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Kedves Diákok!

A 2014/5. számban tovább folytatjuk a Breaking Bad filmsorozatban előforduló kémiai folyamatok felelevenítését. Ezek egyikéről fordíthattok szövegeket.

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On-screen chemistry

Breaking Bad III – thermite break-in

In Breaking Bad Walt is a high school chemistry teacher turned bad, 'cooking up' amphetamine (crystal meth) with his partner Jesse. Their starting material for the crystal meth is an over-the-counter drug from the pharmacist. Unfortunately the pharmacist is only legally allowed to sell a couple of packets to one person, so Jesse has to organise a whole host of 'Smurfs' ('dudes' prepared to go into loads of pharmacists) to go out and collect enough.

Reaction

To bypass this obvious limitation, Walt suggests an alternative precursor which they have to steal from a lockup. They burn out the security lock using a thermite reaction and in a very humorous clip, reminiscent of a scene from Laurel and Hardy, they make away with a large drum. Afterward the local drug squad watch the CCTV footage and enjoy laughing at their antics – carrying the drum rather than rolling it along. In the programme Walt enthusiastically describes the basic chemistry of the thermite reaction to Jesse – something that doesn't happen very often in a Hollywood film!

The thermite is a classic reduction-oxidation reaction. Iron oxide and aluminium powder are often used:

$$Fe_2O_3 + 2\ Al \rightarrow Al_2O_3 + 2\ Fe$$

The further apart the two metals are in the electrochemical series, the faster and more furious the reaction.

I won't ever forget the explosion and 'fallout' that took place in our lab when my inspiring middle school science teacher heated a crucible of lead oxide and magnesium thermite powder!

Really hot!

The thermite reaction is not an explosive but the energetic reaction can produce very high localized temperatures that can be used for welding or 'cutting' through metals. The reaction with aluminium is particularly useful as it melts at relatively low temperatures so the reaction is easy to start. Aluminium also has a high boiling point and so the reaction can reach very high temperatures of around 2500°C and so be used to weld railway tracks together for example.

The army use the reaction for a variety of on-the-spot applications. In the right quantities it is certainly capable of creating the sustained heat to melt a lock, although it could easily have set fire to the door and surroundings!

Thermite Reaction

Brief Description:

Addition of a small amount of glycerine to a pile of iron (III) oxide, aluminium powder, and potassium permanganate produces a flame, sparks, and molten iron.

Purpose/Goal:

Illustrates the concept of exothermic reactions, the metallurgy of iron, and energy of activation.

Explanation of Experiment:

The reaction of iron (III) oxide and aluminium can be represented by the equation:

$$Fe_2O_3(s) + 2\ Al(s) \rightarrow Al_2O_3(s) + 2\ Fe(s)$$

This reaction is one of a class of reactions known as the "thermite" process, which has been used industrially for welding, the preparation of metals from their oxides, and the production of incendiary devices. The process is initiated by heat, but then becomes self-sustaining.

The thermite reaction is initiated by the heat released from the mixture of potassium permanganate and glycerine. Use of the ignition of magnesium ribbon to initiate the desired reaction is not as reliable as the one given.

Materials Preparation:

- 50 – 55 g iron (III) oxide powder, Fe_2O_3
- 15 g aluminum powder
- 20 – 25 g potassium permanganate, $KMnO_4$
- 5 – 6 mL glycerine (glycerol), $C_3H_5(OH)_3$
- 2 terra cotta flower pots, ca. 2 ½ in. inside top diameter with 1 cm hole in bottom
- Filter paper or paper towel to fit the bottom of one pot
- Iron ring with inside diameter of 6 – 7 cm
- 1 m ring stand
- Cement board – heat resistant – ca. 1 m x 1 m
- Large metal bucket filled with dry sand
- Transparent safety shield
- 10 mL beaker
- Tongs
- Heat protective gloves

This demonstration should be performed only in a large well-ventilated room or outdoors. The reaction produces a large quantity of smoke. Sparks may be thrown 2 m vertically and 5 m horizontally. Keep flammable material away from the experimental area. Place a scrap of paper towel or filter paper over the bottom opening of one clay pot and place that pot inside the other clay pot. Mix the iron (III) oxide and aluminium powder intimately. Scoop the mixture into the pot. Form a small cone-shaped indentation in the centre of the mixture ca. 2 cm deep and 1 – 2 cm wide. Fill this indentation with 20 – 25 g of potassium permanganate crystals. Form another small cone-shaped indentation in the $KMnO_4$ *crystals.*

Place the clay pots inside a metal ring clamped to the top of a ring stand. Put the ring stand in the middle of the heat resistant cement board. To catch the molten iron, place a sand bath about 1 m below the reaction vessel. Use the safety shield for protection from sparks.

Presentation:

Place 5 – 6 mL of glycerine in a small beaker. Quickly pour the glycerine onto the depression in the $KMnO_4$ crystals. Step back immediately. Ignition of the mixture is achieved in about 15 seconds. Flame, flying sparks, smoke, and dust are produced. Molten iron runs through the hole in the pot into the sand bath. When the reaction is over, use tongs to pick up the white hot iron. Allow the iron to cool before touching.

Hazards:

This demonstration produces intense heat and molten metal. A fire extinguisher should be readily available at all times. Water should not be used to extinguish the reaction, since addition of water to hot iron produces potentially explosive hydrogen gas. Since fires resulting from thermite reactions can be difficult to control, the chemicals should not be used in larger amounts than suggested. A safety shield should be used for protection from sparks. Care should be taken to avoid exposure to molten iron. Heat protective gloves should be worn, and the hot products should be handled only with tongs. Handle $KMnO_4$ with great care, since explosions can occur if it is brought into contact with organic or other readily oxidizable substances, either in solution or in the dry state. Because of the smoke and dust released, the demonstration should be performed in a well-ventilated room at the end of the lecture.

Disposal:

Allow the solids produced to cool to room temperature. All solids can be scraped off into a waste container.

The inner flower pot invariably cracks, and should not be reused.

Forrás:

http://www.rsc.org/images/Mole-March2012-On-screen-chemistry-breaking-bad_tcm18-233915.pdf

http://cldfacility.rutgers.edu/content/thermite-reaction