SIZE REDUCTION

INTRODUCTION

Size reduction important processing step for biomass before it is finally used. Size reduction allows for biomass to be pelleted for solid fuel, to improve ease in transportation, or increase the specific surface area to improve its reactivity for either biological or chemical conversion. The reduction of the particle size is a mechanical process, and usually consists of cutting, chopping or grinding. The processes are conducted in machines with rotary working parts which require significant energy input. Therefore, measurement of the size of reduced biomass is critical to avoid unnecessary energy expenditure.

Particle size analysis is the determination of the size of particulate solids using lab techniques, which determine the size range, the average size or mean size of the particles in a sample. Particle size has important implications in most biomass processing industries with various types of weighted averages available.

PART 1: SETUP

1. Gather the biomass that you want for the particle analysis. Make sure you have excess.

2. Once you have the desired amount of various particles/ biomass, disperse the particles onto a glass slide. The slide size used to create the procedure had dimensions 3.25 X 4in. The larger the glass, the better your particle analysis will be.

3. Once the particles are on the glass slide, gently disperse the particles on the slide so that the scanner can distinguish between the different particles. Proper separation between particles is essential.

4. Place a U.S. quarter on the slide among the biomass particles. This will be used later to determine scale.

PART 2: SCANNING AN IMAGE

After the glass is clean and the particles are dispersed, place a cover glass of the same size over the slide to prevent getting the substance on the scanner if you will be closing the lid. Smaller particles, especially sand, seem to scan better with the lid open, in which case the cover slide step can be skipped.

1. When ready, press the scan button on the scanner.

2. Save your scan as a JPEG image. Remember the name and location.

3. Within the ImageJ software, open your scanned image by selecting File > Open.

4. Next, using your cursor to click on the corner of the scanned glass slide and drag so a yellow box outlines the slide area. Select File > Edit > Clear Ouside. You should now see just the glass slide area with the particles.

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PART 3: SETTING AN IMAGE THRESHOLD

Now, a threshold range must be set. ImageJ requires that the image be a binary image (2 colors). You will set a range for the threshold, and particles within the range will be one color and particles outside the range will be another color. Black and white is recommended.
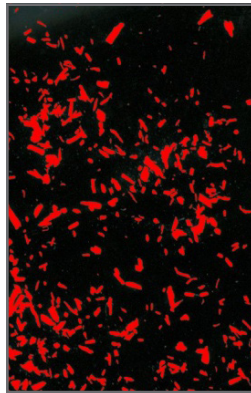
1. Select Image > Adjust > Threshold from the menu.

2. Select the colors you want the particles within the threshold to appear as. When ready, click Apply.

3. Objects in the binary image that are overlapping may be separated by selecting Process > Binary > Watershed

Below is what the correct thresholding process should look like given the process above, using sawdust as an example:

Initial Image

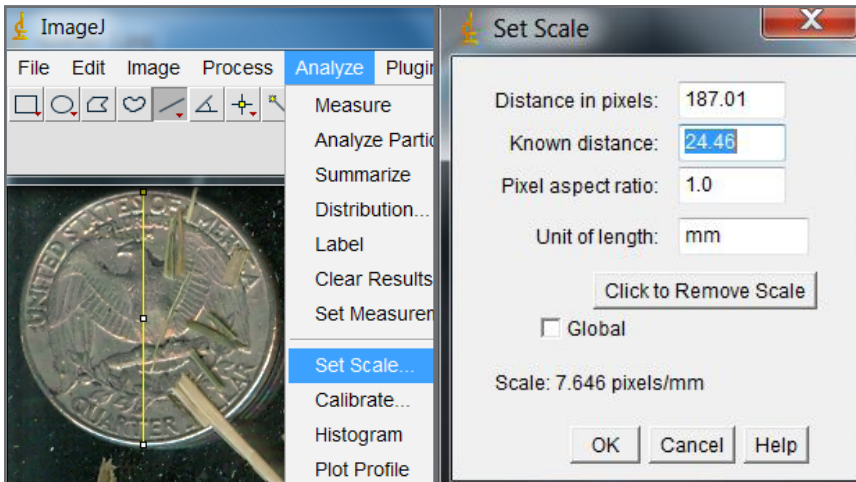Threshold

Applied Threshold
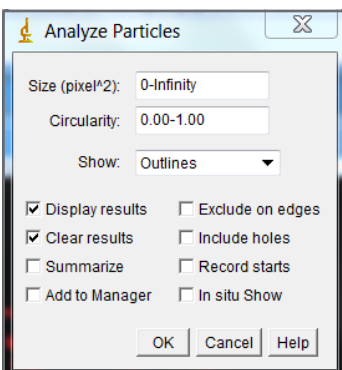
Watershed

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PART 3: SETTING THE IMAGE SCALE

1. Zoom in on the quarter on the image under Image > Zoom

2. Select the Straight Line feature and draw a line from one side of the quarter to the other.

3. Select Analyze > Set Scale. In the Known Distance field, enter the diameter of a standard quarter: 24.46mm. The Pixel Ratio should be 1 and the Unit Length should be in mm.

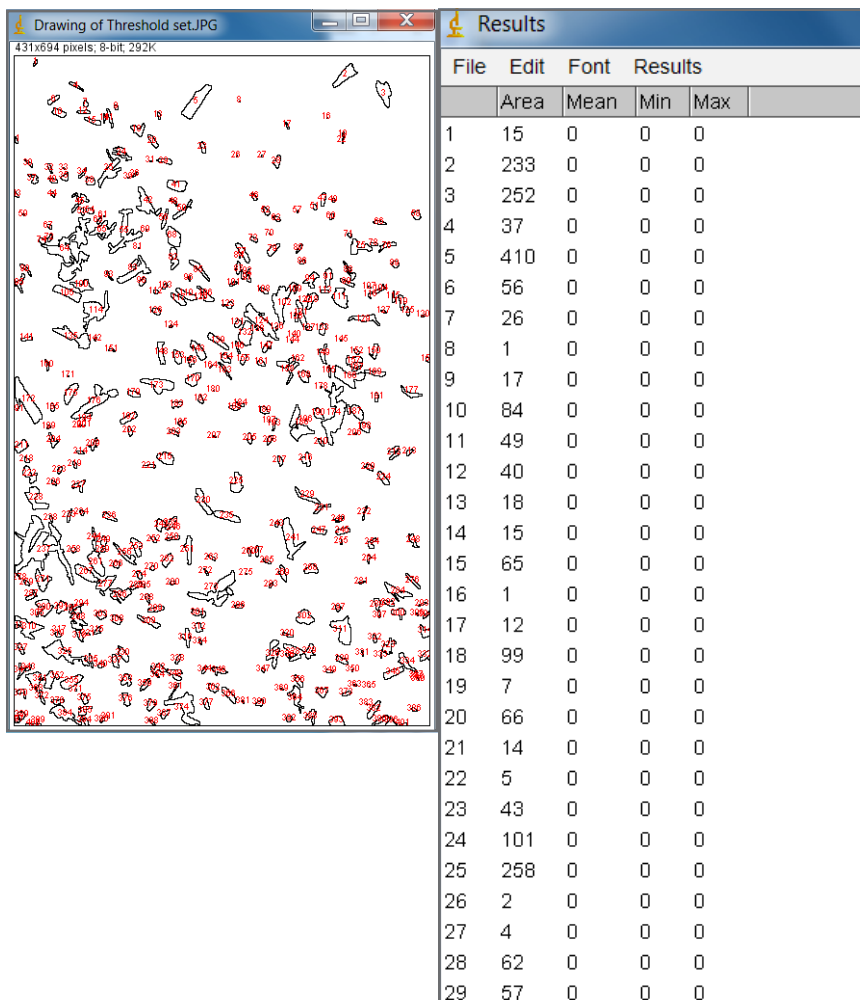## PART 4: ANALYSIS OF PARTICLES

1. Select Analyze > Analyze Particles to gather information on particle size and number of particles

2. Set the minimum and maximum size to exclude objects not being studies in the binary image. For the purpose of this lab, zero to infinity is acceptable.

3. Select the Show Outline option to display an image of the detected objects.

4. Select OK.

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5. Two windows should appear: The window shown on left is the outline of the particles that were counted along with the corresponding particle number. The image on the right is the particle number along with the data for the given particle.

	Area	Mean	Min	Max
1	15	0	0	0
2	233	0	0	0
3	252	0	0	0
4	37	0	0	0
5	410	0	0	0
6	56	0	0	0
7	26	0	0	0
8	1	0	0	0
9	17	0	0	0
10	84	0	0	0
11	49	0	0	0
12	40	0	0	0
13	18	0	0	0
14	15	0	0	0
15	65	0	0	0
16	1	0	0	0
17	12	0	0	0
18	99	0	0	0
19	7	0	0	0
20	66	0	0	0
21	14	0	0	0
22	5	0	0	0
23	43	0	0	0
24	101	0	0	0
25	258	0	0	0
26	2	0	0	0
27	4	0	0	0
28	62	0	0	0
29	57	0	0	0

PART 4: ANALYSIS OF DATA

The chart on the right can be directly copied and pasted into a spreadsheet program that you can use to further analyze data. It is easiest to copy one column at a time. You will need (at a minimum) Feret Diameter in millimeters, Area in millimeters squared, and the particle number.

Using your spreadsheet software, explore relations between particle attributes. Try making a few charts and graphs. Consider these relations as you work through the discussion questions.

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