14.5 Effect of Surface area on rate – Potassium permanganate and glycerin

Subject: Kinetics, combustion, exothermic reactions

Description: The difference of a reaction rate is observed when glycerin is added to ground and unground potassium permanganate.

Materials:
10 g Potassium permanganate, divided equally into 5 gram portions‡
Mortar and pestle
Spatula
Dropper bottle with glycerin
2 porcelain dishes or watch glasses

‡Located on the oxidizers shelf.

Pre-class Preparation:
1. Using the mortar and pestle, grind a 5g portion of potassium permanganate.

Procedure:
Note: Because material is ejected from the reaction mixture, perform this demo in the hood or behind a shield.
1. Place approximately 5 grams of the crystalline potassium permanganate and 5 grams of the ground potassium permanganate in a pile on two dishes.
2. Make a depression in each pile.
3. Add approximately 1 ml of glycerin to the first pile and observe the reaction.
4. Add the same amount of glycerin to the pile of ground material and observe the difference in reaction rate.
5. The reaction produces a white puff of smoke, followed by crackling, sparking, and a purple flame. Combustion continues until the glycerin is consumed.

Discussion:
This demonstration illustrates spontaneous combustion and the effect of surface area on the rate of a reaction. The rate of a reaction is proportional surface area. Thus the finely ground potassium permanganate reacts much more quickly that the unground potassium permanganate.

The oxidation of glycerin by potassium permanganate is initially slow, but as the system generates heat, the reaction speeds up and eventually catches fire.

The reactions taking place include:

$$14KMnO_4(s) + 4C_3H_5(OH)_3(l) \rightarrow 7K_2CO_3(s) + 7Mn_2O_3(s) + 5CO_2(g) + 16H_2O(g)$$

Other reactions are likely taking place. The solid after the reaction includes white areas of potassium carbonate, black areas of manganese oxide, and greenish crystalline material, possible potassium manganate.

Safety: This reaction produces heat, sparking, and flames. Material will be expelled from the reaction. Stand several feet back and perform the reaction behind a shield, in a fume hood, or well away from students in a well-ventilated room. Keep the potassium permanganate away from combustible or oxidizable materials and handle with care.

Disposal: Dispose of residues in the appropriate solid waste container.

References:

1. B.Z. Shakhashiri; *Chemical Demonstrations: A Handbook for Teachers of Chemistry*; Volume 1; Wisconsin; 1983; p. 84-85