

Environmental health and Safety (EH&S)

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Knife Mill Standard Operating Procedure

Procedure: Particle Size Reduction/Grinding of Biomass using Type SM2000 Heavy-Duty Cutting Mill

Department: Bioeconomy Institute

Building/ Room Number: Biomass Preparation Room

Supervisor: Jacquelyn Baughman

Procedure Overview: The knife mill is used to grind biomass to a desired particle size.

Health and safety information for materials used:

Hazard Control Measures:

- Safety glasses
- Lab coat
- Latex or nitrile gloves (for handling samples)
- Respiratory Protection
- Hearing Protection

Waste Disposal Procedures: Biomass can be placed into the non-hazardous waste garbage.

Decontamination Procedures: None

Spill Containment and clean up procedures: Biomass can be swept up or wiped with a wet cloth and disposed of in the garbage.

Using substances requiring special procedures: No

Written By: Cody Ellens

Date: 4/25/2008

Revised By: Zach Bartlett

Date: 6/7/2011

Approved By: Dustin Dalluge

Date:

Detailed procedures, operation instructions, maintenance, and emergency contact information list is attached.

Particle Size Reduction/Grinding of Biomass using Type SM2000 Heavy-Duty Cutting Mill

Equipment Description:

The Type SM2000 Heavy-Duty Cutting Mill physically reduces biomass particles to a predetermined size. The knife mill contains a hopper where the biomass is fed, a 3-bladed rotor to grind the biomass and a sieve or screen to filter out larger particles. The sieve size is chosen based on the desired particle size. Multiple buttons, latches and switches are used to load and unload and turn on or off the mill. Screens ranging from 10.0mm to 0.25mm are available. The knife mill is a powerful and dangerous machine. It should be used with caution. Proper safety equipment must be worn at all times and the standard operating procedure must be followed. The knife mill can be plugged into a 30 A, 120 V outlet. The electrical outlet in Biomass preparation room is located on the east wall by the refrigerator.

The mill consists of four main sections: the feed hopper, the rotor housing, the collection container and the power controls.



Knife Mill in Biomass Prep Room

Potential Hazards:

- **Mechanical:**
 - The knife mill contains a 3-bladed rotor that spins rapidly. Although the machine has a safety feature that prevents the door from opening fully, particles may fly out and cause injury. NOTE: Even when the grinder is shut off, the rotor may keep spinning for more than a minute. Do not open the door during operation or while stopping the grinder.
 - **NEVER** put any metal into the feed hopper. This will damage the blades if caught in the rotor.
 - Do not use any type of push stick to help the feedstock along. The stick could get caught in the rotor or kickback causing damage or injury.
- **Heat:**
 - After operating the knife mill, the housing and rotor may become hot to the touch.
- **Electrical:**
 - The knife mill operates on a 240V, 30A plug-in. Any modification to the plug-in may result in injury during operation or a short.

Particle Size Reduction/Grinding of Biomass using Type SM2000 Heavy-Duty Cutting Mill

- Do not open the electrical panel on the knife mill while energized.
- **Noise:**
 - The grinder is quite loud during normal operation. Ear plugs should be worn while grinding.

Material Handling and Storage:

A typical thermochemical reactor requires preparation of materials being introduced into the reactor unit. Biomass is required for every pyrolysis experiment regardless of the simplicity or complexity. There are some simple procedures which can be followed to ensure that handling biomass leads to a safe and successful test. Before biomass can be used with the feed system in the lab, it must be finely ground. For this reason, in addition to safety glasses, proper respiratory protection is required whenever handling biomass. Biomass is to be kept on or below the shelves in the Northwest corner of the lab. When loading the hopper, be careful to limit the amount of dust produced. A portion of the biomass from each test should be saved in a 1 gallon Ziploc bag and labeled with a unique sample ID as depicted below.

04/25/2008-CORNSTOVER-0.25mm-C.E.

The diagram shows the sample ID '04/25/2008-CORNSTOVER-0.25mm-C.E.' with four horizontal lines underneath it. Below each line is a label: 'Date' under '04/25/2008', 'Feedstock' under 'CORNSTOVER', 'Size' under '0.25mm', and 'Initials' under 'C.E.'. Diagonal lines connect the labels to their respective parts of the ID.

Pre-Analysis Checklist:

- Safety glasses are on
- The grinder is plugged in and turned off to release the safety door latch
- The hopper is empty
- The rotor housing is empty and clean
- The proper sieve is in place
- The door is closed

Instrument Operation:

1. **Opening the grinder** (Refer To Figures 1 and 2 Below)
 - a. Plug grinder in and make sure the motor is completely stopped.
 - b. Turn main power switch **(A)** on. Wait until safety check is complete as indicated by LED's C and E.
 - c. Press Open door button **(E)**. LED E goes out; LED C stays lit. This unlocks the safety latch.
 - d. Pull handwheel **(D)** out; turn **counterclockwise**.
 - e. Open door **(2)**.
 - f. Lift upper housing **(3)**.

NOTE: The rotor housing can be cleaned at this time and the proper screen installed. Make sure the screen is put in the correct direction (arrow on screen points in the same direction as rotor movement – counter clockwise).

2. Closing the grinder

- a. Lower the upper housing **(3)**.
- b. Make sure the mating surfaces are clear.
- c. Close door **(2)**.
- d. Pull handwheel **(D)** out; turn **clockwise**.

3. Loading the Hopper- The hopper must be loaded before the grinder is turned on. As the biomass is being ground, more biomass can be added to the hopper.

- a. Make sure fill plunger **(F)** is closed (down).
- b. Pull out metering plunger **(H)**.
- c. Open fill flap **(G)**
- d. Load biomass.
- e. Close fill flap. **(G)**
- f. As hopper empties, more biomass may be loaded during operation.

4. Start-up

- a. Make sure fill plunger **(F)** is down before starting.
- b. Turn on main power switch **(A)**. Wait while safety check is complete indicated by LED's C and E.
- c. Press Open door button **(E)**. LED E goes out and LED C lights.
- d. Pull handwheel **(D)** out and turn **counterclockwise** to open.
- e. Clean or change screens as needed.
- f. Pull handwheel **(D)** out and turn **clockwise** to close. LED's E and C light.

5. Turning ON

- a. Press Start button **(B)** to start. LED's C and E go out; LED B lights.
- b. Slowly pull fill plunger **(F)** up.
- c. When you hear the grinder begin to grind the biomass keep bringing the fill plunger **(F)** up to allow all biomass to fall into rotor.
- d. Slowly lower fill plunger **(F)** onto biomass.
- e. If grinder sounds overwhelmed with biomass, lift fill plunger **(F)** up.
- f. Repeat steps c) and d) until the fill plunger can rest on the biomass during operation.
- g. Fill hopper as needed. See section G.

6. PAUSING

- a. Press Stop button **(C)**.
- b. Wait until rotor has stopped spinning as indicated by lit LED E and C.
 - i. To open door
 1. Press Open door button **(E)**. LED E goes out.
 2. Pull handwheel **(D)** out and turn **counterclockwise** to open.
 3. The door **(2)** and the housing **(3)** can now be opened if needed.
 4. Close door **(2)** and housing **(3)** when complete.
 5. Pull handwheel **(D)** out and turn **clockwise** to close. LED's E and C light.

7. RESUMING

- a. Resuming after opening door **2**.
 - i. Press Start button **(B)**.
- b. Resuming without having opened door **(2)**.
 - i. Press Start button **(B)**. LED E blinks.
 - ii. Press Stop button **(C)** and Open door button **(E)**.
 - iii. Pull handwheel **(D)** out and turn **counterclockwise** to open.
 - iv. Shut door **(2)**.
 - v. Pull handwheel **(D)** out and turn **clockwise** to close. LED's E and C light.

- vi. Press Start button **(B)** to resume.

8. Turning OFF

- a. Press Stop button **(C)**.
- b. Wait until rotor has stopped spinning as indicated by lit LED E.
- c. Turn off main power switch **(A)**.
- d. Remove all feed from housing and collection container.
- e. Close Housing door.
- f. Unplug grinder and coil cord
- g. Sweep up dust on the ground and grinder
- h. Label and place material back where it belongs

Note:

- Don't open hand-wheel **(D)** while running. This will damage mechanical components.
- Don't turn off main power switch **(A)** while running. This will lock the housing door **(2)**.
- Do no attempt to open door without closing hand-wheel **(D)**. The grinder cannot be started because the safety interlock has been broken. To avoid this, lock the door using hand-wheel **(D)**; turn off main power switch **(B)**; turn on main power switch **(A)**.

Figure 1:

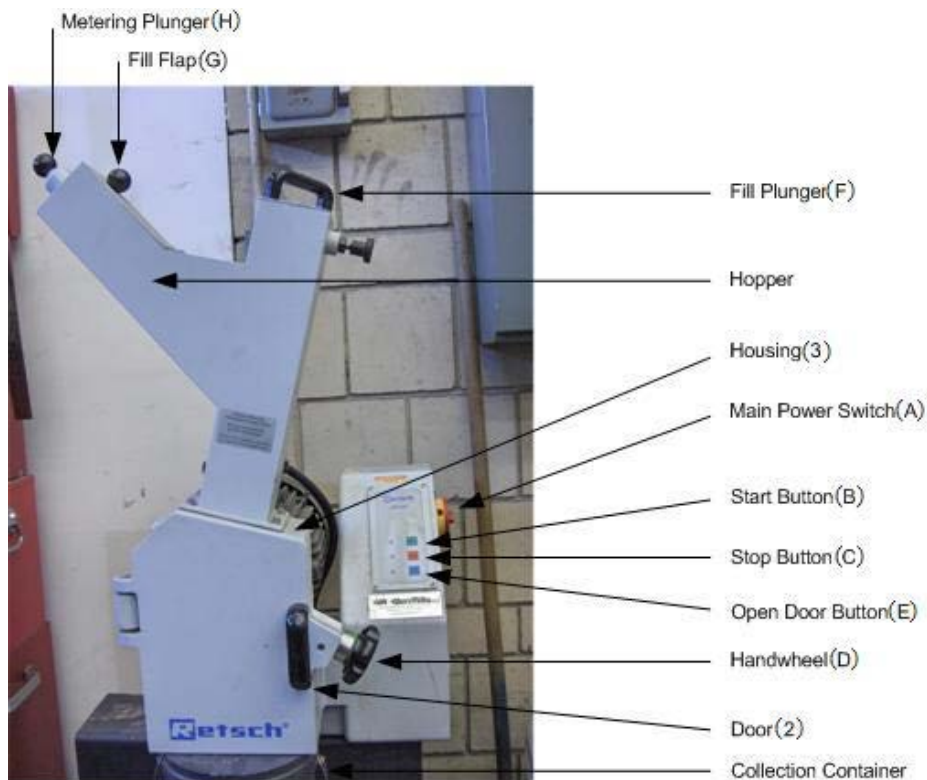
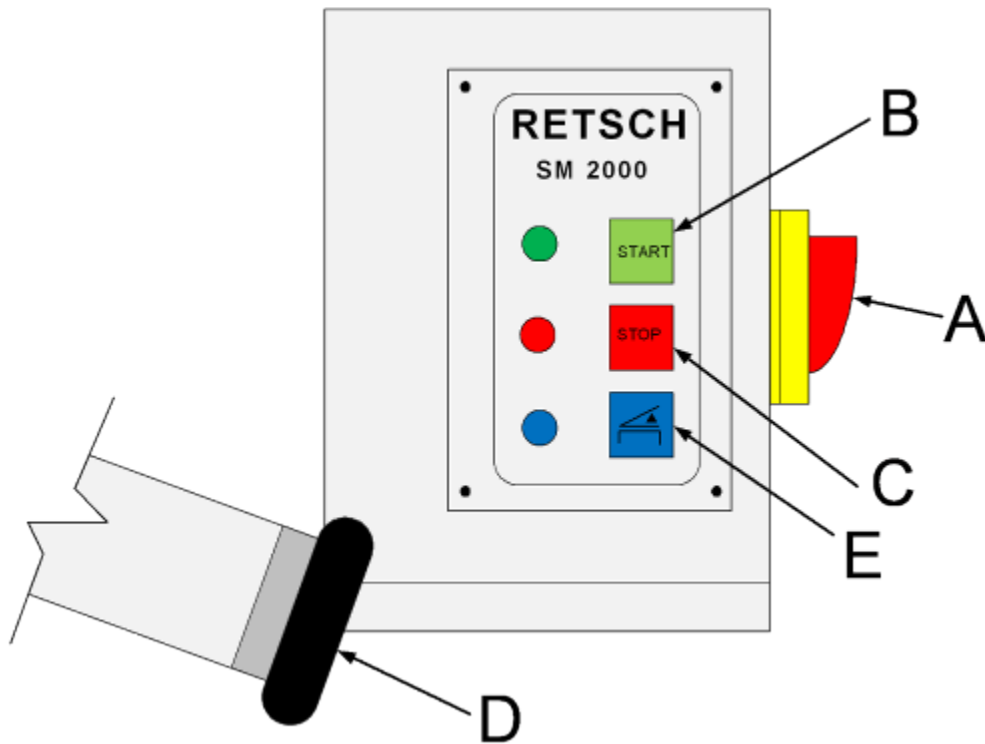


Figure 2:



Troubleshooting:

- A. If too much biomass is fed into the housing at one time, the rotor can jam.
 - a) Press Stop button **(C)**.
 - b) Clean out housing. Be careful not to damage mechanical components. Make sure rotor spins freely.
- B. If biomass is too moist or has a lot of dirt/dust on it, it may plug the screen when using smaller screens.
 - a) Pause or Stop grinder following the above instructions.
 - b) Open housing following the above instructions.
 - c) Remove screen and collection container.
 - d) Clean screen and housing.
 - e) Use a larger screen when resuming, feed slower or dry biomass.
- C. Pay attention to the noise and sound that the grinder makes as this will give a good indication if the grinding has stopped and more biomass is needed.

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Emergency Contacts

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Approved Trainers:

Dustin Dalluge, Zach Bartlett, Adrian Ramirez

Training Sign-Off

<u>Trainee</u>	<u>Date</u>	<u>Trainer</u>
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