



Benefits of Beneficiation

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2018 MINNESOTA MINERALS EDUCATION WORKSHOP

What is Beneficiation or Mineral Processing?

- ▶ It's the process of separating commercially valuable minerals from their ores, BUT MUST:
 - ▶ Create a marketable product
 - ▶ Create a conscientious tailings stream that is not cost prohibitive
- ▶ Steps in Mineral Processing
 - ▶ Comminution – Particle size reduction
 - ▶ Crushing, Grinding (coffee grinder)
 - ▶ Sizing – Particle separation
 - ▶ Screening, Classifying (colander)
 - ▶ Concentration – Using physical or chemical properties to put like particles together
 - ▶ Magnets, Gravity (gold pan)
 - ▶ Dewatering – separating the solids from the liquids
 - ▶ Plate filters, hydro-separators (salad spinner)

So what happens when we process minerals?

- ▶ We separate an ore into separate groups of more concentrated minerals
- ▶ We create at least one product that is saleable
- ▶ We provide opportunities for other valuable products
- ▶ Common terms:
 - ▶ Ore – Total weight of materials from which valuable minerals are extracted and sold at a profit; once beneficiation of ore starts, ore becomes the Feed and is separated into a Product and Tailings (Feed = Product + Tailings)
 - ▶ Product – Weight of processed minerals that contain the valuable product
 - ▶ Tailings – Weight of processed minerals that doesn't contain valuable products
 - ▶ Yield – Amount of Product (by weight) that is extracted from the total ore

Thoughts to optimize mineral processing (tips for design)

- ▶ Know what your marketable product is
 - ▶ Separate only far enough to create product value
 - ▶ Do not assume tailings will always be worthless...plan accordingly
- ▶ Minimize tailings products
 - ▶ Look for co-product, by-product value beyond target mineral value
 - ▶ If tailings are necessary to store, look for other ways to be valuable
- ▶ Reduce processing steps to avoid loss or dilution (material balance)

Intro to Mineral Processing Exercises

- ▶ These exercises will explain the process of mineral processing – the part of mining after the ore is removed from the earth to the final product that is valuable
- ▶ These exercises can help inspire and develop:
 - ▶ Critical thinking
 - ▶ Sequence of operations
 - ▶ Accuracy and precision
 - ▶ Systems design
 - ▶ Fluency in math & word problems

Sweet & Salty Exercise

- ▶ Consider this material a crushed ore containing the following products (minerals):
 - ▶ Sunflower Kernels
 - ▶ Raisins
 - ▶ Peanuts
 - ▶ M&Ms
- ▶ Tools available:
 - ▶ Pie plate (work area)
 - ▶ Cupcake liners (multiple process bins)
 - ▶ Digital scale (laboratory)
 - ▶ Paint Brush (for moving material & cleaning between processes)
 - ▶ Colanders (fine screens)
 - ▶ Potato Masher (primary screen & secondary crusher)

Objective #1

- ▶ There is a need for M&M's and Sunflower Powder to make sunbutter (a yummy peanut butter alternative), provided:
 - ▶ M&M's are at least $\frac{1}{4}$ " or larger and pass visible inspections
 - ▶ M&M's and Sunflower powder are separate sales and cannot be sold together
- ▶ Inside information: You know of a local company that will grind sunflower kernels into sunflower powder for you, provided it is nearly pure sunflower kernels. This same company cannot have raisins in their grinding because they are too sticky.
- ▶ Create the two products using only the tools provided
 - ▶ All processes must be contained in the pie plate and absolutely no fingers can be used for separating
 - ▶ Any materials falling outside of pie plate must be left in place (later it will be swept and weighed as loss)

Questions for Objective # 1

- ▶ What was the total weight (in grams) of your ore at the start? (Make sure to subtract the weight of an empty cupcake liner)
- ▶ How did you separate your materials?
- ▶ What is the weight of your M&M product?
 - ▶ So what was the yield?
- ▶ What is the weight of your sunflower powder product?
 - ▶ So what was the yield?
- ▶ How much tailings did you have? How much loss did you have?
- ▶ What was the most difficult material to work with? Why?
- ▶ What product was the easiest to work with? Why?
- ▶ What did you do with your tailings materials at the end?

Objective #2

- ▶ There just became an opportunity for selling your old raisin waste as an organic binder, but its not that simple. The raisins will be used at another location in southern Minnesota (200 miles away), but its too sticky to dump out of the truck. Develop a plan to use your waste products to create a product that can be delivered.
- ▶ Create a waste product that is at least 80% raisins (by weight) that can pass the shipping inspection (instructor)
- ▶ Remember, any steps you do from this point may make this unprofitable

Questions for Objective #2

- ▶ Are raisins in the trail mix (ore) different than ordinary raisins?
- ▶ Why didn't raisins stick when in the ore, but now do?
 - ▶ What conditions would cause raisins to be more sticky?
- ▶ Could the raisin product be reliably concentrated to 80% just by its shape?
Explain
- ▶ What characteristics make this new product better for transporting?
- ▶ Would you alter the processing steps in Objective #1 had you known this opportunity in Objective #2 from the start?