A Method for Purging and Cleaning a Screw and Barrel

By
Timothy W. Womer, CTO
Xaloy, Incorporated

Introduction

When it comes to maintaining screw and barrels, the most common question asked is, "What is the best method to purge and clean our screws and barrels?"

Hopefully, this paper will address this very common question and help companies be more productive during their production changeover and routine maintenance procedures.

Many times it is more cost effective to pull the screw out of the extruder or injection molding machine than to use a purging compound when it is time to do a product changeover. For extrusion applications, typically, for extruders that are 90mm (3.5") in diameter and smaller, it is often easier to pull the screw out of the barrel and pristine the system to insure that there is no contamination for the next application. When the process is Injection Molding, typically, for machines that have screws that are smaller than 75mm (3.0") in diameter, these too are easier to remove the screw from the barrel and clean the components outside the machine.

What NOT to do!

Plasticating screws are manufactured to very close tolerances. Most of the tolerances on the screw are within +/- .025mm (.001"), straight within .1mm (.004") and have a highly polished finish. Many, many times it is very common for a company's maintenance department's screw cleaning procedure to include the use of an acetylene torch. This is the biggest mistake that can be done which will destroy not only the metallurgical properties of the base metal but also affect the closely machined tolerances of the screw.

Most screws that are built for extrusion applications are made of 4140 H.T. steel. Whenever isolated heat from an acetylene torch is used to remove plastics from the root of the screw, it will cause the metal to expand on that side of the screw and in turn cause the screw to bend. Once the screw cools it is very doubtful that the straightness of the screw will return to what it was originally. Also, the isolated heat, especially if the steel is heated to a point where the isolated area turns to a permanent blue, will cause metallurgical changes to the base metal. There have been occasions where the isolated area actually causes a delamination of the base metal and a large portion of steel will separate itself from the main portion of the screw.

In the case of injection molding screws, most of these screws are manufactured to

withstand abrasive wear from the resins that are being processed. The types of steels used to combat the abrasive wear are typically various types of tool steels. During the manufacturing stages of building tool steel screws, the base metal has to be heat treated to increase the hardness of the steel. If isolated heat from an acetylene torch is used to remove plastic from the root of the screw, it will definitely anneal the base metal and reduce the wear resistance in that area of the screw. Also, annealing the tool steel with the use of isolated heat will reduce the yield strength of the steel, and this will increase the likelihood of screw breakage due to torque. Therefore, the basic statement here is:

Do Not Use Isolated Direct Heat!!!

Purging the Screw

The first step to pristine the plasticating system is to purge the screw. First, close off the flow of the resin that is being processed. This is typically done by closing the slide gate at the bottom of the resin hopper.

The screw rotational speed needs to be reduced to approximately 15 to 25 rpm and operated at this speed until the polymer stops flowing from the end of the die or out of the nozzle on an injection molding machine.

All of the barrel zones should be set to about 200°C (400°F), and the machine needs to come to this temperature before continuing the purging process.

Once the barrel zones have reached the 200°C (400°F) temperature settings, then the purging process can begin. It is this author's experience that a fractional melt (.35 MI) HDPE is used as a purging compound, see Figure 1. The screw size will determine the amount of HDPE that is needed to purge the system. For example, on a 50mm (2") diameter screw it will require about 5 kg (10 lb) of material, and on a 90mm (3.5") diameter screw it may require 15kg (33 lb) of HDPE material.

Figure 1

Depending on the type of extrusion process, it may be necessary to remove the die or head tooling to reduce over pressuring the end of the extruder. This is why it is very important during the purging process that extreme caution be used and two operators perform this portion of the process. One operator should be at the control panel (See Figure 2) to observe the screw speed and drive load meter to insure that the drive does

Figure 2

not overload. The second operator needs to observe the head pressure gauge to make sure that the system is not over pressured. All the while, the screw should be rotating at about 15 to 20 rpm.

If the process allows the die to remain on the extruder, then the purging process should continue until a complete change in the extrudate is noticed. Figure 3 shows the changeover from the processing resin to the HDPE purging resin.

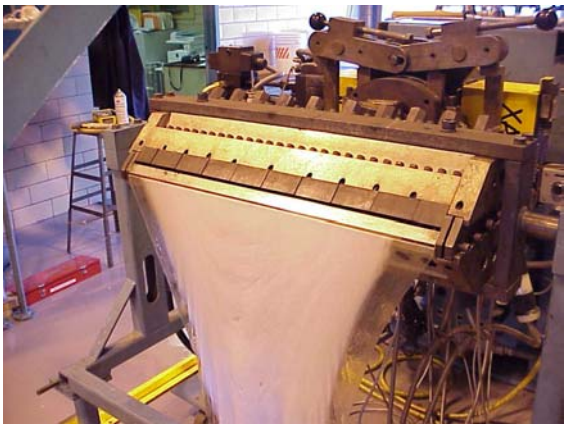

Figure 3

Purging should continue until the extrudate has completely transformed from the processing resin to the purging resin.

Once the die has been completely purged, the screw rotation can be completely stopped so that the die on the extruder or the endcap on the injection molding machine can be removed and the end of the screw can be exposed. With the die or endcap removed, the screw can be restarted and rotated at about 10 rpm to allow the remaining HDPE purging resin to be pumped out of the remaining portion of the screw.

Tools and Cleaning Materials (Figure 4)

The tools and cleaning materials needed to pristine a screw and barrel are very few and simple. They consist of the following:

- Hot gloves
- Brass putty knife
- Brass gauze
- A round wire brush about the diameter of the barrel bore mounted on long rod
- Stearic acid flake
- Electric drill
- Several cotton rags

Figure 4

Stearic acid is used as an ingredient in making candles, plastics, dietary supplements, oil pastels, and cosmetics; for softening rubber; and to improve the fusion of PVC. It is also used to harden soaps, particularly those made with vegetable oil.

NOTE! DO NOT USE STEEL SCREW DRIVERS, SCRAPERS, OR PRY BARS WHEN CLEANING SCREWS AND BARRELS.

Cleaning the Screw

Once the resin has stopped extruding from the screw, then the screw needs to be removed from the machine. For an extruder using a screw cooling system, needs to be removed, see Figure 5, before installing the screw extraction components.

Figure 5

Once the hoses, rotary union, and piping are removed from the back of the extruder, the screw extractor mechanism can be attached to the extruder gearbox. Using the screw extractor, the screw can be pushed down most of the distance of the barrel. (See Figure 6)

Figure 6

The screw should now be pushed forward until about 4 or 5 turns of the screw can be exposed for cleaning. (See Figure 7)

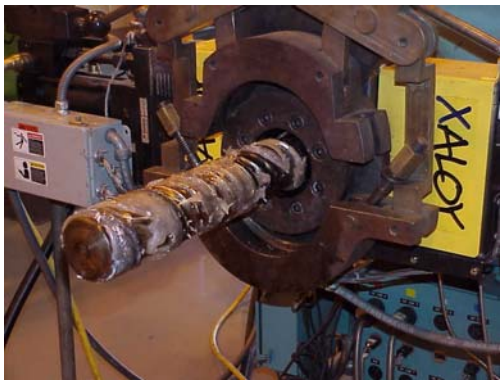

Figure 7

With the first portion of the screw exposed, now the HDPE resin can be cleaned from the channels of the screw as shown in Figure 8, using the brass putty knife and brass wire brush.

Figure 8

As the exposed portion of the screw has the HDPE removed, then another 4 to 5 turns of the screw can be pushed forward using the screw extractor, and the cleaning process is continued.

Once the large amounts of HDPE are removed with the brass putty knife and wire brush, the stearic acid should be sprinkled onto the root of the hot screw, and the brass gauze should be used to remove the remaining HDPE residue. (See Figure 9)

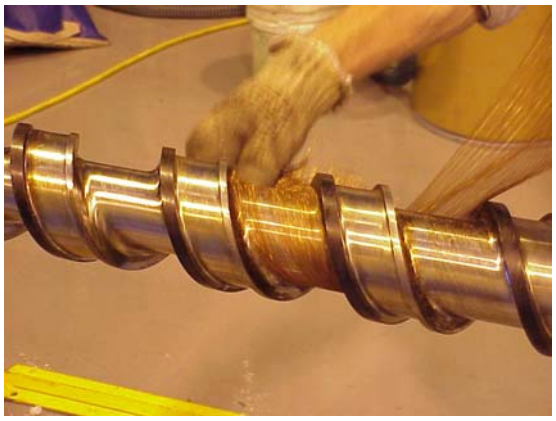

Figure 9

Once the entire screw has been polished using the brass gauze, a final clean-up can be done using a soft cotton rag. In Figure

10, the screw channels and flight outside diameter can be cleaned to the pristine condition to insure that there is no contamination in the next production run.

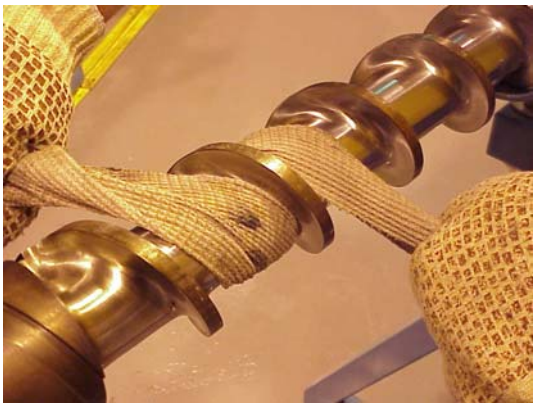

Figure 10

Once the screw has been completely cleaned it can be set aside (Figure 11) until the barrel

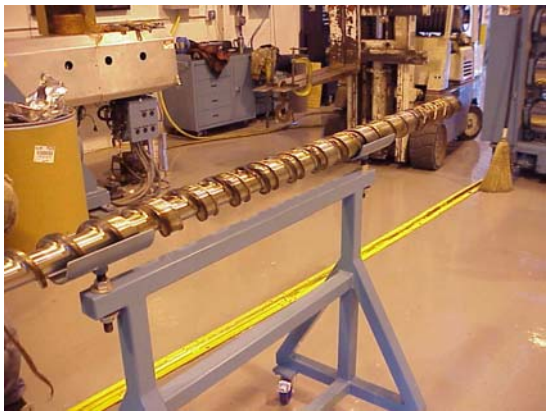

Figure 11

has been cleaned, or it can be placed on the screw rack until it is needed for the next production run requiring its use. If the screw is place on the storage rack, then it should be sprayed and wiped down with a light oil, such as WD-40 or PB Blaster in order to prevent rusting of the base metal to occur.

Also, it is good to mention, that chrome plating is not only an excellent surface coating which will help in preventing plastics from building up on the root of the screw and also improve the feeding of the plastic, but also very good for protecting the screw when it is being stored between uses in production.

Cleaning the Barrel

Cleaning the barrel is much easier than the cleaning of the screw but just as important. (See Figure 12)

Figure 12

With the barrel temperatures still set at the purging temperatures, the barrel is ready for its cleaning process.

The first step of the barrel cleaning process is to assemble the round wire brush, the long extension rod, and the electric drill as a complete assembly. Once these components have been assembled, the copper gauze (See Figure 13) can be wrapped around the outside diameter of the wire brush.

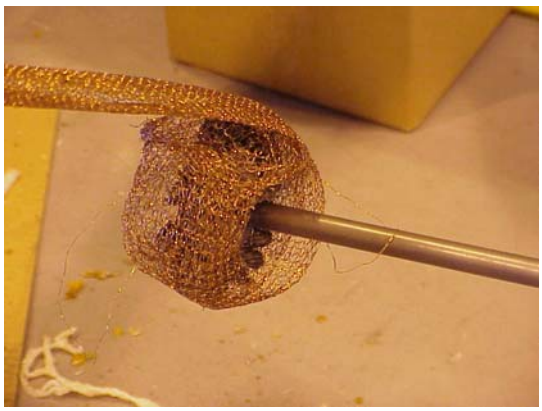

Figure 13

Before inserting the brush/gauze assembly into the bore of the barrel, a handful of stearic acid can be thrown into the bore of the plasticating barrel. Stearic acid can also be sprinkled over the copper gauze before the brush/gauze assembly is inserted and then pushed into the bore of the barrel. (See Figure 14)

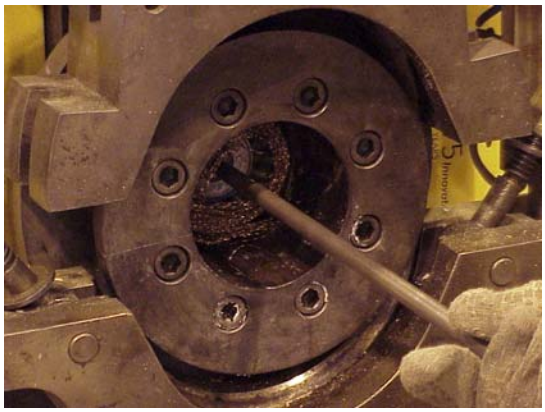

Figure 14

Once the brush/gauze assembly is inserted into the bore of the barrel, the electric drill is used to rotate the brush/gauze assembly in and out of the barrel bore until the brush/gauze assembly moves easily in and out of the bore. It may be necessary to use additional stearic acid before the bore cleaning process is thoroughly completed.

Once the brush/gauze assembly is removed from the barrel bore, a bundle of cotton rags needs to be pushed back and forth the (See Figure 15) length of the barrel bore to swab

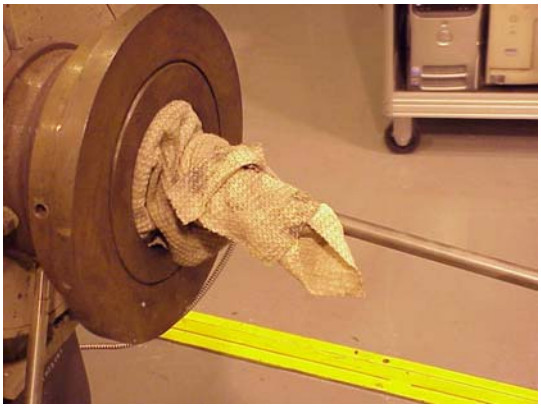

Figure 15

the barrel clear of the HDPE and stearic acid residue. After the rags have been passed back and forth several times and return totally clean, the barrel cleaning process is complete.

Conclusion

By following the procedure described in this paper, the entire screw and barrel assembly will be totally pristine and ready for the next production run.

Many times it can be much more effective and efficient to do a total cleaning process as described here versus using a commercially available purging compound. Sometimes the plasticating process prohibits cleaning the screw and barrel described here; these are processes, such as large blow molding equipment and extremely large cast film or laminating lines.

If the proper equipment is used, screws and barrels up to 150mm (6”) in diameter can be thoroughly cleaned in one to two hours and save enormous amounts of time and materials that it would take otherwise.