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## **Twin Screw Extruder**

### **Model: Process 11**

**Location of Machine:** Advanced Composites Lab, Ingram 1308

**Location of SOP and Machine Operating & Safety Manual:** Composites Lab website under resources; Composites Lab TRACS site; and Hardcopy near machine.

**Emergency Contact:**

- Call 911
- Call EHS & Risk Management at 512-245-3616
- Call Head Lab Technician, Dr. Ray Cook (office 512-245-2050)
- Call Dr. Jitendra S Tate (office 512-245-4872)

**Before using this machine:**

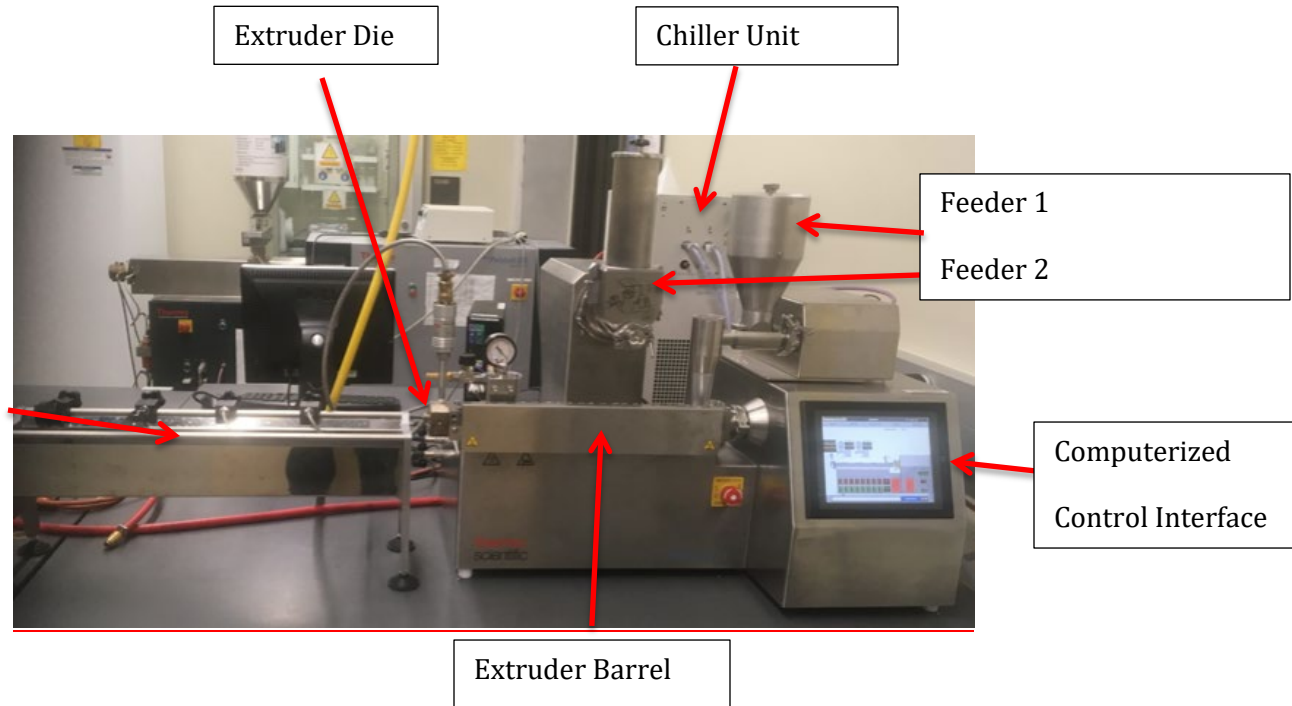
- You must have permission from Dr. Tate.
- You must have received formal training from technician or, trained research student (designated by Dr. Tate) related to machine safety and operation.
- You must read and understand **SOP and Machine Operating & Safety Manual.**
- You must use this machine under direct supervision of Dr. Tate or, Dr. Cook or, trained research student (designated by Dr. Tate).
- You must have signed “Lab Rules” document with Dr. Tate. This document must be signed every semester fall, spring, and summer (as applicable).
- If you do NOT follow above instructions, you will be held responsible for your own safety and damages.

**Safety Precautions:**

Protective Equipment: Prior to performing this procedure, the following personal protective equipment must be obtained and ready for use: **Gloves, Safety Goggles, and Lab Coat.**

**Important Safeguards:**

- Before you start the extruder, ensure that the temperature of all zones rise till where it melts the plastic, otherwise you break the screw.
- **Make sure to always purge the extruder before and after each experiment. Take a handful of purging material (ASACLEAN X-Grade Recommended) and feed it into the feeder. At a low feeder speed (about 30 rpm) and a low extruder speed of (40 rpm) should be used to purge the system. NEVER run the purging process above 50 rpm extruder speed, you might damage the screws.**



### Specifications:

- Twin Screw Extruder
  - Make: Thermofisher Electron Corporation
  - Model: Process 11 (Twin Screw Extruder)
  - Barrel diameter: 11mm
  - Barrel length: 40 L/D (440mm)
  - Screw center line distance: 8.6mm
  - Barrel segments: 8
  - Independent heating zone: 7 internal + 1 external for die
  - Heating capacity: 1750 W (7 x 250W)
  - Temperature range: RT – 350°C
  - Maximum pressure: 100 bar
  - Typical throughput: 20 – 2500g/h
  - Minimum required material: 30g
  - Screw Speed Range: 10- 1000rpm
  - Max. screw torque: 6Nm (2screws, 6Nm each)

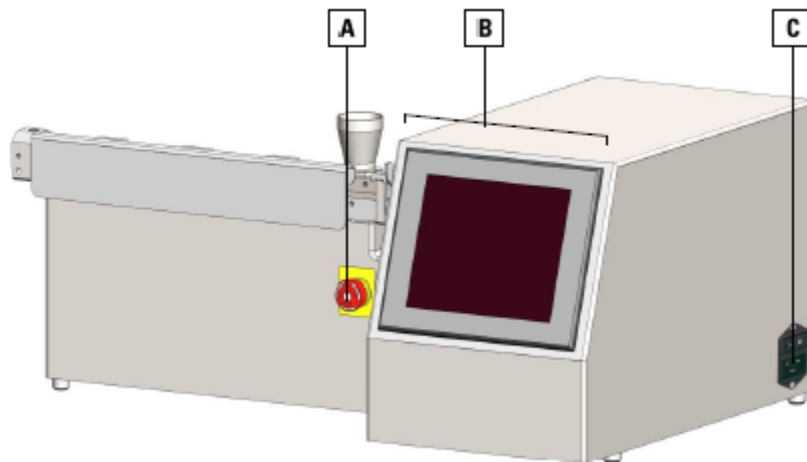
**General Safety Instructions**

The Process 11 Twin Screw Extruder is a universal tool. The details about the application conditions and the nature of the used substances and materials are not known by the manufacturer, thus it can only be the responsibility of the operator. Please take note of the following precaution:

- (1) The machine must be operated and maintained by persons who have read this SOP carefully and understood. The operator must be sufficiently trained in the application, adjustment and operation.
- (2) While working do not let the machine unsupervised. If reasonable and possible, turn off the machine during work breaks or when the machine is not working.
- (3) Never open the covers while the machine is running.
- (4) Do not use the machine in the presence of flammable gases, liquids and solids.
- (5) Work with reason and concentrated. Do not use the machine if you are tired.
- (6) Heated machine parts can be very hot. Never touch them with bare hands. You may wear protective gloves.
- (7) Isolate the electrical supply while:
  - the machine is unattended
  - cleaning
  - carrying out any maintenance.
- (8) Use the machine only to perform the intended work and do not use the machine for purposes for which it is not made.

**Know Your Controls**

<b>A = Emergency Stop</b>	By pressing this button, the power to the drives, controls and so to all movements of the machine will be disconnected. The machine remains electrically powered, until the isolator will be switched into the off position.
<b>B = Touch Screen Control</b>	Touch screen panel for controlling the extruder's operation.
<b>C = Isolator</b>	Switch for connecting the machine controls with electric power supply. Activating this main switch will energize or de-energize the machine and all ancillary devices supplied by the base machine. All electrical devices will come to the operating mode. Position 0 = machine without supply behind that isolator (switched off) Position 1 = machine connected to power supply (switched on)



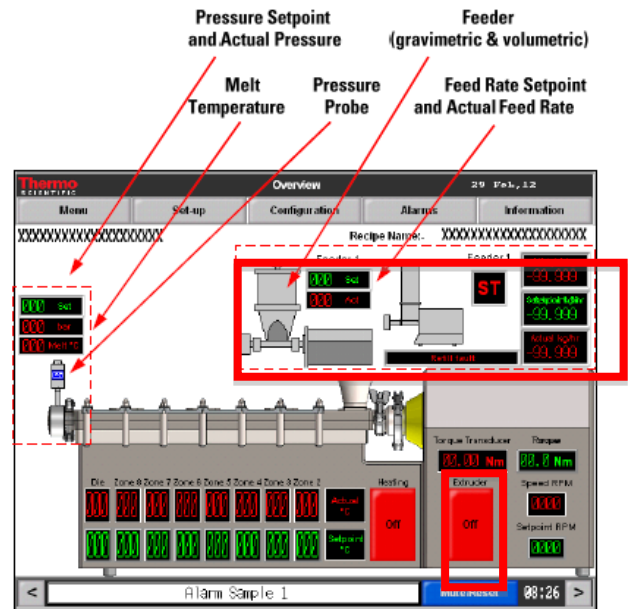
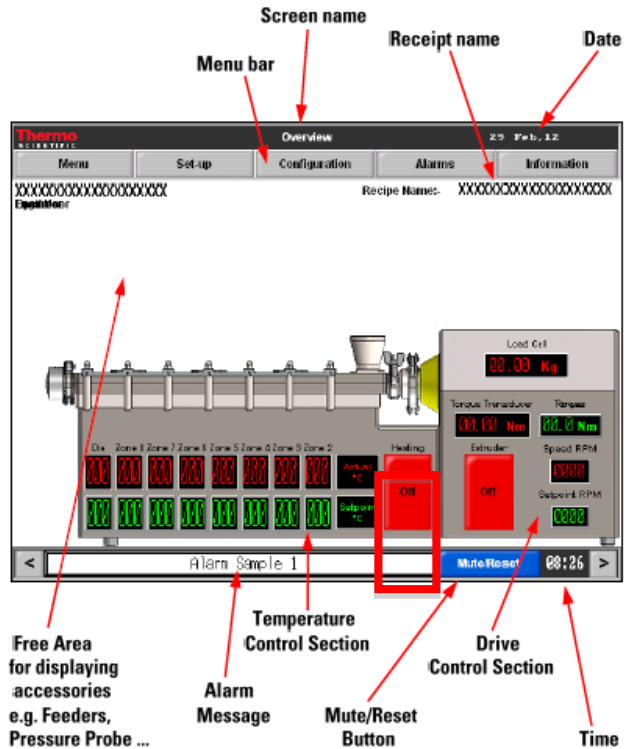
**Turning and preparing the Extruder for instrumented operation**

**Behind the Twin-Screw Extruder:**

1. Turn **ON** the Chiller Unit. Set the temperature to 15°C and wait for the temperature to cool down to the set temperature

**On the extruder:**

2. Locate the isolator on the extruder (as shown above as C) and turn it on.
3. Start the machine and touch the control screen to enter the **overview page**
4. Set barrel temperature and press ‘**Heating On**’ button. Allow time for machine to thermally stabilize. Ensure that the barrel set-point temperature is above the melting point of the material.
5. Set extruder to required speed. Press **Extruder On-/Off-button**. Set "Extruder Speed" to zero. Touch "Extruder Start" button. Adjust low speed setting e.g. 50 rpm or less. Observe the % Torque Indicator. If Torque Indicator detects the maximum torque level without screw turning, then the drive stops immediately. With stopped drive wait for a few minutes to allow time for solid product inside barrel to melt or increase temperatures above the melting point of any residual product and then repeat the process. When screws are turning freely, leave running at crawl speed (50 rpm). **Without product material running screws grind on barrels internal surface. Screws and barrel will be damaged at high speed. Never run at high speed (> 50 rpm) when the barrel is empty!**
6. Set feeder (s) to required speed. **Start feeder (s)**  
Set "**Feeder Speed Control**" to zero, and press "Feeder Start" button. Increase extruder speed to approx. 150 rpm. Gently turn Feeder Speed Control until feed rate is such that the extruder % Torque Indicator is showing approx. 60 %. Increase extruder speed in several steps to required speed (max. speed is 1000 rpm). Gently increase



feeder speed, ensure that % Torque Indicator does not exceed 80 %. Always operate the Feeder Control gently increasing in small increments, whilst monitoring the extruder % Torque reading. Over-feeding can result in flood feeding in the extruder funnel, or over-torque trip-out. If the extruder % Torque level rises 90%, stop the Feeder immediately, and allow the torque level to reduce before re-starting the feeder. The following diagram explains the process steps of a typical start-up procedure.

A = Start with low feeding rate at slow speed

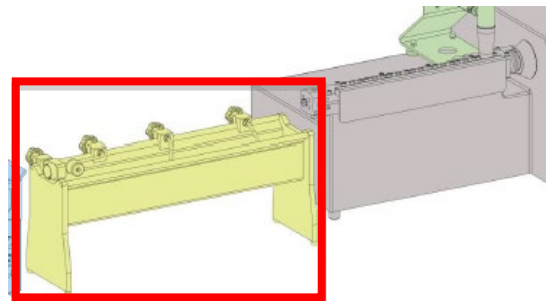
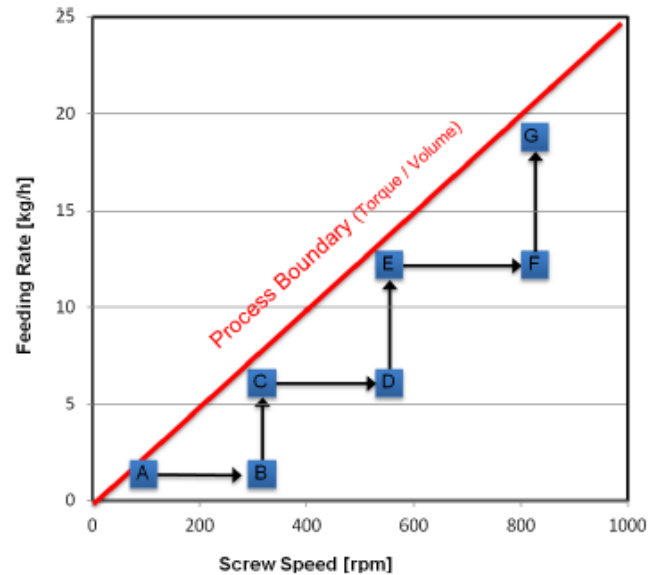
B= Increase the speed

C= Increase the feeding rate not exceeding 60% of max. torque.

D= Increase screw speed. The torque value will decrease

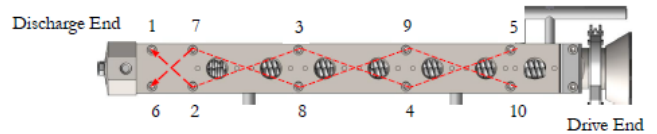
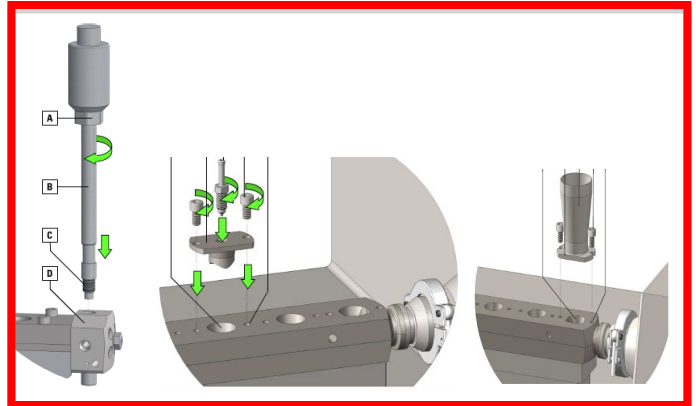
E-G = Increase charge rate and screw speed alternately till max. feeding rate is achieved. While performing this, ensure the torque value doesn't exceed 80%

- Once the product is being processed successfully, forward it to the **downstream** process equipment. The downstream is a water bath placed next to the extruder. Ensure the feet are on the same level with the extruder but below the extruder die outlet. So material can drop into the water. Use a crimp or tweezers to guide the strand below the two guiding rolls and over the outlet roll. Constantly pull the strand to get a steady strand diameter. It is good practice to cut the strand using scissors before the strand is inserted into the pelletizer or spooler.

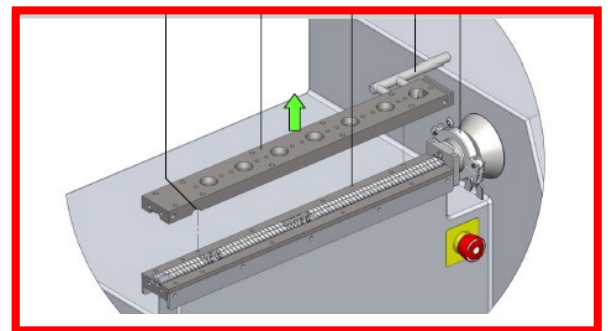


**Cleaning the Barrel Extruder**

1. Ensure that after every experiment, the extruder barrel should be first cleaned by extruding the purging material and later dismantling for **mechanical cleaning**.
2. **OPENING THE BAREL:** Because of molten material, after running the extruder it is necessary to clean the barrel at temperatures above the melting point of the processed material. Therefore, it is suitable to open the barrel and clean it in place.
3. Dismantle the additional barrel equipment as barrel plugs, liquid injection Adaptor or vacuum assembly for better cleaning or a new configuration
4. Lose the screws of the top half of the extruder barrel in the following order, from 1-10



5. Slide the twin screws out of the barrel together and take them apart to clean the screws with **mechanical brush**. Ensure that the twin screws are thoroughly cleaned before assembly.
6. After cleaning, place the twin screw together on a flat surface and ensure the elements **mesh together**. **This can be ensured by trying to rotate the twin screw together with your HAND.**
7. After ensuring the elements of the twin screws are meshed, place them together into the extruder barrel and push it inside towards the two inner couplings. Try rotating the twin screws with your hand and ensure it moves freely. **If not, the twin**



<p>screws elements are not properly meshed. Take it out again and repeat the alignment process of the twin-screw elements</p> <p>8. After ensuring the twin-screw elements are properly aligned in the extruder barrel, place back the top half, according to step 4</p>	