   - The first step is the preparation and clamping of the two halves of the die. Each die half is first cleaned from the previous injection and then lubricated to facilitate the ejection of the next part. The lubrication time increases with part size, as well as the number of cavities and side-cores. Also, lubrication may not be required after each cycle, but after 2 or 3 cycles, depending upon the material. After lubrication, the two die halves, which are attached inside the die casting machine, are closed and securely clamped together. Sufficient force must be applied to the die to keep it securely closed while the metal is injected. The time required to close and clamp the die is dependent upon the machine - larger machines (those with greater clamping forces) will require more time. This time can be estimated from the dry cycle time of the machine.

2. **Injection**

   - The molten metal, which is maintained at a set temperature in the furnace, is next transferred into a chamber where it can be injected into the die. The method of transferring the molten metal is dependent upon the type of die casting machine, whether a hot chamber or cold chamber machine is being used. The difference in this equipment will be detailed in the next section. Once transferred, the molten metal is injected at high pressures into the die. Typical injection pressure ranges from 1,000 to 20,000 psi. This pressure holds the molten metal in the dies during solidification. The amount of metal that is injected into the die is referred to as the shot. The injection time is the time required for the molten metal to fill all of the channels and cavities in the die. This time is very short, typically less than 0.1 seconds, in order to prevent early solidification of any one part of the metal. The proper injection time can be determined by the thermodynamic properties of the material, as well as the wall thickness of the casting. A greater wall thickness will require a longer injection time. In the case where a cold chamber die casting machine is being used, the injection time must also include the time to manually ladle the molten metal into the shot chamber.

3. **Cooling**

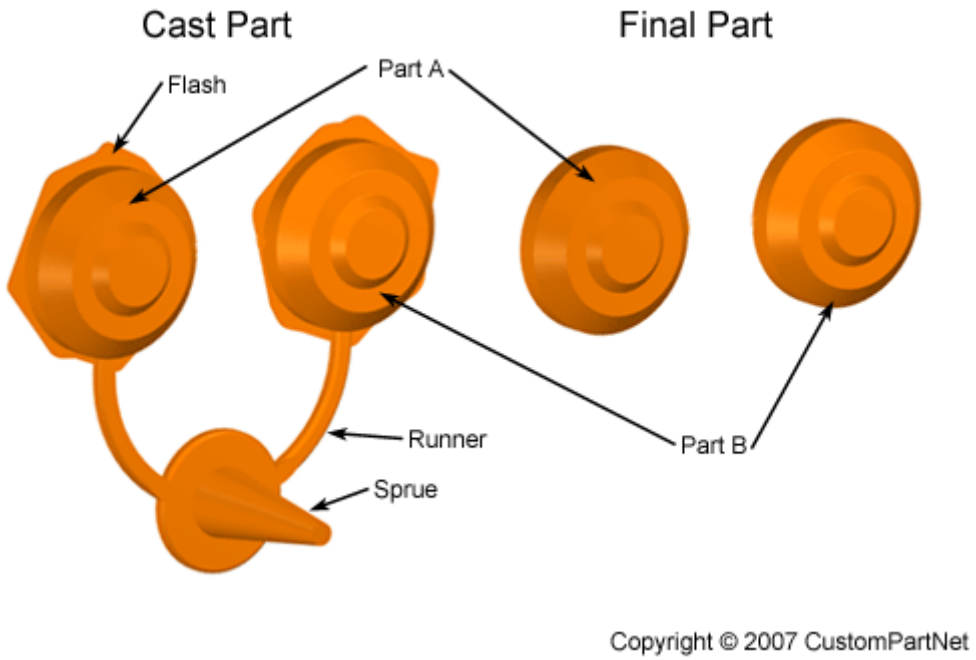
   - The molten metal that is injected into the die will begin to cool and solidify once it enters the die cavity. When the entire cavity is filled and the molten metal solidifies, the final shape of the casting is formed. The die can not be opened until the cooling time has elapsed and the casting is solidified. The cooling time can be estimated from several thermodynamic properties of the metal, the maximum wall thickness of the casting, and the complexity of the die. A greater wall thickness will require a longer cooling time. The geometric complexity of the die also requires a longer cooling time because the additional resistance to the flow of heat.

4. **Ejection**

   - After the predetermined cooling time has passed, the die halves can be opened and an ejection mechanism can push the casting out of the die cavity. The time to open the die can be estimated from the dry cycle time of the machine and the ejection time is determined by the size of the casting's envelope and should include time for the casting to fall free of the die. The ejection mechanism must apply some force to eject the part because during cooling the part shrinks and adheres to the die. Once the casting is ejected, the die can be clamped shut for the next injection.

5. Trimming

- During cooling, the material in the channels of the die will solidify attached to the casting. This excess material, along with any flash that has occurred, must be trimmed from the casting either manually via cutting or sawing, or using a trimming press. The time required to trim the excess material can be estimated from the size of the casting's envelope. The scrap material that results from this trimming is either discarded or can be reused in the die casting process. Recycled material may need to be reconditioned to the proper chemical composition before it can be combined with non-recycled metal and reused in the die casting process.



Die cast part

Die casting materials:

Die casting typically makes use of non-ferrous alloys. The four most common alloys that are die cast are shown below, along with brief descriptions of their properties. (Follow the links to search the material library).

Materials	Properties
Aluminum alloys	Low density Good corrosion resistance High thermal and electrical conductivity High dimensional stability Relatively easy to cast Requires use of a cold chamber machine
Copper alloys	High strength and toughness High corrosion and wear resistance High dimensional stability Highest cost Low die life due to high melting temperature Requires use of a cold chamber machine
Magnesium alloys	Very low density High strength-to-weight ratio Excellent machine ability after casting Use of both hot and cold chamber machines
Zinc alloys	High density High ductility Good impact strength Excellent surface smoothness allowing for painting or plating Requires such coating due to susceptibility to corrosion Easiest to cast Can form very thin walls Long die life due to low melting point Use of a hot chamber machine

The selection of a material for die casting is based upon several factors including the density, melting point, strength, corrosion resistance, and cost. The material may also affect the part design. For example, the use of zinc, which is a highly ductile metal, can allow for thinner walls and a better surface finish than many other alloys. The material not only determines the properties of the final casting, but also impacts the machine and tooling. Materials with low melting temperatures, such as zinc alloys, can be die cast in a hot chamber machine. However, materials with a higher melting temperature, such as aluminum and copper alloys, require the use of cold chamber machine. The melting temperature also affects the tooling, as a higher temperature will have a greater adverse effect on the life of the dies.

Possible Die Casting Process Defects:

Defect	Causes
Flash	Injection pressure too high Clamp force too low
Unfilled sections	Insufficient shot volume Slow injection Low pouring temperature
Bubbles	Injection temperature too high Non-uniform cooling rate
Hot tearing	Non-uniform cooling rate
Ejector marks	Cooling time too short Ejection force too high

Many of the above defects are caused by a non-uniform cooling rate. A variation in the cooling rate can be caused by non-uniform wall thickness or non-uniform die temperature.

Reference:

http://www.custompartnet.com/wu/die-casting#process_cycle

Workplace Housekeeping - Basic Guide

Note: please see workplace housekeeping in Module-7 Conduct moulding and extrusion operations

Videos:

	Topic	Hyperlink
	Metal Die Casting	https://www.youtube.com/watch?v=wKjgJT8iswM
	Aluminum die casting process	https://www.youtube.com/watch?v=Nq10h68UEFE

AUTOMOTIVE PARTS PRODUCTION MACHINE OPERATOR

Module-10
LEARNER GUIDE
National Vocational Certificate Level 4

Version 1 - October, 2019

Module 10: 0716001049 Perform gear cutting operation

Objective of the module: This module covers the specific skills and knowledge related to perform gear hobbing process, material handling, inspection techniques and maintain the machine and workplace.

Duration: 110 hours **Theory:** 22 hours **Practical:**88 hours

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1. Prepare for gear cutting	**The trainee will be able to:** Arrange material as per drawing or process sheet. Select tools and equipment. Set machine as per job specification.	Knowledge and understanding about how to arrange material as per drawing or process sheet. Knowledge and understanding about material. Knowledge and understanding about how to select the tools and equipment. Knowledge and understanding about how to set machine as per job specification.	PPEs Gear hobbing machine Cutting tools Clamping devices Pliers set Screw driver set Spacers Combination spanner set Socket set with Handle Vanier caliper Micro meter Dial indicator with stand First aid box

LU2. Conduct pre-operational checks on hobbingmachine	**The trainee will be able to:** Inspect all electrical connections. Check all mechanical fitting and joint. Check operation of emergency switches. Check and maintain correct machine lubricant and coolant levels.	Knowledge and understanding about how to check electrical connections Knowledge and understanding about how to check mechanical fitting and joints. Knowledge and understanding about how to check emergency switches. Knowledge and understanding about how to check machine lubricant, temperature and pressures. Knowledge and understanding about how to check machine operation.	PPEs Gear hobbing machine Cutting tools Clamping devices Pliers set Screw driver set Spacers Combination spanner set Socket set with Handle Vanier caliper Micro meter Dial indicator with stand Allen key set First aid box
LU3. Select tools	**The trainee will be able to:** Select the cutter as per gear type and module. Select the clamping device as per job. Select measurement tools.	Knowledge and understanding about Cutting tools. Knowledge and understanding about Clamping devices. Knowledge and understanding about how to Select measurement tools.	PPEs Gear hobbing machine Cutting tools Clamping devices Pliers set

		Knowledge and understanding about calculation and formulas.	Screw driver set Spacers Combination spanner set Socket set with Handle Vanier caliper Micro meter Dial indicator with stand Allen key set First aid box
LU4. **Operate machine**	**The trainee will be able to:** Clamp the tool. Clamp the work piece. Set all parameters. Align the tool according to work piece. . Proceed with operation. Monitor operation to ensure compliance with job requirements.	Knowledge and understanding about how to Clamp the tool. Knowledge and understanding about how to Clamp work piece. Knowledge and understanding about machine selection. Knowledge and understanding about machine and parameters setting. Knowledge and understanding about different types of gears.	PPEs Gear hobbing machine Cutting tools Clamping devices Pliers set Screw driver set Spacers Combination spanner

		Knowledge and understanding about operation. Knowledge and understanding about how to align work piece. Knowledge and understanding about how to monitor operation. Knowledge and understanding about different parts of gear cutting machine.	set Socket set with Handle Vanier caliper Micro meter Dial indicator with stand Allen key set First aid box
LU5. Inspect final product	**The trainee will be able to:** Perform visual inspection of defects. Check dimensionally. Complete inspection report.	Knowledge and understanding about visual inspection. Knowledge and understanding about Checking dimensionally. Knowledge and understanding about checking with the gauges. Knowledge and understanding about how to make inspection report.	PPEs Vanier caliper Micro meter Dial indicator with stand Profile projector First aid box
LU6. **Perform workplace cleaning and maintenance**	**The trainee will be able to:** Maintain all check sheets and work instruction on machine. Perform cleaning of machine and floor. Apply Anti-rust spray/Cleaning agent. Perform lubrication.	Knowledge and understanding about how to Maintain all check sheets and work instructions on the machine. Knowledge and understanding about how to maintain the tools and equipment. Knowledge and understanding about how to Keep tools and equipment at their appropriate place.	

	Maintain tools and equipment. Keep tools and equipment at appropriate place. Transfer wastage material in to the wastage area. Return Excess material to store.	Knowledge and understanding about lubricants and lubrication. Knowledge and understanding about how to Perform cleaning of machine, mould/die and floor. Knowledge and understanding about how to Apply anti-rust spray/cleaning agent Knowledge and understanding about how to handle waste/excess material	

Examples and illustrations

Gear hobbing:

Gear hobbing is a specialized process of gear cutting, spline cutting and sprocket cutting. The central equipment in the gear hobbing process is the milling machine. This gear hobbing milling machine does the task of cutting the spline or teeth using a series of cuts using a hob. Gear hobbing is often used for spur gear and helical gear making, because of its ease of use and cost effectiveness.

The process of gear hobbing is as follows:

a. The gear hobbing machine is checked for any mechanical issues. This includes the synchronization of the rotating gears for the work piece and the hob.
b. The gear hobbing machine has two skew spindles, one of which has the gear blank while the other one has the hob.
c. The spindles are set at an angle from each other, depending on the type of teeth to be set on the gear blank.
d. The two spindle shafts are then rotated proportionally with the hob cuts on the gear blank. Having them properly rotating is the key to making the right gear teeth on the gear blank.
e. The hob would then be applied to the gear blank until the correct tooth depth has been reached.
f. The hob is then run through the gear blank's axis of rotation as a final step.
g. The process is repeated for each gear blank, which is often stacked one atop another. The rotation ensures identical gear spindle depth and a consistent number of teeth on each gear blank.
h. The completed gears are removed from the milling machine.

The central tool to gear hobbing is the hob, a worm-shaped cutter. The hob makes successive cuts on the gear blank to create the gear teeth. In order for the cutting to be precise, the gear blank and the hob must be synchronized in the rotation.

Advantages of Gear Hobbing

Gear manufacturing gives us lots of options. There are a handful of different processes we can use to make dozens of different gear types from dozens of different materials. Accordingly, when we choose a gear manufacturing method, it's because it's the best one for the job.

Gear hobbing is just one way we can manufacture gears. It relies on a special form milling machine with a tool known as a hob, which generates the teeth in both gears and splines. So what are the advantages of this process?

1. **Speed.** Some gear manufacturing processes take a long time, but gear hobbing is relatively fast. The machine is simple, so it doesn't require as much operational attention, and for some gears, we can stack multiple units to hob them all at the same time.

2. **Precision.** That said, not just anyone can operate a hobbing machine. With the right expertise, hobbing can be highly precise, resulting in high quality gears.
3. **Flexibility.** There's more than one type of hob—and more than one type of hobbing machine. There are countless variations that cater to specialized applications, so you always have options available.
4. **Applications.** While hobbing is often used for spur gears, the process can be used for a variety of other gears, such as cycloid gears, helical gears, worm gears, ratchets, splines, and sprockets (as long as you have the right tools for the job).
5. **Related processes.** One of hobbing's only weaknesses is that it does not work for internal gears (with inward-facing teeth). However, there's a related process called shaping that can be used instead—with all the same advantages of hobbing.

References:

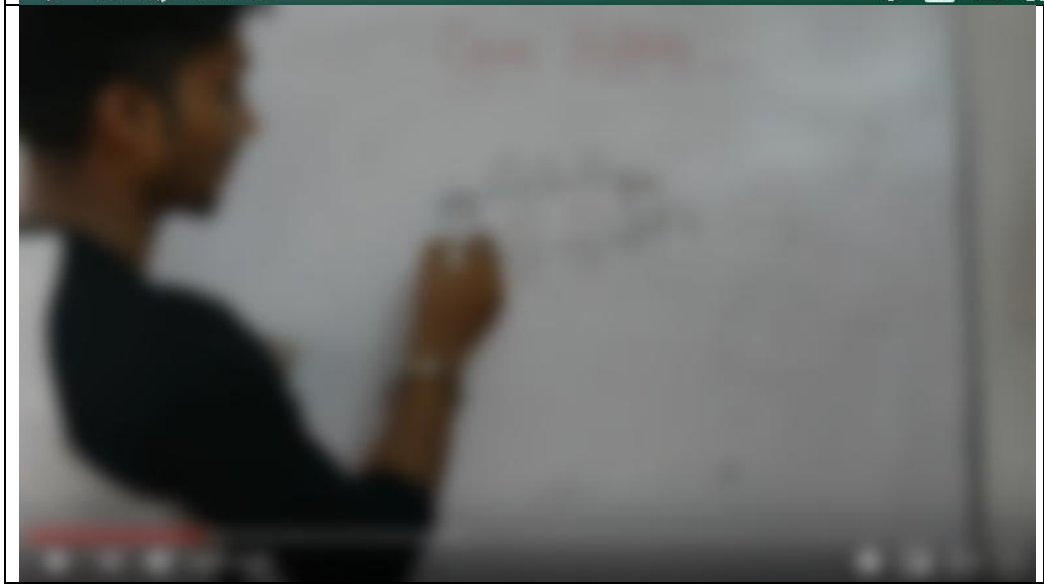
https://true-gear.com/how-gear-hobbing-is-done/blog.html

http://www.federalgear.com/blog/the-5-advantages-of-gear-hobbing

Workplace Housekeeping - Basic Guide

Note: please see workplace housekeeping in Module-7 Conduct moulding and extrusion operations

Videos:

	Topic	Hyperlink
	The process of Gear Hobbing	https://www.youtube.com/watch?v=fMxKMLIDkqo
	Gearhobbing process	https://www.youtube.com/watch?v=ix_Ywse-Zuw

Summary of the module:

Module Title and Aim	Learning Units	Timeframe of modules
Module 1:Contribute to Work Related Health and Safety (WHS) Initiatives **Aim:** The Aim of this module is to describe the skills and knowledge required to manage the identification, review, development, implementation and evaluation of effective participation and consultation processes as an integral part of managing work health and safety (WHS).	**LU1:** Contribute to initiate work-related health and safety measures. **LU2:** Contribute to establish work-related health and safety measures. **LU3:** Contribute to ensure legal requirements of WHS measures. **LU4:** Contribute to review WHS measures. **LU5:** Evaluate the organization's WHS system. .	30 Hours

Module Title and Aim	Learning Units	Timeframe of modules
Module 2:Comply with Workplace Policy and Procedures **Aim:** The Aim of this module is to describe the skills and knowledge required to develop and implement a workplace policy & procedures and to modify the policy to suit changed circumstances. It applies to individuals with managerial responsibilities who undertake work developing approaches to create, monitor and improve strategies and policies within workplaces and engage with a range of relevant stakeholders and specialists.	**LU1:** Respect work timeframes. **LU2:** Manage to convene meeting. **LU3:** Decision making at workplace. **LU4:** Set and meet own work priorities at instant. **LU5:** Develop and maintain professional competence. **LU6:** Follow and implement work safety requirements.	30 hours
Module 3:Perform Advanced Communication **Aim:** The Aim of this module is to describe the performance outcomes, skills and knowledge required to develop communication skills used professionally. It covers plan and organise work and conduct trainings at workplace, along with demonstrating professional skills independently.	**LU1:**Demonstrate professional skills. **LU2:**Plan and Organize work. **LU3:** Provide trainings at workplace.	30 Hours

Module Title and Aim	Learning Units	Timeframe of modules
Module 4:Develop Advance Computer Application Skills **Aim:** The Aim of this module is to provides an overview of Microsoft Office programs to create personal, academic and business documents following current professional and/or industry standards, i.e. Data Entry, Power Point Presentation and managing data base and graphics for Design It applies to individuals employed in a range of work environments who need to be able to present a set range of data in a simple and direct form.	**LU1:** Manage Information System to complete a task. **LU2:** Prepare Presentation using computers**.** **LU3:** Use Microsoft Access to manage database. **LU4:** Develop graphics for Design.	40 Hours
Module 5:Manage Human Resource Services **Aim:** The Aim of this module is to describe the skills and knowledge required to plan, manage and evaluate delivery of human resource services, integrating business ethics. It applies to individuals with responsibility for coordinating a range of human resource services across an organization. They may have staff reporting to them.	**LU1:** Determine strategies for delivery of human resource services. **LU2:** Manage the delivery of human resource services. **LU3:** Evaluate human resource service delivery. **LU4:** Manage integration of business ethics in human resource practices.	20 Hours

Module Title and Aim	Learning Units	Timeframe of modules
Module 6:Develop Entrepreneurial Skills **Aim:** The Aim of this module is to identify the competencies required to develop entrepreneurial skills, in accordance with the organization's approved guidelines and procedures. You will be expected to develop a business plan, collect information regarding funding sources, develop a marketing plan and develop basic business communication skills. Your underpinning knowledge regarding entrepreneurial skills will be sufficient to provide you the basis for your work.	**LU1:** Develop a business plan. **LU2:** Collect information regarding funding sources. **LU3:** Develop a marketing plan. **LU4:** Develop basic business communication skills.	30 Hours

Module Title and Aim	Learning Units	Timeframe of modules
Module 7:Conduct moulding and extrusion operations **Aim:** The aim of this module is to cover the specific skills and knowledge related to the plastic and rubber parts manufacturing operation on moulding and extrusion machines, material handling, inspection techniques and maintenance of machines and workplace.	**LU1:** Prepare for moulding and extrusion. **LU2:** Conduct pre-operational checks on machine. **LU3:** Prepare moulds (Injection, Compression, blow, rubber injection,PU). **LU4:** Prepare Die. **LU5:** Operate injection moulding machine. **LU6:** Operate rubber compression mounding machine. **LU7:** Operate blow moulding machine. **LU8:** Operate rubber injection moulding machine. **LU9:** Operate Polyurethane moulding mchine. **LU10:** Operate extrusion machine. **LU11:** Inspect the final product. **LU12:** Perform workplace cleaning and maintenance.	290 Hours
Module 8: Perform hot forging operations **Aim:** This aim of this module is to cover the specific skills and knowledge related to the process of hot forging parts manufacturing operation on hot forging and press forging machines, material handling, inspection techniques and maintain of machines and workplace.	**LU1:** Prepare for hot press forging. **LU2:** Conduct pre-operational checks on machine. **LU3:** Prepare mould/die. **LU4:** Operate machine. **LU5:** Inspect final product. **LU6:** Perform workplace cleaning and maintenance.	100 Hours

Module Title and Aim	Learning Units	Timeframe of modules
Module 9: Perform metal die casting operations **Aim:** The aim of this module is to cover the specific skills and knowledge related to prepare a machine for die casting process, material handling, formulation/ construction, defects & remedies and maintains machine and workplace.	**LU1:** Prepare for die casting. **LU2:** Conduct pre-operational checks on machine. **LU3:** Prepare casting mould. **LU4:** Operate machine. **LU5:** Inspect final product. **LU6:** Perform workplace cleaning and maintenance..	100 Hours
Module 10: Perform gear cutting operations **Aim:** The aim of this module is to cover the specific skills and knowledge related to perform gear hobbing process, material handling, inspection techniques and maintain the machine and workplace.	**LU1:** Prepare for gear cutting. **LU2:** Conduct pre-operational checks on hobbing machine. **LU3:** Select tools. **LU4:** Operate machine. **LU5:** Inspect final product. **LU6:** Perform workplace cleaning and maintenance.	110 Hours

Frequently asked questions

1. What is Competency Based Training (CBT) and how is it different from currently offered trainings in institutes?	Competency-based training (CBT) is an approach to vocational education and training that places emphasis on what a person can do in the workplace as a result of completing a program of training. Compared to conventional programs, the competency based training is not primarily content based; it rather focuses on the competence requirement of the envisaged job role. The whole qualification refers to certain industry standard criterion and is modularized in nature rather than being course oriented.
2. What is the passing criterion for CBT certificate?	You shall be required to be declared “Competent” in the summative assessment to attain the certificate.
3. What are the entry requirements for this course?	The entry requirement for this course is National Vocational Certificate level-3, in (Automotive Parts Production Machine Operator or relevant)
4. How can I progress in my educational career after attaining this certificate?	You shall be eligible to take admission in the National Vocational Certificate Level-5 DAE or equivalent course. In certain case, you may be required to attain an equivalence certificate from The Inter Board Committee of Chairmen (IBCC).
5. What is the duration of this course?	The duration of the course work is 600 hrs. (06 months)
6. What are the class timings?	The classes are normally offered 25 days a month from 08:00am to 01:30pm. These may vary according to the practices of certain institutes.
7. What is equivalence of this certificate with other qualifications?	As per the national vocational qualifications framework, the level-4 certificate is equivalent to Matriculation. The equivalence certificate can be obtained from The Inter Board Committee of Chairmen (IBCC).
8. What is the importance of this certificate in National and International job market?	This certificate is based on the nationally standardized and notified competency standards by National Vocational and Technical Training Commission (NAVTTC). These standards are also recognized worldwide as all the standards are coded using international methodology and are accessible to the employers worldwide through NAVTTC website.

9. Which jobs can I get after attaining this certificate? Are there job for this certificate in public sector as well?	You shall be able to take up jobs in the Automotive industries in the functions of Machine operator, Supervisor/ Line Incharge Die/Mould Setter, Production executive etc.
10. What are possible career progressions in industry after attaining this certificate?	You shall be able to progress up to the level of supervisor after attaining sufficient experience, knowledge and skills during the job. Attaining additional relevant qualifications may aid your career advancement to even higher levels.
11. Is this certificate recognized by any competent authority in Pakistan?	This certificate is based on the nationally standardized and notified competency standards by National Vocational and Technical Training Commission (NAVTTC). The official certificates shall be awarded by the relevant certificate awarding body.
12. Is on-the-job training mandatory for this certificate? If yes, what is the duration of on-the-job training?	On-the-job training is not a requirement for final / summative assessment of this certificate. However, taking up on-the-job training after or during the course work may add your chances to get a job afterwards.
13. How much salary can I get on job after attaining this certificate?	The minimum wages announced by the Government of Pakistan in 2019 are PKR 17,500. This may vary in subsequent years and different regions of the country. Progressive employers may pay more than the mentioned amount.
14. What is the teaching language of this course?	The leaching language of this course is Urdu and English.
15. Is it possible to switch to other certificate programs during the course?	There are some short courses offered by some training institutes on this subject. Some institutes may still be offering conventional certificate courses in the field.
16. What is the examination / assessment system in this program?	Competency based assessments are organized by training institutes during the course which serve the purpose of assessing the progress and preparedness of each student. Final / summative assessments are organized by the relevant qualification awarding bodies at the end of the certificate program. You shall be required to be declared “Competent” in the summative assessment to attain the certificate.

Test Yourself (Short &Multiple Choice Questions)

Module-7

Question	Candidate's answer
1. Enlist three important steps of mould setting in the machine?	
2. What is the most common reason of damage of die / Mould during operation?	
3. Enlist three main reasons defects of productive parts?	
1. What is the main reason of short moulding during moulding operation?	
2. Which chemicals are used in polyurethane product?	

Question	Candidate's answer
3. Define curing time in PU process?	
4. Select the blow moulding product in given list. a) Cup b) Pet Bottle c) Spoon d) Bumper	
5. Which of the following is the main part of Injection mould ? a) Core, Cavity b) Crank c) Piston d) Cam	
9. In injection moulding process Injector is used to; a) Ejection of material b) Ejection of mould c) Ejection of part. d) Ejection of waste material	

Question	Candidate's answer
10. Which defect is produce by improper degassing? a) Pinhole, air bubble, air cut b) Part color, location, and thickness. c) Part hole, position, and surface d) All on the above	

Module-8

Question	Candidate's answer
11. Enlist the types of presses used in hot forging?	
12. What is the Carbon steel deformation temperature?	
13. Enlist the three hot forging operations?	

Question	Candidate's answer
14. Write any three advantages of hot forging?	
15. Enlist the common PPE's used in Hot Forging?	
16. Select which one is forging defect in below list. a. Soaking b. Gas marks c. Non filling d. Pin hole	
17. Which is the right method for pre heating of mould in below list? a) Gas Burner b) Kerosene burner c) Ceramic heater d) Stove	

Question	Candidate's answer
18. Select main operation name during forging in below list. a) Creeper b) Blocker c) Holder d) Finder	
19. Can deep draw performed on forging press? a. True b. False	
20. ISO stands for? a) International Standard Organization b) International System Organization c) Industry System Organization	

Module-9

Question	Candidate's answer
21. Enlist any three metal die casting defects?	

Question	Candidate's answer
22. Write any three advantages of metal die casting process.	
23. Write the three types of casting process.	
24. What is the function of plunger?	
25. Write any four components of casting die.	
26. Select the right molten temperature of aluminum in below list. a) 660 degree Celsius b) 1260 degree Celsius c) 1600 degree Celsius d) 250 degree Celsius	

Question	Candidate's answer
27. Which material in below list is not used in die casting process? a) Aluminum b) Plastic c) Lead d) Zinc	
28. HPDC stands for? a) High Pressure Die Casting b) High pouring die casting c) High pouring define cost d) Not in above	
29. Is zinc melting temperature is 320 degree Celsius. a) True b) False	
30. Can we use hot chamber machine for the material melt upto 400 degree Celsius. a) True b) False	

Module-10

Question	Candidate's answer
31. Enlist the three types of gears	
32. What is the difference between the spur gear and helical gear?	
33. Write any three advantages of gear hobbing?	
34. What is cutting feed formula?	
35. Write the cutting speed formula?	

Question	Candidate's answer
36. What is the bilateral tolerance? a) Total tolerance is in one direction b) Total tolerance is in both direction c) May or not may be in one direction d) Tolerance provided all over the component body	
37. Which gear has higher torque ability? a. Spur gear b. Rack gear c. Helical gear d. Worm gear	
38. For higher rate of gear production, we use milling machine. a. True b. False	
39. M-series high speed steel tool has more efficient that T-series high special steel tool? a. True b. False	
40. Spur Gear has straight teeth? a. True b. False	

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