Working with the Machine

LESSON 2: Startup and Shutdown Procedures

Lesson Two: Startup and Shutdown

Good startup procedures will help get the molding machine making quality parts as soon as possible. Clear shutdown procedures will help minimize downtime and waste of plastic materials. This lesson introduces some of the procedures that make good startups and shutdowns.

Objectives of Lesson Two

1. Learn how to find the critical path
2. Learn how to formulate a pre-start checklist
3. Learn the important steps for starting the machine
4. Learn what to do for planned shutdowns
5. Learn what to do for unplanned shutdowns
6. Identify some of the common purging procedures

Objective One

Finding the Critical Path

The molding technician's first goal is to start the machine and make quality parts as soon as possible. Finding the critical path means beginning the startup with the tasks that take the longest time. Starting the longest task first will get the machine running sooner. Figure 1 shows a critical path example.

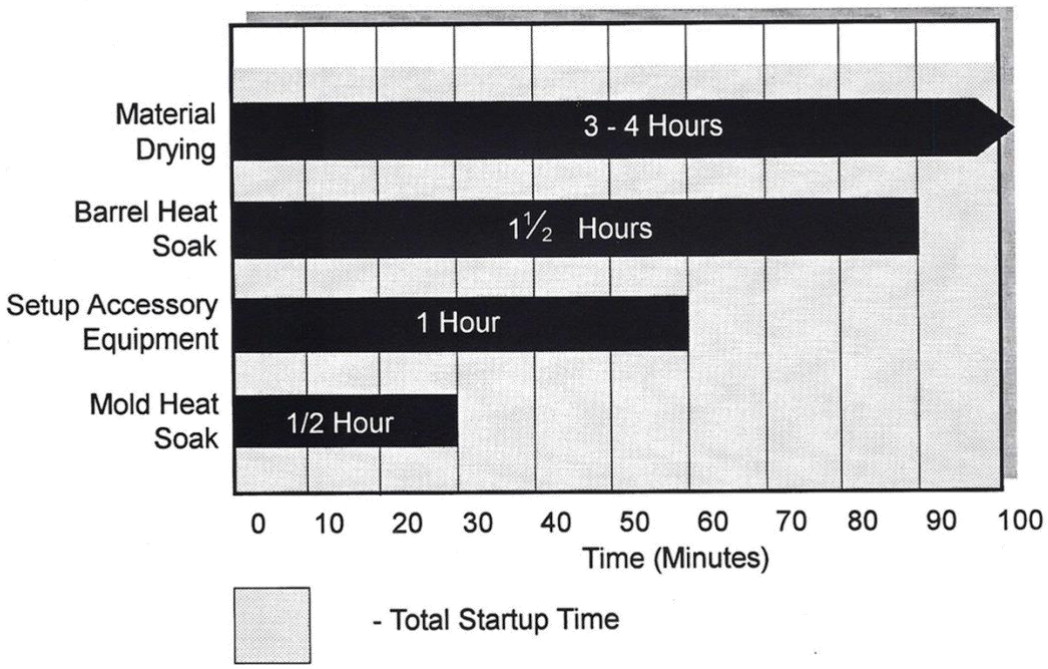

Figure 1- Critical Path

If the plastic needs to be dried, it must be loaded into the dryer well before the machine is to be run. Most materials need at least three to four hours of drying time. Getting the temperature set points from the setup sheet, and heating the barrel, can take a few hours on large machines. The mold also requires time to hook up the water lines and preheat. Secondary equipment setup time varies a lot from job to job.

The following tasks are usually part of the critical path. Start with these steps before moving on to simpler tasks.

Check Mold Setting

You should always check that the mold is set properly at startup time. The mold clamps should be in place and tight. Many shops require you to check the clamps with a wrench. You should also check that all the water and oil lines are hooked up properly. Be sure the fittings are tight and not leaking. The cores and core pulls should be hooked up to the appropriate hydraulic lines.

Checking the mold in the machine is especially important when the mold has been out of the machine for maintenance. It is also important when a new mold has been set in the machine. Use good judgment if the machine has only been down for a short time.

Checking the mold is part of the critical path, because improper mold setting or hookups could take several hours to correct. Mold related problems often involve hydraulic and electrical maintenance help.

Exercise One

Setup

Find a newly set mold, and complete the following checklist to make sure the mold is ready to run.

Mold Parallel ..... ☐

Clamps in Place ..... ☐

Water Inlet Lines ..... ☐

Water Outlet Lines ..... ☐

Hydraulic Core Pull Lines ..... ☐

Servo Core Pull Lines ..... ☐

Transducer Cables ..... ☐

Instructor Date

Check Mold Temperature

Molds are massive pieces of steel. It can take a long time for a mold to heat up to its proper temperature. If the mold is cold, the molding technician should make sure the mold heater is turned on as soon as possible. The best way to ensure that the mold is up to temperature is to check the steel with a hand held thermos camera or Infrared thermometer, like the ones illustrated in Figure 2.

Figure 2 - Thermo Imaging Cameras and IR Thermometers

Exercise Two

Mold Temperature

On several machines, record the temperature of the mold with a hand held thermometer, and compare your readings to the temperature on the mold water heater.

Machine Number	Nozzle Temperature	Mold Temperature

Instructor Date

Check Barrel Heaters

The barrel and screw must be hot enough to melt the plastic pellets before the screw can be turned. Most barrels have several independent temperature zones. Since it can take a while for the zones to come up to the correct temperature, check the barrel heaters early as part of the critical path.

Even after the barrel has reached the correct temperature, most machines need additional heat soaking time. The extra time is used to ensure that the screw inside the barrel has come up to the same temperature as the barrel zones. At startup, most screws are still covered with a thin layer of plastic from a previous job. The plastic coating acts as an insulator, keeping the screw colder than the barrel. Most shops allow an extra half hour or more to make sure that the screw warms up to the barrel temperature.

Never attempt to tum or move the screw until the barrel has completely heat soaked. If plastic material in the barrel is still solidified, trying to rotate the screw can break off the screw tip or shear pin. In extreme cases, the rear portion of the screw, where the root diameter is the smallest, can be broken off.

Exercise Three

Barrel Heaters

On several startup machines, record the barrel zone temperature, and the amount of soak time required, to start up the machine. Is there a relationship between the size of the machine or the part, and the amount of soak time?

Machine Number	Barrel Temperature (°F)	Soak Time (mins)	Size of Part

Instructor Date

Part Handling Equipment and Packaging Supplies

Most molding jobs require the use of conveyors (Figure 3) or bins to handle the parts as they come out of the machine. Operators may require tables to put the parts on for trimming and inspection. Often specific sized boxes, or other packing materials, are needed to store the parts as they accumulate next to the machine. Check that the appropriate equipment is in place before the machine is ready to start. It may take a while to alert other personnel to move the equipment to the machine.

Figure 3 - Conveyors (MAC Brand)

Check Machine Operation (Dry Cycle)

If the machine has been down for a long time, or if it has undergone recent maintenance, the molding technician should perform a quick check of the hydraulically operated parts of the machine. Open and close the mold and check the ejector system. Make sure that the action is smooth, and there are no hydraulic leaks around the machine.

Exercise Four

Machine Function Check

Complete the following checklist on the movements of the injection molding machine. Check for proper setup and smooth operation.

	Yes	No
Mold Parallel	☐	☐
Clamps in Place	☐	☐
Water Inlet Lines	☐	☐
Water Outlet Lines	☐	☐
Hydraulic Core Pull Lines	☐	☐
Servo Core Pull Lines	☐	☐
Transducer Cables	☐	☐

Instructor Date

Check and Dry Plastic

As early as possible, check to see that the correct plastic material has been secured and is ready to run. Check the material feeding device, and the level of material in the hopper.

Some plastic pellets, such as nylons, polycarbonates, and ABS actually absorb moisture from the air. Plastics that absorb moisture are called hygroscopic plastics. These plastics need to be dried before loading them into the hopper. They are usually dried in desiccant type dryers. These may be separate units, or mounted directly onto the machine hopper. Some shops use circulating air ovens with shallow material trays for their low volume drying needs.

If it is not dried, the moisture in a hygroscopic plastic turns to steam in the hot barrel, this steam is then injected into the mold. One sign of wet plastic is tiny bubbles, or silver streaks, in the finished part. Drying the plastic is part of the critical path, because it can take several hours to dry the plastic pellets.

Critical tasks should be done as early as possible in the startup process. Any of them could delay the startup for hours.

Objective Two

Pre-Start Checklist

Once the critical tasks have been performed, it is time to tum to the other tasks that need to be done before the machine can be started. The following items are tasks the molding technician should do as the machine is being readied for startup.

Check Machine Guards and Safety Doors

Always check the safety equipment before starting the machine. Inspect the guards that protect the operating personnel from pinch and bum hazards. Make sure they are properly attached and mounted correctly.

Also check the safety doors before running the machine. The doors should be in place and functioning properly. Double check the safety drop bar or ratchet mechanism as well. Typical safety guards are shown in Figure 4.

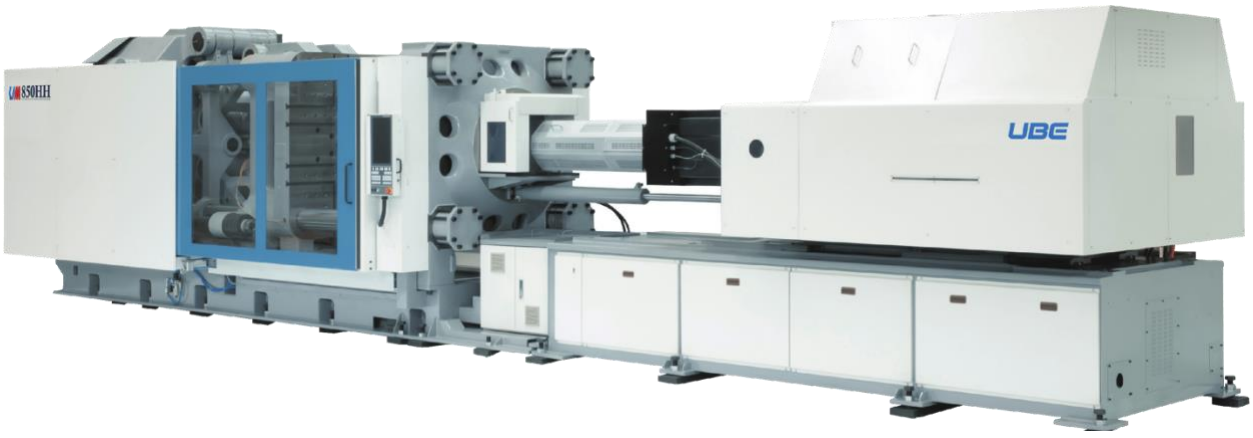

Figure 4 - Machine Safety Gates

Check the Hydraulic System

Most molding machines have a sight glass that can be used to check the oil level in the machine. Check the oil level any time a machine has been down, especially if the machine has been down for maintenance on the hydraulic system.

Oil temperature should be checked at the same time to be sure it has not overheated. Most manufacturers recommend oil tempera-ture between 90° and 110° Fahrenheit.

Also check the oil filters on the machine. Most filters have an indicator to show when they need to be changed. Even though you may not be responsible for changing filters, assume the responsibility for periodically checking the filters and notifying the appropriate people to change them.

Also check the pressure gauges on the hydraulic system. Check the clamp pressure and the ejection pressure settings. These pressures should all be within the specifications on the startup sheet.

Exercise Five

Startup

Check each of the following items on the machine. After you have made sure that each is correct, check the appropriate box.

Fluid Level ..... ☐

Fluid Temperature ..... ☐

Oil Filters ..... ☐

Pump Pressure ..... ☐

Clamp Pressure ..... ☐

Ejection Pressure ..... ☐

Instructor Date

Check the Injection End

The primary concern at the injection end is that the machine, and all its parts, are at the proper temperature and functioning cor-rectly.

Check the barrel temperature zones to see if they are all rising at the expected rate. If the barrel is up to the correct temperature, make sure that the full heat soaking period is allowed to take place.

Also check the feed throat temperature. If the feed throat is too hot, plastic pellets can melt and clog the hopper. Adjust the flow of water into the feed throat cooling jacket if needed.

Before a good part can be made, the mold must be at the right temperature. Make sure that the mold temperature matches the specified set point on the setup sheet.

Check the shot size indicator. Make sure the shot size indicator is set equal to or slightly larger than the expected shot size for the new job. If the shot size is set too small, the mold has no chance of completely filling.

Check the Mold

During pre-start, it is a good idea to check the mold, and the condition of the mold faces. The mold faces should be clean and free of flash. Clean the mold protectant off the cavities and mold faces if this has not already been done.

Check the Robot

If the machine runs in full automatic mode and has a robot, such as the one in Figure 5, make sure that it is turned on and operational. If a new job is starting in the machine, check with the appropriate person to be sure the robot is running the right program. Be sure the robot will move in the correct pattern. Inspect the robot end grippers or suction cups. Make sure they move properly and are in good condition.

Figure 5 - Arburg Multilift V Robot

Objective Three

Starting the Machine

Once the pre-start checklist of the machine has been completed, and all the appropriate parts of the machine are heated to the proper temperature, it is time to do a final check, purge the barrel, and then make the first shots.

Final Check

Before making the first shot, you should make a final inspection of the mold. Carefully inspect the face of the mold. Watch the mold as it closes and locks on the first shot, especially if it is a new mold in the machine. The mold faces should meet squarely, and the machine should lock up properly.

Check the barrel zone temperatures again. Be sure each zone is at the proper temperature and has had enough soak time to warm the screw.

With the feed throat closed, run the screw forward and back at low speed. Be sure it moves and rotates easily.

Purging

Complete purging procedures will be covered later in this lesson. On most new jobs you will have to purge the barrel. Purging in this case means forcing out the existing material in the barrel with the plastic to be used in the new mold.

Figure 6 - Typical Purge & Guarding

Check to be sure the purge guard is in the proper position and that you have proper safety devices such as a face shield, gloves, and long sleeve shirt. Open the feed throat and cycle the screw. Melt will leave the nozzle and ooze into the purging area. Continue to purge until the melt has a uniform texture and color. Purge until the melt is completely clean. Purging is safest at low injection speed and low injection pressure. Figure 6 illustrates a typical purge.

Checking the First Shot

After the final check and the barrel purge, the machine is ready for the first shot. Most shops have defined procedures for making and analyzing the first shots of a new job. These procedures are designed to minimize the time it takes to get quality parts out of the mold. Another important objective of the mold sampling procedure is to minimize the chances of parts becoming stuck in the mold or for any mold damage to occur.

Examining the Parts

As the machine cycles and begins to reach an equilibrium state, the technician can start to read the parts. Reading the parts means carefully examining the molded plastic parts, looking for possible defects, or evidence that the process is incorrect. Reading the parts helps determine what adjustments need to be made in the process to begin to make good parts. The following should serve as a checklist for technicians to fine tune the process until good parts are being made.

Check the Cavity Fill

As the machine cycles and stabilizes, the parts should begin to fill out properly. If the parts are not filling out, the technician should be aware that the speed or temperature may need to be increased. Any speed or temperature increases should be done gradually. Fill problems tend to get better as the mold picks up heat after hot plastic is shot into it repeatedly.

Technicians should also inspect the parts to make sure all the pieces are present. ay careful attention to thin sections and fins. These sections of the part can often be unfilled and go unnoticed.

Check Ejector Pin Marks

Inspect the startup parts carefully for ejector pin marks. If the parts are too hot, or the ejection force too high, then the ejector pins may be punching into the part. Ejector pins that are too long will also leave an indentation in the part. Ejector pins that are too short will leave bosses (Figure 7). Damaged ejector pins may leave a rough spot on the part. Looking for ejection marks is especially important on new molds, or molds with new ejector pins.

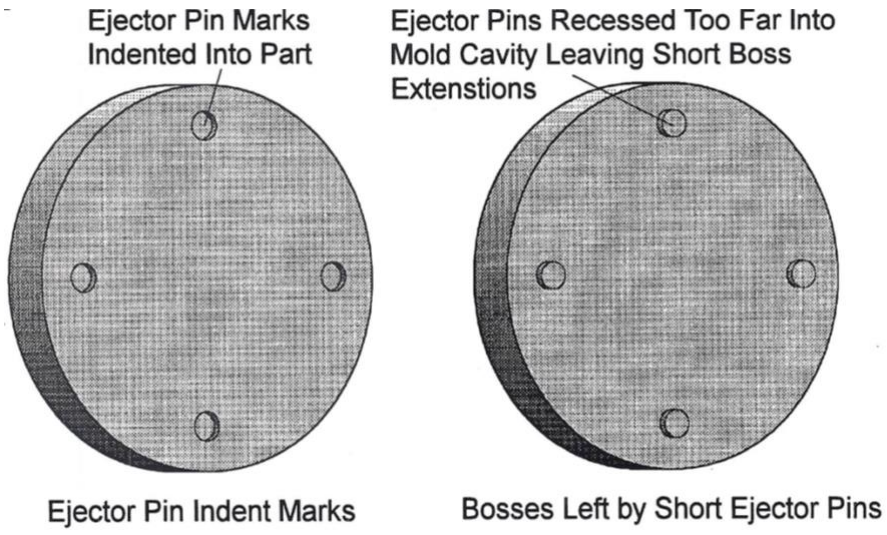

Figure 7 - Ejector Pin Marks

Check Cored Holes and Core Pins

Inspect all of the cored holes. Make sure that there is no flash over the end of the hole. Also, check that all of the core pins are in place and releasing properly. Even slightly bent or mushroomed core pins can cause enough damage for the part to be scrapped.

Check for Warping or Bending

Startup parts may be warped because the cycle time is too short or the mold temperature too hot. Warping can also be caused by excessive ejection force. Warping and bending problems must be corrected before full production begins.

Get the Parts to Inspection

The final step before putting the machine into full production, is to get a sample of parts approved by the inspection department. Many production parts that are not closely inspected look good, but are scrapped later because of hidden defects. Make sure the machine is producing good parts that are dimensionally accurate before going into full production.

As with many of the lessons in this series, the checklists presented are intended to serve as guidelines. Individual plants should modify these checklists to fit their specific needs.

Exercise Six

First Shot

Check the following items on the first shot after startup.
Record shot number when the item passes initial inspection.

	Good	Shot #
Fill Condition	☐	_____
Cored Holes	☐	_____
Ejector Pin Marks	☐	_____
Warping or Bending	☐	_____
Parts Ready for Production	☐	_____

Instructor Date

Objective Four

Planned Shutdowns

Planned shutdowns usually occur when a job is finished, or at the end of a shift, day, or week. Planned shutdowns are usually scheduled when the machine is expected to be down for at least a few hours, or maybe even a number of days. Planned shutdowns are scheduled for maintenance purposes, or when there is no new job scheduled to run in that machine.

A planned shutdown involves a series of important tasks. Most of these tasks involve securing the machine, and making sure it is ready for maintenance or repairs. The following are typical shutdown tasks for most shops. Individual shops will probably have their own procedures in addition to these.

Save the Last Part

The last part shows the condition of the mold before the mold is removed from the machine. Most shops label and record the final part's dimensions and surface finish. These measurements help determine if core pins, ejector pins, or other mold parts need repair or replacement.

Purge the Barrel

Complete purging procedures will be covered later in this lesson. On most planned shutdowns you will have to purge the barrel. The purpose of purging for shutdown is to clean out the barrel and screw of as much of the leftover plastic residue as possible.

Whenever you are purging the barrel, always check to be sure the purge guard is in the proper position, and that you have proper safety devices like a face shield, gloves, and long sleeve shirt. For shutdown purging, close the feed throat so no new plastic can enter. Cycle the screw back and forth under low pressure on manual. Melt will leave the nozzle and ooze onto the purging plate. Continue to purge until the screw cannot pick up any more material.

Heat Unstable Shutdown Purging

Closed feed throat purging will not completely empty the barrel. Unless you remove and clean the screw, there will always be a small amount of plastic left. If this plastic is heat sensitive, you will need to complete a second purging stage with a heat stable plastic such as polystyrene or polyethylene. In this case, purge the second plastic through the barrel until it removes all of the heat sensitive plastic. Then shut off the feed throat and run the barrel empty.

It is important not to leave a residue of heat sensitive plastic on the screw. When the machine is restarted later, the small amount of unstable plastic still on the screw will degrade

during barrel heat soaking. These plastics need to be purged with a heat stable plastic during shutdown.

Check the material suppliers list of recommendations for purging when using a material with which you are not familiar. This is especially important when dealing with heat sensitive or high temperature plastics.

Turn off the Heat

Most planned shutdowns involve shutting off the barrel heaters and the mold temperature control unit.

Turn off the Cooling Water

Turn off the cooling water to the machine and mold. Cooling water may be used in the mold, the hydraulic system heat exchanger, and the feed throat. Sometimes the cooling water to the feed throat can be left on for a while to reduce the chances of any plastic melting in the back of the screw.

Take Care of the Mold

After the mold has cooled sufficiently, clean the cavity and mold faces, and remove any flash. Spray the mold with protectant. Even if the mold is not going to be pulled, it is safe practice to close it to keep out dirt and moisture. Then the hydraulic pumps may be shut down.

Record the Final Shot Count

Record the final shot count from the machine. The shot count is often recorded with the final part information. Nearly all ma-chines have a shot counter. Know where the shot counter

is and be able to read it. The final shot count is often used by quality and maintenance people to help determine the production and maintenance schedules.

Clean Up

During shutdown, the technician has a good chance to clean up the machine and the area around the machine. Hydraulic oil and plastic pellets can cause safety, quality, and productivity prob-lems. Use the shutdown to clean up the machine and ready it for the next job.

Planned Shutdown To Change the Mold

Quick Mold Changes

Not all the tasks listed above need to be completed when the purpose of the planned shutdown is to change the mold. Some shops have implemented "fast mold changes". These are planned shutdowns, but the machine may be down for only fifteen min-utes. This type of special shutdown requires that everyone involved follow very specific procedures, much like a pit crew at an auto race. The tasks and procedures are usually very well documented and rehearsed.

Normal Mold Changes

There are many things you can do to make the mold change go as smoothly as possible. The following are a few of the most useful tasks you can do.

Maintain a Safe Barrel Temperature

When one active job is immediately changed over to another mold, there is no reason to shut off the barrel heats. Follow the proper purging steps for the materials involved, and set the barrel heats for the new molding job. In some cases, lowering the barrel heats during extended mold changes is recommended instead of purging.

Get Tools Ready

Anticipate what tools will be necessary to do the mold change. You will probably need wrenches, lifting chains, eye bolts, T-bolts, and clamps. Even though you may not be

responsible for gathering the tools, help the other setup personnel. Work together to have the tools ready.

Remove Water and Oil Lines

During a mold change, you may be responsible for removing the water and oil lines from the outgoing mold. Some machines use quick disconnects for water and oil, which are easy to disconnect. Other machines use standard fittings and threads that need tools and wrenches to remove. Know where the tools are, and which ones you are likely to need.

Spray the Mold

Before the mold is placed in storage, clean off the face with a towel. Many shops like to spray the mold cavity and core sections with a protective spray (Figure 8). Pay particular attention to the cavity and core inserts, and the parting line faces.

Remove Hydraulic Lines

Moveable cores have hydraulic lines that need to be removed from the core pull cylinders. These fittings are often threaded. Remov-ing them requires wrenches and other tools. Take care when disconnecting hydraulic lines. The fittings and lines are easily damaged.

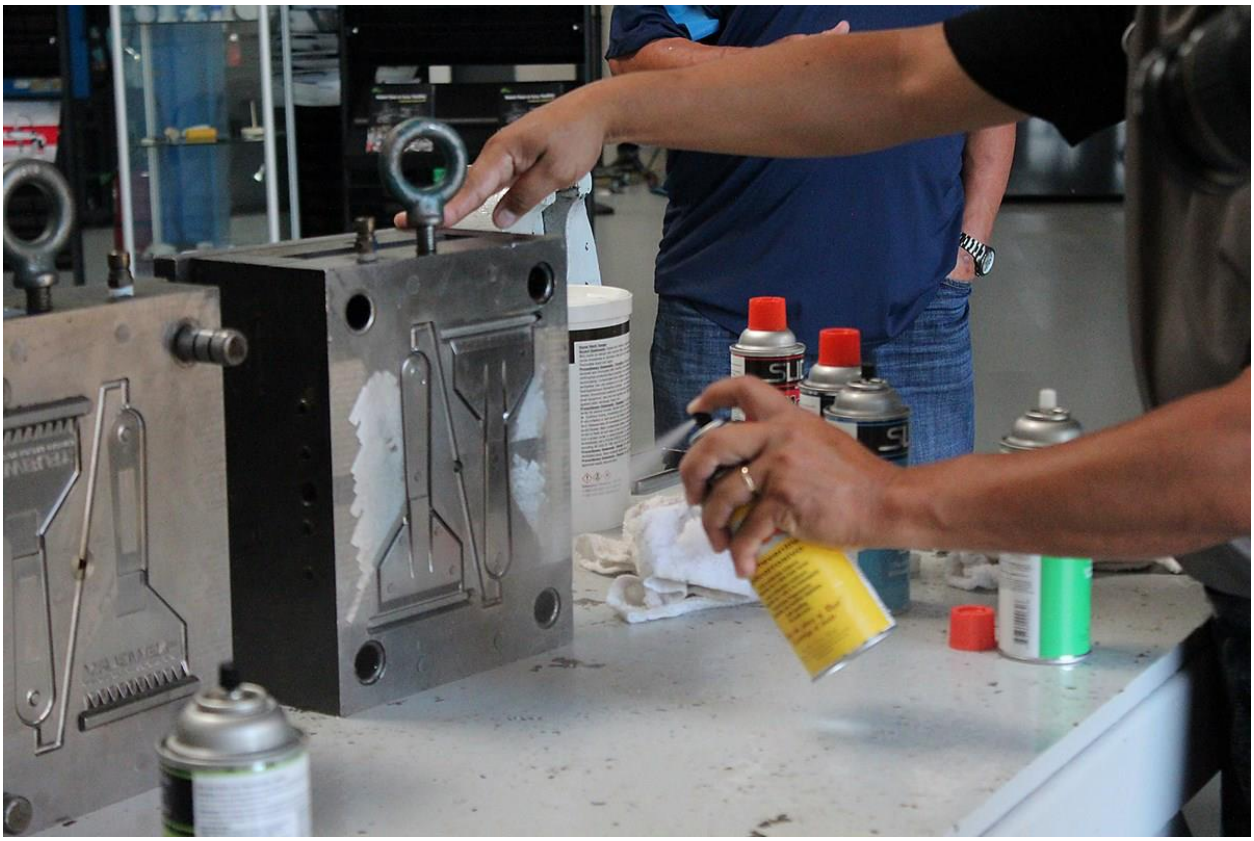

Figure 8 - Spraying the Mold

Hooking up the New Mold

Specific mold removal and installation procedures can be found in Lesson 6 of Working with the Machine.

Objective Five

Unplanned Shutdowns

Unplanned shutdowns can occur at any time. They often require some action to stop the plastic in the barrel from degrading. What step needs to be taken depends on how long the machine may be down.

The technician's first responsibility in an unplanned shutdown is to preserve the quality of the melt. The way this is done depends on how long the unplanned shutdown might be. Consult with maintenance persons and supervisors as soon as possible to get an idea of how long the shutdown might last.

For our purposes, we will discuss three types of unplanned shutdowns; short duration shutdowns that last less than fifteen minutes, medium shutdowns that last from fifteen minutes to an hour, and long shutdowns that last over an hour.

Short Unplanned Shutdowns

(Less than Fifteen Minutes)

Your first concern during a short unplanned shutdown is preserving the plastic in a useable state. While the machine is down, it is very easy for the plastic in the injection barrel to overheat or degrade. You need to take whatever action is necessary to keep the plastic in the barrel at the proper temperature.

After the short unplanned shutdown is over, you should make an air shot to empty the barrel of the suspect plastic. Do this only in close cooperation with the other people working on the machine. Never attempt to purge the barrel when other personnel are near the machine, or working on the mold.

Whenever purging the barrel, always check to be sure the purge guard is in the proper position, and that you have proper safety devices like a face shield, gloves, and long sleeve shirt. For short shutdown purging, keep the feed throat open so new plastic can enter. Cycle the screw several times under low pressure in manual mode. Do this several times until the melt has a uniform color and good texture.

For heated molds, like the one in Figure 9, it may be necessary to close the mold. If the mold is not the cause of the unplanned shutdown, closing the mold helps retain the heat. Keeping the mold warm means it will be ready to go when the machine is ready.

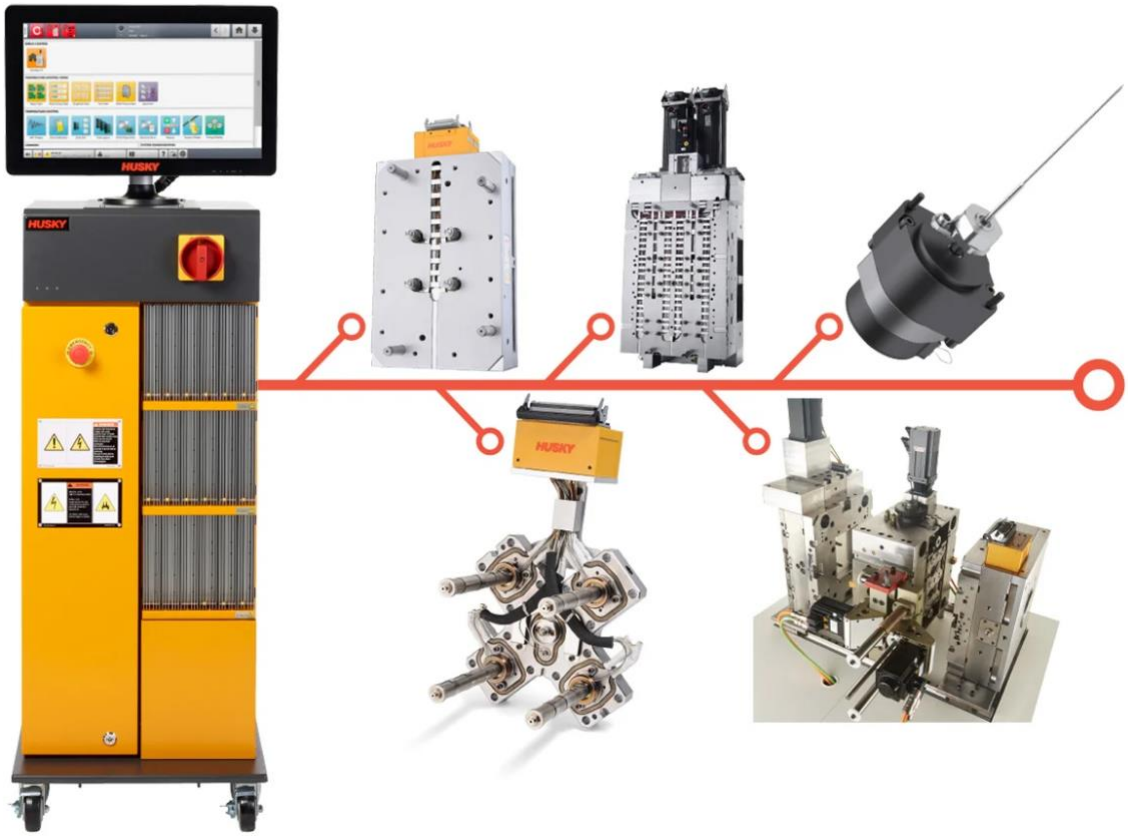

Figure 9 - Hot Runner Mold

Medium Unplanned Shutdowns

(Fifteen Minutes to an Hour)

If the machine is going to be down for more than fifteen minutes, start with the procedures for the short unplanned shutdown. When the time looks as if it is going to be longer, close the hopper and purge the barrel.

With many of the more heat sensitive plastics, it is more economical to purge them out of the barrel, and follow them with a heat stable plastic until the needed repairs can be made. Constantly using air shots to keep the material from

degrading can waste many pounds of plastic over a twenty to thirty minute shutdown.

Medium length unplanned shutdowns usually give you a chance to do some of the other miscellaneous tasks around the machine. This is a good time to trim, clean, stack, and inspect parts. Always make good use of your time during a shutdown. It means you will go home sooner and safer.

Long Duration Unplanned Shutdown
(Over an Hour)

Long duration shutdowns are usually treated in the same way as a planned shutdown . The primary goal is to secure the machine and clean up the area. Additionally, you will probably do some of the following:

1. Shutdown the hydraulic system
2. Turn off the cooling water
3. Record the final shot count
4. Clean up the work area
5. Purge the barrel
6. Shutoff or lower the heat to the barrel heaters

Productive Ways To Use the Shutdown

It is a good idea to develop a checklist of helpful things to do during a shutdown. Anything you can do to reduce downtime will make you more productive.

Your final responsibility during shutdown is to stay alert for a sudden notice to restart the machine. It may take time to

learn the cause of the shutdown, but once determined many repairs are quick. Stay nearby the machine.

Exercise Seven

Unplanned Shutdowns

List several common reasons why unplanned shut-downs occur. Separate the list into the shutdowns that are likely to be short, and the ones that are likely to be longer.

Machine Number	Barrel Temperature (°F)

Instructor Date

Objective Six

Purging Procedures

One measure of plant efficiency is the ability of the shop to change jobs quickly. Unless you are using the same material, changing jobs on a machine usually involves some kind of purging. Experienced technicians are familiar with many of the different techniques and procedures used for purging and material changes.

Purging Safety Procedures

Whenever purging the barrel, always check to be sure the purge guard is in the proper position, and that you have proper safety devices like a face shield, gloves, and long sleeve shirt.

Air Shots

Air shot purging is generally done when the machine will only be down for a short period of time. The main purpose of air shot purges is to clear the barrel of one sample of overheated or contaminated plastic before continuing the machine cycling.

Complete Purging

Complete purging is needed when making a material or color change. Complete purging is also needed when removing highly degraded material. Unless you remove and clean the screw, there will always be some small amount of plastic left in the barrel.

Following the contaminated or heat sensitive plastic with a heat stable purging material is the best state in which to leave the barrel for shutdowns.

Purging Materials

There are several materials that can be used to do a complete purge. The best cleansing materials are amorphous, heat stable, and have a wide melt range. Amorphous plastics generate more shearing action, and purge out the old material faster. Heat stability keeps the material from degrading as easily in the hot barrel. Having a wide melt range allows the purging material to be used with many different melting point plastics.

Polystyrene and acrylic are often used for purging. They are amorphous plastics that have a dry surface texture. Inside the barrel they act like a scouring pad, cleaning out the residue of the old plastic material. Polyethylene also works well. It is very heat stable over time, and can be run fairly well even at temperatures approaching 650° Fahrenheit.

Chemical purging compounds are also available to clean out the barrel and screw on a complete purge. Some of these compounds are designed to be mixed with plastics before being run through the barrel. Others are meant to be run through by themselves. Check with your supervisor to learn what types of purging compounds are used in your shop.

Removing the Screw

Sometimes even a complete purge will not clean the barrel well enough for a new job. This is particularly true when the old plastic has been contaminated, or when changing over to a transparent plastic. With transparent plastics, even the slightest impurity of residue will show up in the part. In these circumstances, you will probably have to remove the screw to clean it.

Removing a hot screw from a hot barrel can be dangerous. Be sure to use heat protective gloves, a face shield, and long sleeve clothing. Check with your supervisor to learn your shop's safety procedures for removing a screw.

The general procedure for removing the screw is first to remove the nozzle and nozzle adapter. Many machines are built with pivoting barrels. This makes it much easier to get at the end of the barrel and remove the screw. The screw can often be pushed out of the barrel some distance using the injection unit. When enough of the screw is showing, grasp the tip with gloved hands and pull it out of the barrel. You can use a wire brush and brass gauze to scrub the screw clean of residue and impurities.

Clean the inside of the barrel with a rod that has a wire brush on the end. Some shops use electric drills with wire brush attach-ments to scour the inside of the barrel.

Cleaning Ovens

Some shops have had success baking the screws and nozzles in controlled atmosphere ovens. For this procedure, the entire screw is placed inside a long oven filled with an inert gas. The ovens are designed to bake the plastic off the screw tip without leaving a residue behind.

Cleaning the Nozzle and Screw Tip

No matter how well the barrel was purged, the nozzle and screw tip will always contain some plastic residue. Many shops clean the nozzle and screw tip by burning the residue off with a propane torch. Ask your supervisor what procedures are used in your shop to clean nozzle tips and screws.

Self-Test

1. Which of the following is not considered downtime?
   a. Startup
   b. Setup
   c. Shutdown
   d. Purging
   e. None of the above
2. Most manufacturers recommend oil temperatures:
   a. Less than 50°F
   b. 50°F to 90°F
   c. 90°F to 110°F
   d. 110°F to 150°F
3. For shutdown purging you should:
   a. Open the feed throat
   b. Close the feed throat
   c. Replace the feed throat
   d. Leave the feed throat alone

4. Your first priority during an unplanned shutdown is:
   a. To protect the mold
   b. To protect the part
   c. To protect the melt
   d. To protect yourself
5. Always purge with:
   a. High pressure
   b. Low temperature
   c. Low pressure
   d. High speed
6. A long duration unplanned shutdown should be handled like:
   a. A medium unplanned shutdown
   b. A short unplanned shutdown
   c. A planned shutdown
   d. A total plant shutdown
7. Two of the most common plastics used to purge other plastics are:
   a. Polyethyelene and cellulose
   b. Polystyrene and nylon
   c. Acrylic and polystyrene
   d. PVC and acrylic

8. The molding technician's first goal is:
    a. To keep the machine running no matter what
    b. To start the machine and make quality parts as soon as possible
    c. To protect the quality of the melt at all times
9. Checking the mold is part of the critical path because it does not take very much time.
    a. True
    b. False
10. Which of the following is probably not on your pre-start checklist?
    a. Check hydraulic oil level
    b. Check clamp pressure setting
    c. Check ejection pressure setting
    d. Check melt viscosity setting
    e. Check hydraulic oil temperature

Glossary

Air Shot - moving the screw forward to purge the barrel of one sample of overheated melt.

Critical Path - the practice of beginning a startup with the tasks that take the longest time.

Purging - the process of forcing out the existing plastic in the barrel by using a new plastic or a purging compound.

Planned Shutdown - a pre-arranged time when the machine will be down. The most common planned shutdowns are the end of the day, shift, or week, or for scheduled maintenance.

Soak Time - extra time given after a temperature setpoint is. reached to allow temperature settings to stabilize throughout parts of the machine.

Unplanned Shutdown - an unscheduled episode of machine downtime. Unplanned shutdowns are short (less than fifteen minutes), medium (fifteen minutes to an hour), or long (over an hour).