FUNDAMENTAL MANUFACTURING PROCESSES

PLASTIC INJECTION MOLDING

SCENE 1.
CG: THE INJECTION MOLDING MACHINE
white text centered on black

SCENE 2.
tape 405, 10:13:57-10:14:00
injection molding machine
tape 420, 03:06:55-03:07:03
injection molding machine
tape 422, 16:04:51-16:04:54
injection molding machine
tape 420, 03:00:47-03:00:52
injection molding machine
tape 405, 10:21:03-10:21:09
injection molding machine
tape 421, 15:12:34-15:12:38
injection molding machine
tape 400, 05:07:47-05:07:51
injection molding machine
tape 405, 10:14:32-10:14:34
two platen injection molding machine
tape 405, 10:14:20-10:14:23
two platen injection molding machine
tape 420, 03:16:50-03:17:00
electric injection molding machine

NARRATION (VO):

THERE ARE A VARIETY OF INJECTION MOLDING MACHINES IN USE TODAY. THE VAST MAJORITY OF THESE MACHINES ARE HYDRAULICALLY ACTUATED AND HAVE THREE PLATENS, BUT NEWER STYLES SUCH AS TWO-PLATEN INJECTION MOLDING MACHINES, AND ELECTRIC INJECTION MOLDING MACHINES ARE NOW GAINING MARKET ACCEPTANCE.

SCENE 3.
tape 420, 03:03:50-03:03:59
injection molding machine
tape 416, 13:17:35-13:17:39
tilt down, still of small injection molding machine
tape 416, 12:00:40-12:00:50
large injection molding machine
tape 400, 05:12:59-05:13:05
injection molding machine producing part
tape 398, 02:01:14-02:01:20
vertically oriented injection molding process
tape 398, 02:06:45-02:06:52
vertically oriented injection molding process, zoom in

NARRATION (VO):

INJECTION MOLDING MACHINES RANGE IN SIZE AND COMPLEXITY, FROM DESK-SIZED UNITS UP TO MACHINES THE SIZE OF A SMALL HOUSE. MOST INJECTION MOLDING MACHINES ARE HORIZONTALLY ORIENTED, BUT VERTICALLY ORIENTED MOLDING MACHINES ARE AVAILABLE. THESE VERTICAL MACHINES ARE PRIMARILY USED FOR INSERT MOLDING.

SCENE 4.	**NARRATION (VO):**
tape 422, 16:05:59-16:06:10	
wide, injection molding machine	ALL INJECTION MOLDING MACHINES ARE A COMBINATION
CG, SUPER: Injection System	
Clamping System	OF TWO SYSTEMS,
build with red bullets	
	AN INJECTION SYSTEM,
	AND A CLAMPING SYSTEM.
SCENE 5.	**NARRATION (VO):**
tape 417, 12:05:16-12:05:25	
machine heating plastic, dissolve to next shot	THE INJECTION SYSTEM HEATS THE THERMOPLASTIC
tape 417, 12:04:32-12:04:40	MATERIAL TO ITS APPROPRIATE VISCOSITY OR
machine injecting melt into mold	
CG, SUPER: Injection System	FLOWABILITY AND THEN FORCEFULLY INJECTS IT INTO
	THE MOLD.
SCENE 6.	**NARRATION (VO):**
continue previous shot	
tape 424, 18:08:02-18:08:11	THERE ARE TWO TYPES OF INJECTION MECHANISMS:
reciprocating screw injection molding machine	THE RECIPROCATING SCREW, WHICH IS THE MOST COMMON,
tape 421, 15:14:09-15:14:14	
two-stage screw injection molding machine	AND THE TWO-STAGE SCREW.
SCENE 7.	**NARRATION (VO):**
tape 417, 12:16:26-12:16:36	
wide, reciprocating screw inject system	THE MAIN PARTS OF THE RECIPROCATING SCREW
tape 427, 21:12:15-21:12:25	INJECTION SYSTEM ARE:
shot of hopper	
CG, SUPER: Hopper	THE HOPPER,
tape 423, 17:08:04-17:08:12	
reciprocal screw outside of machine	A RECIPROCATING SCREW,
CG, SUPER: Reciprocating Screw	INSIDE AN EXTERNALLY HEATED INJECTION BARREL,
tape 427, 21:10:39-21:10:51	
pan of injection barrel	A HYDRAULIC MOTOR,
CG, SUPER: Injection Barrel	
tape 427, 21:12:32-21:12:38	AND AN INJECTION CYLINDER.
shot of hydraulic motor	
CG, SUPER: Hydraulic Motor	
tape 427, 21:10:22-21:10:30	
pan of injection cylinder	
CG, SUPER: Injection Cylinder	
SCENE 8.	**NARRATION (VO):**
tape 398, 02:17:51-02:18:00	
hopper	RESIN MATERIAL IS FED TO THE INJECTION BARREL FROM

THE HOPPER.

SCENE 9.
tape 390, 03:21:41-03:21:44
hopper filled manually
tape 398, 02:18:03-02:18:15
pan, hopper filled automatically to dryer on top

NARRATION (VO):

THESE HOPPERS MAY BE FILLED MANUALLY, OR VACUUM FED AUTOMATICALLY, AND OFTEN HAVE DRYERS ATTACHED TO THE TOP TO REMOVE THE MOISTURE FROM THE MATERIAL.

SCENE 10.
tape 428, 00:00:48-00:01:20
ANI: resin entering the injection barrel from the hopper, driven forward by the rotation of the screw

NARRATION (VO):

AS THE RESIN ENTERS THE INJECTION BARREL IT IS DRIVEN FORWARD BY THE ROTATION OF THE SCREW, WHICH IS POWERED BY THE HYDRAULIC MOTOR.

SCENE 11.
continue animation

NARRATION (VO):

THE RESIN PLASTICIZES, OR MELTS, AS THE TURNING SCREW "DRAGS" IT TOWARDS THE NOZZLE END. THIS IS REFERRED TO AS DRAG FLOW. DRAG FLOW CAUSES THE POLYMER MOLECULES TO SLIDE OVER EACH OTHER CREATING FRICTIONAL HEAT WHICH MELTS THE MATERIAL.

SCENE 12.
tape 417, 12:12:19-12:12:35
pan, heating bands on injection barrel
tape 427, 21:02:32-21:02:42
zoom out from thermocouple in barrel
tape 427, 21:02:11-21:02:15
thermocouple in nozzle

NARRATION (VO):

EXTERNAL HEATING BANDS PROVIDE ADDITIONAL HEAT TO THE INJECTION BARREL. THE HEATING BANDS BRING THE MATERIAL TO ITS FINAL TEMPERATURE AND COMPENSATE FOR THE RADIATION HEAT LOSS. THE TEMPERATURE IS CONTROLLED BY THREE THERMOCOUPLES IN THE BARREL AND ONE IN THE NOZZLE.

SCENE 13.
tape 428, 00:02:40-00:02:50
GRAPHIC: wide of reciprocal screw
tape 428, 00:03:02-00:03:12
GRAPHIC: reciprocal screw's feed zone highlighted
CG, SUPER: Feed Zone

NARRATION (VO):

THE SCREW CONSISTS OF THREE ZONES. THE FIRST ZONE, WHICH IS ONE HALF OF THE SCREW, IS CALLED THE FEED ZONE. IT HAS A CONSTANT FLIGHT DEPTH, WHICH FORCES

tape 428, 00:02:00-00:02:07
ANI: c.u. feed zone area, arrows indicating constant flight depth, screw begins to rotate, forcing plastic pellet material together

THE MATERIAL TOGETHER AND RIDS IT OF AIR.

SCENE 14.
tape 428, 00:03:22-00:03:32
GRAPHIC: reciprocal screw's melt zone highlighted
CG, SUPER: Melt Zone
tape 428, 00:04:16-00:04:32
ANI: c.u. melt zone area, arrows indicating decreasing flight depth, screw rotating, plastic pellet material melting
tape 428, 00:03:43-00:03:53
GRAPHIC: reciprocal screw's metering zone, highlighted
CG, SUPER: Metering Zone

NARRATION (VO):

THE SECOND ZONE, CALLED THE MELT ZONE, HAS A DECREASING FLIGHT DEPTH WHICH REDUCES THE PLASTIC VOLUME. THIS CAUSES THE PLASTIC MOLECULES TO RUB HARDER AGAINST EACH OTHER, PLASTICIZING THE MATERIAL. THE MELT ZONE LEADS TO THE THIRD, OR, METERING ZONE.

SCENE 15.
tape 428, 00:05:12-00:05:48
ANI: c.u. metering zone area, arrows indicating decreased, constant flight depth, screw rotating, plastic pellet material melting

NARRATION (VO):

THE METERING ZONE HAS A CONSTANT FLIGHT DEPTH MUCH SMALLER THAN THAT OF THE FEED ZONE. THIS SECTION ACTS AS A PUMP.

SCENE 16.
continue animation

NARRATION (VO):

THE TIP OF THE SCREW HAS A ONE-WAY VALVE WHICH LETS THE MATERIAL FLOW ONLY TOWARDS THE NOZZLE END. THE FORCE OF THE PLASTICIZED MATERIAL PUSHES THE SCREW BACK AS IT TURNS. THIS BUILDS A CHAMBER OF PLASTIC IN FRONT OF THE SCREW. WHEN ENOUGH MATERIAL FOR THE INJECTION SHOT IS MELTED, THE SCREW STOPS AND PULLS BACK TO DECOMPRESS THE MATERIAL.

SCENE 17.
tape 428, 00:06:23-00:06:43
ANI: material injected into mold

NARRATION (VO):

FOR INJECTING THE MATERIAL, THE ONE-WAY VALVE CLOSES AS THE SCREW IS HYDRAULICALLY PUSHED

FORWARD BY THE INJECTION CYLINDER. THIS SENDS THE MOLTEN MATERIAL THROUGH THE INJECTION UNIT'S NOZZLE, AND INTO THE INJECTION MOLD.

SCENE 18.
tape 400, 05:13:31-05:13:52
zoom out, injection process

NARRATION (VO):

THE PRIMARY SPEED AND THE INJECTION PRESSURE, CALLED THE PACKING PRESSURE, IS HIGH, USUALLY AROUND 20,000 PSI, BUT SOMETIMES REACHING UP TO 30,000 PSI OR HIGHER. A SECONDARY LOWER PRESSURE IS APPLIED SHORTLY AFTER THE INITIAL INJECTION.

SCENE 19.
tape 398, 02:19:25-02:19:39
pan, injection process

NARRATION (VO):

AT THE TIME OF INJECTION, THE MATERIAL'S TEMPERATURE RANGES FROM APPROXIMATELY 320 TO 600 DEGREES FAHRENHEIT, OR 160 TO 320 DEGREES CELSIUS.

SCENE 20.
tape 428, 00:07:22-00:07:39
ANI: after injection, sprue bushing solidifying, reciprocating screw begins to rotate again, melting material for the next shot

NARRATION (VO):

ONCE THE PLASTIC SOLIDIFIES, NO MORE PRESSURE CAN BE EXERTED UPON IT IN THE MOLD. THE RECIPROCATING SCREW THEN BEGINS TO ROTATE AGAIN, MELTING MATERIAL FOR THE NEXT SHOT.

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SCENE 21.
tape 421, 15:13:23-15:13:30
wide, two-stage screw machine
tape 421, 15:15:19-15:15:36
pan of screw and bore cylinder
tape 421, 15:15:49-15:16:06
two-stage screw injecting material into mold

NARRATION (VO):

THE TWO-STAGE SCREW TYPE MACHINE HAS A SCREW WHICH CONSTANTLY FORCES MELTED RESIN INTO A SECOND STRAIGHT BORE CYLINDER WITH ITS OWN PLUNGER. WHEN THE CORRECT AMOUNT OF MATERIAL HAS BEEN TRANSFERRED, THE SCREW STOPS TURNING, AND A VALVE CLOSES, SEPARATING THE CYLINDERS. THE PLUNGER PULLS BACK TO DECOMPRESS THE MATERIAL, WHICH IS

THEN INJECTED INTO THE MOLD.

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SCENE 22.
tape 400, 06:05:09-06:05:28
tilt, clamping system as mold opens
CG, SUPER: Clamping System

NARRATION (VO):

THE FUNCTION OF AN INJECTION MOLDING MACHINE'S CLAMPING SYSTEM IS TO KEEP THE PLASTIC MATERIAL FROM LEAKING OUT, OR FLASHING, AT THE PARTING LINE OF THE MOLD'S CAVITY AND CORE.

SCENE 23.
tape 400, 05:11:44-05:12:00
pan, hydraulic clamping system of injection molding machine
tape 427, 21:04:33-21:04:46
clamping system as mold opens

NARRATION (VO):

THE CLAMPING SYSTEM OF THE INJECTION MOLDING MACHINE HAS TWO CONFIGURATIONS. ONE IS A FULLY HYDRAULIC SYSTEM WHERE THE TOTAL CLAMPING FORCE IS GENERATED BY THE HYDRAULIC CLAMPING CYLINDER.

SCENE 24.
tape 421, 15:10:22-15:10:34
toggle clamping system of injection molding machine

NARRATION (VO):

THE SECOND IS A TOGGLE SYSTEM WHERE A MUCH SMALLER HYDRAULIC CYLINDER IS USED IN CONJUNCTION WITH A SERIES OF TOGGLE LEVERS TO PROVIDE THE FULL CLAMPING FORCE.

SCENE 25.
tape 415, 10:28:06-10:28:26
pull back of injection molding machines

NARRATION (VO):

INJECTION MOLDING MACHINES ARE DESIGNATED BY THEIR CLAMP TONNAGE, WHICH IS THE AMOUNT OF SEALING FORCE A MACHINE CAN PRODUCE AGAINST THE HIGH PRESSURES GENERATED DURING THE INJECTION PROCESS.

SCENE 26.
tape 415, 10:23:12-10:23:25
med, pull back, platen holding mold, machine closes
tape 415, 10:08:10-10:08:30
static of injection molding machines, image grays down with each platen highlighted
CG, SUPER: Stationary Platen

NARRATION (VO):

PLATENS ARE LARGE THICK BLOCKS OF TOUGH STEEL WHICH WILL NOT DEFLECT ENOUGH TO AFFECT THE INJECTION PROCESS. THERE ARE THREE PLATENS ON MOST

Movable Platen
Rear Stationary
Platen

INJECTION MOLDING MACHINES:

A STATIONARY PLATEN...,

A MOVABLE PLATEN...,

AND A REAR STATIONARY PLATEN.

SCENE 27.
tape 415, 10:11:11-10:11:19
zoom in, hole on stationary platen
wide,
tape 415, 10:01:16-10:01:33
zoom out, stationary platen with cavity side of the mold,
anchoring the machines four tie bars

NARRATION (VO):

THE STATIONARY PLATEN HAS A HOLE DIRECTLY IN LINE WITH THE INJECTION CYLINDER'S NOZZLE. THE CAVITY SIDE OF THE MOLD, SOMETIMES CALLED THE "A" OR STATIONARY SIDE IS ATTACHED TO THE STATIONARY PLATEN. THE STATIONARY PLATEN ALSO ANCHORS ONE END OF THE MACHINES FOUR TIE BARS.

SCENE 28.
tape 415, 10:04:02-10:04:13
zoom in, movable platen holding the "b" half of the mold

NARRATION (VO):

THE MOVABLE PLATEN HOLDS THE CORE SIDE OF THE MOLD. THIS IS ALSO REFERRED TO AS THE EJECTION, KNOCKOUT, OR "B" SIDE OF THE MOLD.

SCENE 29.
tape 400, 06:09:00-06:09:18
movable platen moving back on the tie bars, mold opens, part expelled

NARRATION (VO):

THIS MOVABLE PLATEN MOVES BACK AND FORTH ON THE TIE BARS. AS THE MOLD OPENS, THE EJECTION SYSTEM EXPELS THE MOLDED PART.

SCENE 30.
continue previous shot

NARRATION (VO):

THE REAR STATIONARY PLATEN HOLDS THE OTHER END OF THE TIE BARS, ANCHORING THE ENTIRE CLAMPING SYSTEM.

SCENE 31.
tape 417, 12:19:41-12:19:58
zoom out injection molding machine with all the safety feature in place, running parts

NARRATION (VO):

INJECTION MOLDING MACHINES ARE DESIGNED NOT TO OPERATE UNLESS THE FRONT AND REAR SAFETY GATES ARE CLOSED. THIS LIMITS ACCESS TO THE PLATEN AREA

WHILE THE MACHINE IS IN OPERATION.

SCENE 32.
tape 417, 12:28:51-12:29:04
zoom in, safety bar coming down as door to injection molding machine is opened, dissolve to later in same shot
tape 417, 12:29:09-12:29:13
injection molding operation, cut on action with previous shot

NARRATION (VO):

A SAFETY DROP BAR IS REQUIRED ON INJECTION MOLDING MACHINES. IT DROPS DOWN BETWEEN THE PLATENS WHEN THE SAFETY GATE IS OPEN, SO THAT THE MACHINE CANNOT CLOSE UPON A PERSON. THIS IS IN ADDITION TO OTHER HYDRAULIC AND ELECTRICAL SAFETY SYSTEMS.

SCENE 33.
tape 417, 12:15:20-12:15:31
machine run in a semi-automatic mode, the operator removes the part, then closes the gate, starting the next cycle
tape 398, 02:13:51-02:14:03
automatic operation, parts falling into a container
tape 399, 03:10:16-03:10:25
automatic operation, parts falling onto a moving belt
tape 398, 02:25:05-02:25:13
automatic operation, parts removed by robot

NARRATION (VO):

WHEN MACHINES ARE RUN IN A SEMI-AUTOMATIC MODE, THE OPERATOR REMOVES THE PART, THEN CLOSES THE GATE, STARTING THE NEXT CYCLE. IN AUTOMATIC OPERATION THERE IS NO OPERATOR INTERVENTION AND PARTS EITHER FALL DOWN INTO A CONTAINER, OR ONTO A MOVING BELT OR OTHER DEVICE, OR ARE REMOVED BY A ROBOT.

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