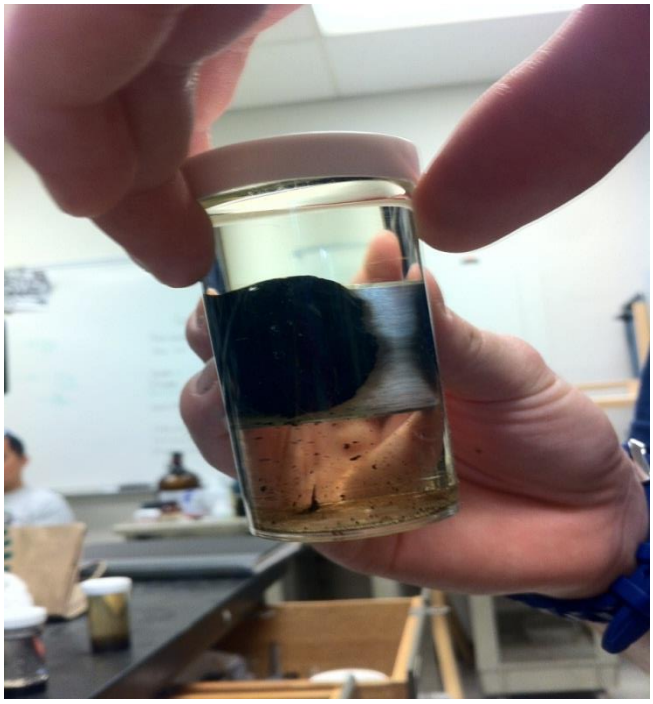
California State University of Bakersfield, Department of Chemistry

Ferrofluid



Standards:

3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

3-PS2-4: Define a simple design problem that can be solved by applying scientific ideas about magnets.

MS-PS2-3: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

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HS-PS3-5: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

Introduction:

This project involves making a magnetic liquid that is fun to play with and fun to make.

Materials:

- Iron III Chloride
- Iron II Chloride
- Ammonium Hydroxide
- Tetramethylammonium Hydroxide
- Hydrochloric Acid (1M)
- Mineral Oil
- Distilled Water
- Strong Magnet
- Stirring Rod
- 125 mL Erlenmeyer flask
- 50 mL Erlenmeyer flask
- Weighing Boat
- Small Pipets
- Liquid Waste Container
- Small Spatula
- Permanent (STRONG) Magnet

Safety:

- Always have an adult with you to help you during your experiment.
- Dispose any chemicals in a liquid waste container.
- Wear lab aprons, gloves, and goggles when performing this experiment.
- Hydrochloric acid can be highly corrosive. Handle with care.
- Keep all personal electronics away from work station.
- Be extremely careful with the magnet. Do not leave it around other metal objects.

Procedure:

<u>Step 1</u>

- Weigh 2.7g of Iron III salt using balance and weighing boat.
- Place iron salt into a 125 mL Erlenmeyer flask or beaker.
- Use graduated cylinder to measure 25 mL of distilled water.
- Use graduated cylinder to measure 10 mL of 1M hydrochloric acid.
- Add water, then HCL into iron and shake (swish) until the iron has been completely dissolved. **Note:** Iron may get stuck to bottom. Use a stirring rod to scrape off and mix.

<u>Step 2</u>

- Weigh 1g of Iron II salt as before with balance
- Place Iron salt in a small beaker container

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- Measure 2.5 mL or 1M hydrochloric acid and add to the Iron salt
- Shake until iron salt is completely dissolved

Step 3

- Combine the iron solutions by adding the Iron II solution with the Iron III.
- Mix the solutions well by swishing.
- Wash out the Iron II beaker with a small amount of distilled water and add to the solution.
- Mix solution again by shaking
- Add 50 mL of ammonium hydroxide by drops while shaking as much as possible.
- After all is in the solution, shake for at least three minutes.

Step 4

- Put the magnet under the beaker
- Wait until upper solution gets clear
- Decant solution into a waste beaker.
- Take 50 mL distilled water and add to magnetic particles
- Repeat this washing step at least 2 more times

Step 5

- Leave 50 mL of distilled water in the solution and shake to make all black again.
- Transfer the solution in small amounts to a weighing boat, using the magnet to settle the particles.
- Decant the clear upper solution into the waste beaker. Hold the magnet when decanting. **Note:** To remove everything, extra water may be required.
- Once all all magnetic particles are in the weighing boat, get rid of as much water as possible.

Step 6

- Measure 5 mL of 25% tetramethylammonium hydroxide by using a pipette and add it to the magnetic particles stir/mix with a glass rod. Wait at least 3 minutes. Remove the black liquid on top.

Step 7

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- Check the ferrofluid with a magnet for spikes. If there are no spikes, there is too much water.
- Fill a vial with mineral oil and add just a few drops of ferrofluid.
- Seal the container; try to leave as much air out as possible.

Data and Observations:

Record your observations in this space. What did you see? Anything you were not expecting? Something really awesome? Describe it here.

References:

Make Your Own Ferrofluid. KoserLab. https://sites.google.com/site/koserlab/outreach/make-your-own-ferrofluid (Acessed July 18, 2013)

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