Lab #9 – Electrostatic Separation

Name: _____ Grade: _____ Feedback:

Group Name: _____ Day: ☐M ☐T

Pledge: "On my honor as a Virginia Tech student, I have neither given nor received unauthorized assistance on this assignment." Initial_____

By participating in this class, all students agree to abide by the Virginia Tech Wellness principles:

https://ready.vt.edu/well.html

If you answer yes to any questions in the Hokie Health survey (questions can be posted in the syllabus), you must not attend class in person. Notify me by email and contact Schiffert Health Center for testing and quarantine protocol.

Introduction

High-tension separators are electrodynamic separators used to separate conducting from non-conducting solids. In this process, particles are charged by a corona discharge prior to being dropped onto a rotating metallic drum. Upon colliding with the drum, conducting particles lose their charge and are removed via centripetal acceleration. Non-conducting particles remain on the drum surface and eventually drop off or are removed using a brush. High-tension separators are preferred for feeds containing coarse conductors and fine non-conductors. The feed must be very dry and have a narrow size distribution in the range of 28 to 150 mesh. Industrial plants use multiple stages of scavenging and cleaning to improve separation efficiency. The most common use of high-tension separators is in the heavy mineral sands industry where the units are used to separate titanium-bearing minerals from silicate minerals.

In a laboratory high-tension separator, feed is introduced into a hopper and heated to ensure that it is completely dry. Then, the hopper door is opened and the feed flows in a thin layer onto a rotating wheel. An electrode showers the feed material with electrons. In the case of those materials that are conductors, the electrons easily pass through the material and the material is thrown from the wheel by centrifugal force. In the case of those materials that are non-conductors, a charge builds up on the surface of the minerals causing them to be pinned to the wheel until they are brushed off. A series of splitters on the product chutes can be used to control the amount of conductor, middling, and non-conductor products produced. The rotational speed of the wheel, the feed rate, and the applied potential are also operating parameters that may be controlled. It is generally desirable to operate with maximum applied potential, up to the point where the electrode arcs, since maximum potential gives maximum pinning force; however, if the electrode arcs, the field is disrupted and the separation becomes very inefficient. Likewise, it is generally desirable to operate with a thin layer of feed on the wheel to prevent conducting particles from being trapped behind non-conducting particles.

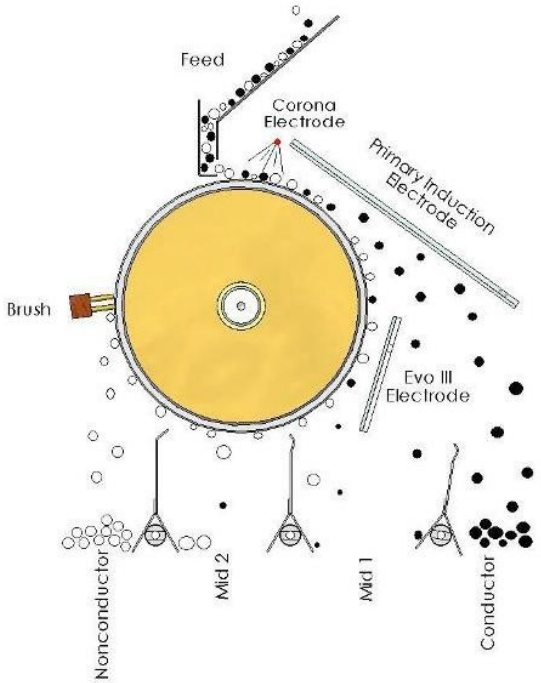


Figure 1. High-tension separation.

The objective of this lab is to identify the optimum technical operating point for separating titanium minerals from silicate minerals. This optimum will be identified in terms of

separation efficiency, titanium mineral recovery, titanium mineral grade, and gangue rejection. You should also qualitatively identify the operating conditions (wheel speed, feed rate, splitter position, applied potential) and procedures that seem to provide the best separation.

Helpful Equations

Two Product Formula	$Y = 100\,\frac{(f-t)}{(c-t)}$
Recovery	$R = 100\,\frac{Cc}{Ff} = (100\,Y)\,\frac{c}{f}$
Rejection	$J = 100\,\frac{Tt}{Ff} = (100-Y)\,\frac{t}{f}$
Separation Efficiency	$SE = R_{Valuable} - R_{Gangue}$

Procedure

1. Don all appropriate safety and personal protective equipment.

2. Obtain a 2-kg sample of minus 28 mesh titanium-bearing sand from the course instructor. The sample is a split of feed from the heavy mineral sands from DuPont's Trail Ridge facility in Starke, Florida. Please note the following:
   - The sand contains approximately 35% titanium minerals.
   - Titanium-bearing minerals are present primarily as ilmenite along with small amounts of rutile and leucoxene.
   - Gangue minerals are present as quartz, zircon, and staurolite.

2. Using the laboratory high-tension separator at Plantation Road, separate the titanium-bearing minerals from the other gangue constituents. Your lab instructor will show you how this device works. Please pay close attention to the safety protocols presented by the instructor.

3. For this particular laboratory exercise, the specific experimental procedure will be left up to the individual lab groups. Each lab group should spend the first half of the period becoming familiar with the separator in order to decide on an experimental procedure. Controllable variables include left diverter angle, right diverter angle, drum speed and electrode kilovolts.

4. During the last half of the period, each lab group should perform the "best possible" separation. Be sure to record everything you do as you perform your separation so that you can describe what you determine to be the "best method" of operating the separator.

5. Each lab group must ultimately produce two products; a titanium concentrate and a tailings. The goal is to obtain the best separation efficiency possible. In calculating separation efficiency, all valuable material will be classified as "titanium mineral" and everything else will be considered "gangue mineral."

6. After the separation is complete, place the two samples of "titanium mineral" and "gangue mineral" in bags labeled with group number, sample type (concentrate or tailings), and sample weight. Once the samples have been analyzed, you will be given the results of similar tests conducted by other groups using this technology on the same sample.

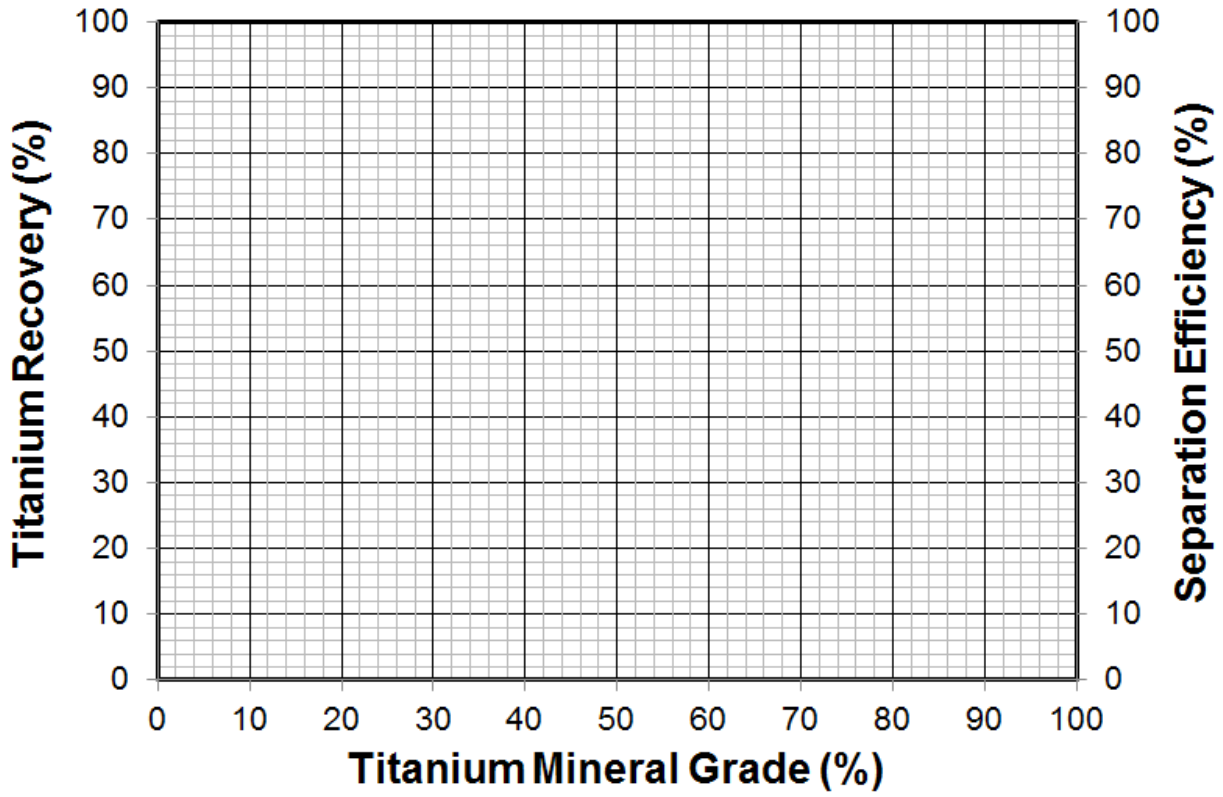
Data Records & Calculations

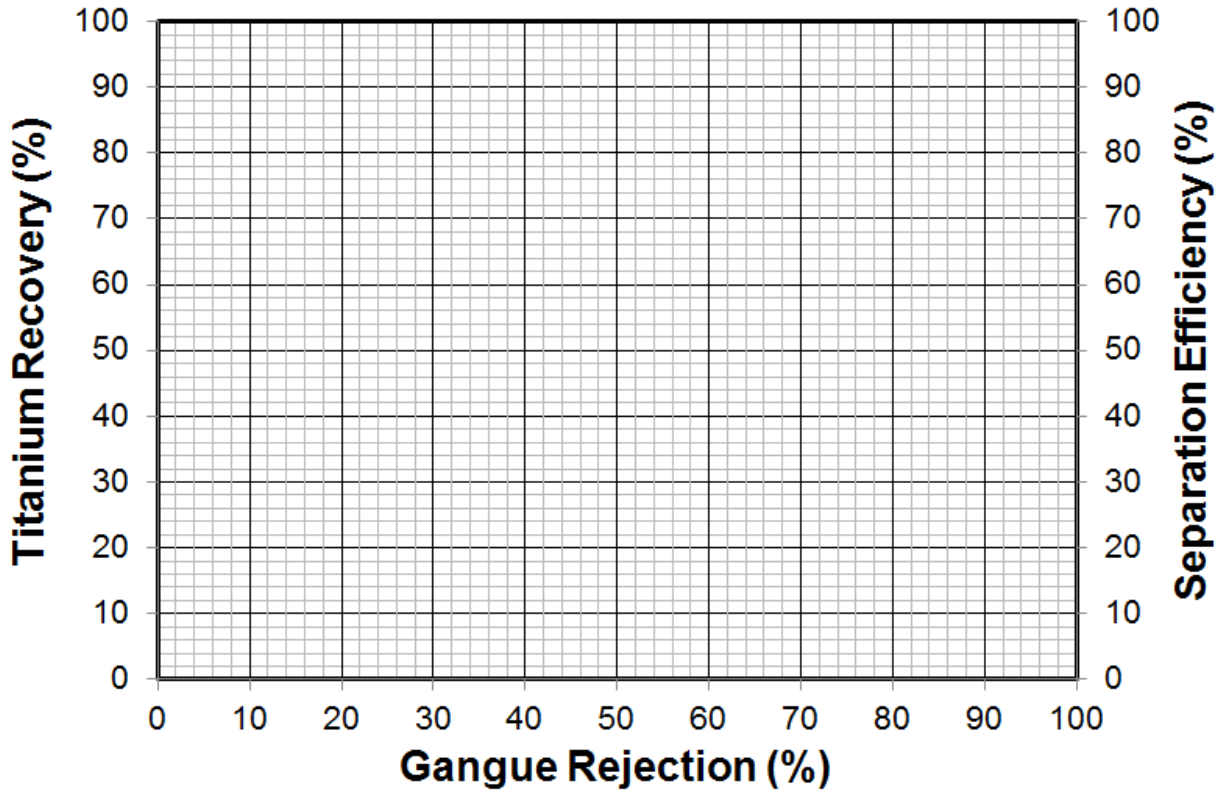
1. Carefully record the procedure you used to make the "best possible" separation. You are encouraged to draw a flowsheet to show the process steps.

2. Complete the following table for your data set.

Stream	Weight (%)	Titanium Mineral (%)	Gangue Mineral (%)	Titanium Distribution	Gangue Distribution	Separation Efficiency (%)
Concentrate						
Tailings						
Feed						

3. Using data from all lab groups (to be provided by the instructor), please prepare plots of (i) titanium mineral recovery and separation efficiency versus titanium mineral grade and (ii) titanium mineral recovery and separation efficiency versus gangue rejection. Graphs are provided on the next page for your use.


Titanium Recovery (%)
Separation Efficiency (%)
Titanium Mineral Grade (%)
0
10
20
30
40
50
60
70
80
90
100


Titanium Recovery (%)
Separation Efficiency (%)
Gangue Rejection (%)
0
10
20
30
40
50
60
70
80
90
100

Discussion Questions

1. Briefly explain how a high-tension separator separates titanium minerals from gangue minerals.

2. What did you observe to be the best way to operate the separator?

3. What combination of titanium mineral grade, titanium mineral recovery, separation efficiency, and gangue rejection represent the optimum technical operating point? Why?

4. What experimental difficulties were encountered which may have limited your ability to achieve the best separation?

Conclusions

1. What was the objective of this laboratory exercise?

2. What were your major findings?

3. What important fundamental concepts did you learn from the exercise?