

Experiment 10

Alcohol Breath Analyser

Student Handout

Purposes

1. To prepare a disposable breath alcohol tester.
 2. To test the efficiency of the tester.
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Background

There is a direct correlation between drunk drivers and automobile accidents. Numerous severe traffic accidents caused by drinking driving are reported in our local area each year. The government has not only educated the public about the seriousness of drinking driving, but also tightened the alcohol limit from 35 μg per 100 cm^3 of breath in 1995 to 22 μg per 100 cm^3 in 1999. Road checking is carried out with breathalyser test to deter people from drinking driving. Portable intoxilyser or intoximeter is commonly used by traffic police to carry out the test. Breathalyser test based on the reduction of the orange dichromate(VI) ion to the green chromium(III) ion by the reaction with ethanol is still used today by some law enforcement agencies.

Safety

Handle all chemicals with great care. Avoid direct contact of chemicals with skin. Dispose of chemical waste, broken glassware and excess materials according to your teacher's instruction.

Students should be cautious when handling concentrated acids and open flames.

Potassium dichromate(VI) and chromium(III) ions formed will cause chronic health effect. Avoid contact with skin.

Fine silica gel will irritate the respiratory system. Handle with care to avoid the gel from spreading out in the air.

Ethanol is a flammable liquid. Do not let it get close to open fire or other ignition sources.



**EYE PROTECTION
MUST BE WORN**

Safety information on the chemicals used in the investigation can be found in the Material Safety Data Sheet (MSDS). Consult your teacher for details.

Materials and Apparatus Available

Concentrated sulphuric acid



Potassium dichromate



Ethanol



Silica Gel

Test tube

Beer

Dropper

Red wine

Glass wool or cotton

Whiskey

Beaker

100-cm³ Syringe

Glass rod

Balloon

Petri dish

Two-way stopcock connector

Funnel

Experimental Procedure

 Photos of the experiment are available at <http://www.chem.cuhk.edu.hk/ssc.htm>.

1. Test-tube experiment: add 1 cm³ of 6 M H₂SO₄ and 1 cm³ of 0.1 M K₂Cr₂O₇ into a test tube. Add a few drop of ethanol. Observe the colour change for the solution. 
2. Stir ~4 g silica gel with 5 cm³ of 6 M sulphuric acid and 2.5 cm³ of 0.1 M K₂Cr₂O₇ solution in a 250-cm³ beaker for a few minutes and let it stay for half an hour. Spread the gel on a Petri dish and air-dried in the hood (this takes ~7 hours). In humid weather, the coated gel should be dried in an oven at 50 °C for ~10 minutes before use. 
3. Use a glass rod to insert a small piece of glass wool into a dropper. 
4. Transfer the dried silica gel to the dropper. Tap the dropper to ensure good packing of the silica. Pack the gel to ~6 cm in length. 
5. Insert another piece of glass wool to prevent the gel from coming out.
6. Connect the stopcock connector to the dropper.
7. Add a few drops of ethanol, beer, red wine or whiskey to a balloon. Fill the balloon with air to a diameter of ~15 cm.
8. Connect the balloon to the other side of the stopcock connector. 
9. Turn the stopcock to let air pass through the filled dropper. Squeeze the balloon to make sure that all the air has passed through the dropper.

10. Observe the colour change of the silica gel. 
 11. Roughly mark the length of the silica gel with colour change.
 12. Repeat the experiment with different samples. A large-volume syringe can also be used to replace the balloon to deliver a more precise volume.
 13. Comment on the concentration of ethanol in different samples.
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Questions for Further Thought

1. Give a balanced equation for the reaction of acidified dichromate(VI) ions with ethanol.
 2. Silica gel comes in different sizes. What will happen if the silica gel is too fine? On the other hand, what will happen if the silica gel is too coarse (e.g., with a diameter of ~2 mm)?
 3. Blood tests can also be used to measure alcohol concentration in human body. What are the advantages and disadvantages of using the blood analysis instead of the breath analyser?
 4. Alcohol breath analyser based on infra-red spectroscopy has also been developed. Draw a diagram of the instrument.
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References

1. K. J. Dombrink, *J. Chem. Educ.*, 1996, **73**, 135.
 2. D. A. Labianca, *J. Chem. Educ.*, 1990, **67**, 259.
 3. <http://chem.lapeer.org/Chem1Docs/Breathalyser.html>
 4. http://www.intox.com/about_alcohol_testing.asp
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