

Briggs-Rauscher Reaction – Yellow to Blue Switcheroo

Description: The standard among oscillating reactions. Three colorless solutions are mixed to produce an oscillating reaction which changes from yellow to blue to colorless. The period of oscillation is rapid and the reaction reaches completion within 10 minutes.

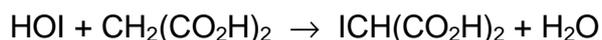
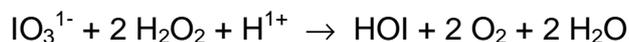
Materials:

30% H ₂ O ₂	Soluble starch
KIO ₃	Deionized water
1 M H ₂ SO ₄	Large beaker
MnSO ₄ •H ₂ O	Graduated cylinders (3)
Malonic acid	Stir plate / stir bar

Procedure:

1. Solution A: Prepare 100 mL of 9% H₂O₂ by diluting 30 mL of 30% H₂O₂ with 70 mL of deionized H₂O.
2. Solution B: Prepare an acidified 0.2 M KIO₃ solution by adding 10 mL of 1.0 M H₂SO₄ to 80 mL of deionized water. Dissolve 4.3 g KIO₃ in this solution and dilute to 100 mL.
3. Solution C: Prepare starch solution by dissolving 0.1 g of soluble starch in 90 mL of boiling deionized water. When cool, add 1.5 g malonic acid, 0.4 g MnSO₄•H₂O, stir and dilute to 100 mL.
4. Add 50 mL of Solution A to a clean beaker fitted with a stir bar. Next add 50 mL of Solution B and let solutions mix thoroughly. Once complete, add 50 mL of Solution C and let reaction stir. Upon addition of the final solution, bubbles should appear. The solution will turn yellow then blue, then colorless. This reaction will oscillate for 5-10 minutes.

Discussion: A more detailed description of this reaction can be found in the Shakhashiri reference. The three colors observed are a result of an increase in the concentrations of I_2 (yellow), starch-iodine complex (blue), and I^{1-} (colorless) in order of appearance during the demonstration. The BR reaction can be summarized by two chemical reactions:



When the reaction begins, the solution becomes yellow as I^{1-} (generated from reaction of HOI with H_2O_2 , not shown) reacts with HOI under acidic conditions to produce I_2 . The solution suddenly changes to dark blue as a buildup of I^{1-} reacts with I_2 in the presence of starch to generate the pentaiodide ion (I_5^{1-}) which is encased in the amylose present in solution. The reaction proceeds by consuming I_2 at a rate greater than it is being produced thus removing the presence of I_5^{1-} and increasing the concentration of I^{1-} (colorless). The oscillations continue until malonic acid or IO_3^{1-} is completely consumed.

Safety: Wear proper protective equipment including gloves and safety glasses when preparing and performing this demonstration. Concentrated hydrogen peroxide can cause burns. KIO_3 is an oxidizer. Sulfuric acid is severely corrosive to eyes, skin and other tissue. Malonic acid solution is moderately toxic and corrosive to eyes, skin and respiratory tract. The reaction produces iodine which is toxic by inhalation and irritating to eyes, skin, and respiratory tract. Perform the demonstration in a well-ventilated room.

Disposal: Dispose of final solution in an appropriate aqueous waste container.

Reference:

Shakhashiri, B. Z. In *Chemical Demonstrations: A Handbook for Teachers of Chemistry*, The University of Wisconsin Press: 1985; Vol. 2, p 248-256.

Weinberg, R. B.; Muyskens, M. *J. Chem. Educ.* **2007**, *84*, 797.

Field, R. J.; Schneider, F. W. *J. Chem. Educ.* **1989**, *66*, 195.

Video:

<http://www.youtube.com/watch?v=Ch93AKJm9os>

<http://www.youtube.com/watch?v=yNsCU-V0oM>