Teachers' Card

Gold panning for begginners

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General Introduction

This toolkit helps teachers to demonstrate a diverse mineral processing method, the separation based on density, through an interesting application, using only a simple physical property of materials. With the help of the experiment, it will be easy to distinguish between a high and low density material, even if the actual densities are unknown.
The target age group is 10 years and older students, as no chemicals are needed, and the experiments can be done in a few very easy steps:

- The two materials with unknown densities should be thoroughly mixed and put in the gold pan
- Put water in a bowl or basin that is bigger than the gold pan, then carry out the separation of the materials

Density is one of the basic physical properties of materials, which is determined by the mass and the volume of the material. In case of mixed primary raw materials, the density of the mixed materials is one of the most important property that can help with the separation. Thus, the useful material can be separated from the not useful gangue. The density based separation is the basis for gold panning as well.

Keywords:

Sustainability, Physical properties, Raw material processing

Extended background information

The definition and determination of density

Density is the substance's mass per unit of volume. There is a linear relationship between the mass and the volume, which means that if the density stays the same, but the volume is doubled, the mass of the material will double as well.

Various different material pairing can be used in the toolkit, but they have to meet two important criteria: the size of both materials has to be similar (very small), and the density difference should be notable, so that the separation would be easier.

Can we use density based separation for raw material processing?

During the processing of primary raw materials, numerous dry and wet methods can be used to separate the constituents based on the difference in density. This step is important for the proper preparation of the raw material, as in most cases, not only the useful ore is mined, but

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the ensuing rock formation, the gangue material as well. Thus, we should be able to separate the useful and not useful parts of the mined material, as the gangue will decrease the quality and applicability of the final product.

For example, in case of coal mining, the separation of the gangue is of utmost importance, as having gangue in the final product would greatly decrease the energetic (calorific) value of the coal during burning. On the other hand, as a result of the continuous technological development, we can re-process old mining waste-heaps to recover even more coal, which could not be extracted in the past using older technologies. Thus, not only further raw materials can be obtained, but the amount of waste heaps can be decreased as well, which is also favourable for environmental protection.

The density of some solids

- Basalt: 3.0 g/cm^3
- Brick: 2.5 g/cm^3
- Cement: 1.44 g/cm^3
- Clay: 1.38 g/cm^3
- Concrete: 2.4 g/cm^3
- Copper: 8.92 g/cm^3
- Glass: 2.6 g/cm^3
- Gold: 19.3 g/cm^3
- Gypsum: 2.32 g/cm^3
- Iron: 7.86 g/cm^3
- Magnesium: 1.74 g/cm^3
- Pyrite: 5.03 g/cm^3
- Quartz: 2.65 g/cm^3
- Salt: 2.15 g/cm^3
- Sand: 1.2 g/cm^3
- Silver: 10.5 g/cm^3

Learning outcomes

By the end of the activity the students will be able to know:

- The definition and use of density
- The aim of density based separation in the case of primary raw materials

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Key Competence European Framework

Literacy competence
S1. Ability to understand and interpret concepts, feelings, facts or opinions in oral and written form.
S2. Ability to express concepts, feelings, facts or opinion in written and oral form.
S4. Ability to interact in an appropriate and creative way in any situation.
Multilingual competence
S1. Ability to understand and interpret concepts, feelings, facts or opinions in oral and written form.
S2. Ability to express concepts, feelings, facts or opinion in oral and written form.
S4. Ability to interact in an appropriate and creative way in any situation.
S7. Ability to use technical language accordingly to the field of work.
Mathematical competence and competence in science, technology and engineering
S1. Ability to use constructed thinking in order to solve a problem in every situation.
S4. Readiness to address new problems from new areas.
S9. Ability to formulate complex problems of optimisation and decision making and to interpret the solutions in the original contexts of the problems
Digital competence
S2. Basic skills in ICT
Personal, social and learning to learn competence
S1. Ability to pursue and persist in different kinds of learning.
S2. Identifying available opportunities.
Citizen competence
S2. Ability to adapt to the changing situation, being flexible and work under pressure
S3. Ability to work effectively and collaborate with other team members
Cultural awareness and expression competence
S1. Ability to turn idea into action
S2. Creativity/innovation
S3. Ability to plan and manage tasks
S4. Independence, Motivation and Determination

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United Nations' Sustainable Development Goals

The Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate change, environmental degradation, peace and justice. Goals linked to this activity:

	Enable access to basic services	✓	Equal access to global expertise
	Safe medical devices		Sustainable urbanization
✓	Access to education	✓	Responsible consumption and production
	Less hardship, more opportunities		Strengthen resilience, reduce disaster impact
	Safe and affordable water		Reduce marine pollution
	Energy – the golden thread	✓	Sustainable use of terrestrial ecosystems
	Safety of workers and economic growth		Promote peaceful and inclusive societies
	Resilient infrastructure and sustainable industrialization	✓	Better access to technology and innovation

Contents – Theoretical principles

The Greek ρ (rho) is used to illustrate density, the measurement unit can be e.g. g/cm^3 or kg/m^3. The density of different materials can be calculated with the following formula:

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$$\rho = \frac{m}{V}$$

where ρ – density
m – mass
V – volume

This means that if the volume of two materials is the same, the one with the higher mass will have higher density, but in the case of two materials with the same mass, the one with lower volume will have higher density.

The conversion of the measurement units can be done as follows:

$$1\frac{g}{cm^3} = 1\frac{kg}{dm^3} = 1000\frac{kg}{m^3}$$

Thus 1 kg/m^3 = 0.001 g/cm^3
1 kg/m^3 = 0.001 kg/dm^3
1 kg/dm^3 = 1 g/cm^3

To determine the mass and volume of a material, the pressure and the temperature of the material are important parameters. For solids and liquids, the volume change due to pressure changes can be neglected. However, temperature can be a very important parameter, so in many cases, the density value should be given along with the temperature (e.g. the density of water is. 1000 kg/m^3 at 5 °C, but at 25 °C it changes to 997.1 kg/m^3).

In the case of separation based on density differences, there are dry and wet methods that can be used. In the following section, some wet gravity separation methods will be detailed that are applied in the raw material preparation industry.

1. Using liquids with different densities for sedimentation

Sedimentation is a universal method for the separation of materials that can be carried out in many ways. In this case, liquids with different densities are used (ρ_1, ρ_2, ρ_3) to separate material mixtures with different densities by the sedimentation of the particles. With this method, not only two materials with different densities can be separated, but (based on the number or liquids we use) several products can be prepared. First, we put the material mixture in the liquid with the highest density, some of the material will sink down and some will float on top. The particles which did not sink can be transferred to the second liquid with lower density. This step can be repeated many times with different liquids. The particles that sink have higher density than the liquid, while the floating particles are lower density. This method is illustrated in Figure 1.

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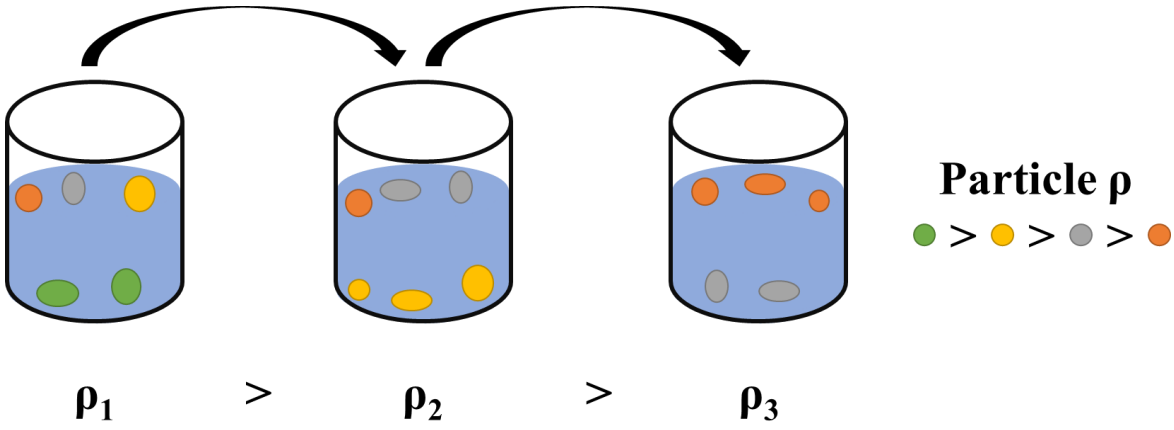

Figure 1. Density separation with liquids

This method can be useful for the separation of coal from the gangue material. The worthless rock or other material in which valuable minerals cannot be found are referred to as gangue. The density of pure, clean coal is around 1.3 g/cm^3, on the other hand, the gangue material has higher density, which can be around or above 2 g/cm^3.

2. Jiggling separation

The basis for jiggling separation is that there is a screen (jig screen) inside the equipment and the material bed is put on top of the screen. For wet separation, water is used as a media. The separation of the material mixture can be carried out in two different ways: in one type of equipment, the screen is moving in still water, but in other equipment types (which are more common) the sieve is fixed, and the mineral bed is repeatedly moved up by the water, it expands, and then re-settles. Due to the continuous moving (jiggling) of the material bed, the higher density particles settle to the bottom, and the lower density particles stay on top of the bed (Figure 2). This separation method is common in case or gold ore separation.

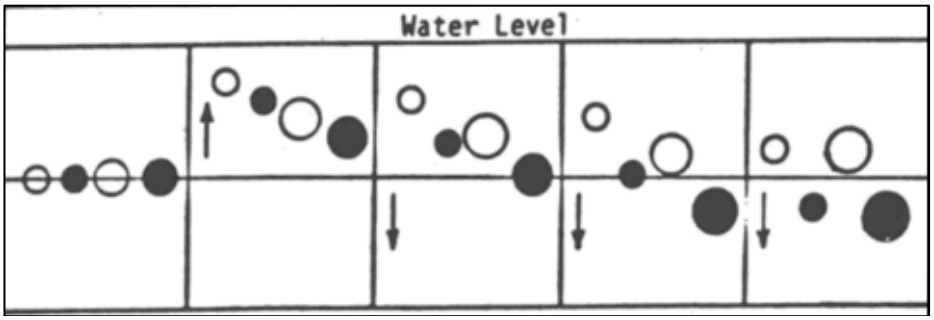

Figure 2. The operation of a jiggle separator, white – low density particles, grey – high density particles (Michaud, 2016)

3. Wet shaking tables

Wet shaking tables are commonly used in raw material preparation to separate fine particle sized materials based on their density difference. These equipment have a slightly inclined table

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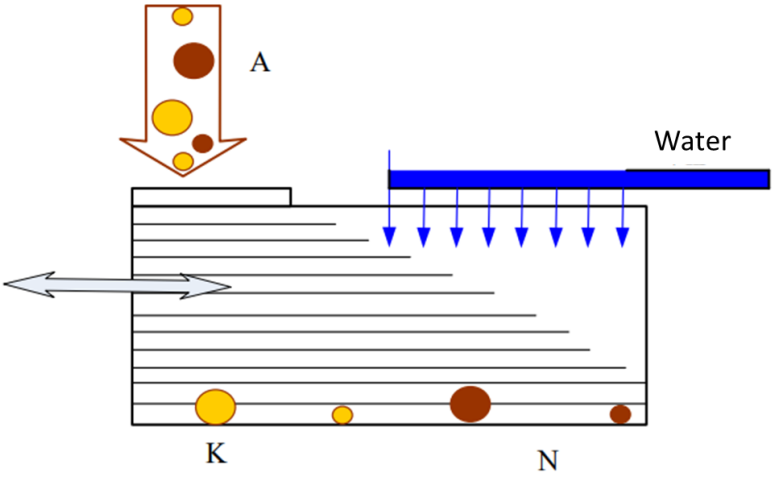
surface, and water is continuously flowing on the table. Wet shaking tables require only a thin stream of water, the incline is usually between 3-5°. The surface of the shaking table can be smooth or ribbed. As it can be seen in Figure 3, the shaking tables are generally densely ribbed, the material feed is added on the top of the table, which then exists the table in a fan-shape. The water is also continuously added on the top, a bit further from the material feed, while the table is moving in a lateral direction. The material bed is loosened by the water stream, and the ribs are filled with the particles, while the higher density particles move with higher speed in a lateral direction than the low-density particles. Thus, the low-density particles travel less distance and will settle on the side of the material feed, while the higher density particles will travel to the other side of the table. This equipment is capable of separating fine particle-sized sand from magnetite.



A – feed; N – high density material; K – low density material

Figure 3. Principle of the wet shaking table (Csőke, 2011)

Lab procedure

During the experiments, students model one of the most important method of the separation of natural resources, the density based separation.

Learning Pathway

Step 1. – Time & Activity: 1 h: Teachers give a short introduction about density, certain separation methods using density differences in primary raw material preparation

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Step 2. – Time & Activity: 25 min: Students are divided into groups and perform the gold pannin experiments with the material mixture.

Step 3.– Time & Activity: 15 min: discussion of the results obtained by the various groups.

Step 4.– Time & Activity: 30 min: evaluation test. The time spent on the assessment test depends on the number of questions entered.

Evaluation

Possible questions to learn some key concepts about density- based separation:

1. What is the definition of density?

Density is the substance's mass per unit of volume.

2. Put the materials in order based on their density (start with the lower density)!

Gold	1. Sand
Iron	2. Quartz
Sand	3. Pyrite
Quartz	4. Iron
Pyrite	5. Gold

3. Convert the following density values to the given measurement units!

2500 kg/m^3	2,5 g/cm^3
3 kg/dm^3	3 kg/cm^3
4 kg/m^3	0.004 kg/dm^3

4. From the following pairings, which pairs could be easily separated based on their densities?

Basalt – gypsum	Yes
Gold – silver	Yes
Brick – glass	No
Clay – sand	No
Gypsum – pyrite	Yes

5. Give three examples of wet density separation methods that are used in the preparation of primary raw materials!

Using different density fluids, jigging equipment, shaking table.

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Sources

- A sűrűség. https://slideplayer.hu/slide/2063807/
- Csőke B. (szerk.): 12. kötet – Hulladékgazdálkodás. In: Domokos E. (szerk.) Környezetmérnöki Tudástár, Pannon Egyetem, Veszprém, 2011. ISBN: 978-615-5044-37-3
- Faitli J., Gombkötő I., Mucsi G., Nagy S., Antal G.: Mechanikai eljárástechnikai praktikum. Miskolci Egyetemi Kiadó, Miskolc, 2017.
- Michaud, D.: Gold jig & mineral processing jigs, 2016. https://www.911metallurgist.com/blog/gold-mineral-processing-jigs

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