Dehydration of Sugar by H_2SO_4

Description: Concentrated sulfuric acid is added to sugar producing a black substance which expands out of the container.

Materials:

Granulated sugar
Conc. H_2SO_4
Tall beaker
Glass stirring rod

Procedure:

For large lecture halls, perform demonstration using a document camera.

This demonstration is best performed inside a plastic bin to contain the materials produced. Add 50 g of granulated sugar to the tall-form beaker. Insert stirring rod into center of sugar. Add 50 mL of concentrated sulfuric acid to this and stir. The mixture will change from white to yellow to black. At this point the mixture will begin to expand out of the beaker.

Discussion: Sulfuric acid is commonly used as a dehydrating agent because a large energy change occurs when sulfuric acid becomes hydrated (*see Diluting H_2SO_4 demonstration*). The dehydration of sucrose is an exothermic process and coupled with this, water generated upon dehydration, dilutes sulfuric acid, which is also an exothermic process. The ΔH^o_{rxn} (eq. 1) can be calculated by subtracting the ΔH^o_f of CO_2 (eq. 2) from the ΔH^o_{comb} of sucrose (eq. 3).

Eq.				ΔH^o (kJ/mol)
1	$C_{12}H_{22}O_{11}$ (s)	$\rightarrow$	12 C (s) + 11 H_2O (l)	-918.9
2	C (s) + O_2 (g)	$\rightarrow$	CO_2 (g)	-393.5
3	$C_{12}H_{22}O_{11}$ (s) + 12 O_2 (g)	$\rightarrow$	12 CO_2 (g) + 11 H_2O (l)	-5640.9

The overall heat evolved in this demonstration can be calculated using the ΔH^o_{rxn} combined with the ΔH^o_f ($H_2SO_4 \bullet nH_2O$) as detailed in the Shakhashiri reference.

Safety: Wear proper protective equipment including gloves and safety glasses when preparing and performing this demonstration. Sulfuric acid is a very strong acid and is extremely corrosive to skin. Stand clear of the beaker as steam is generated during this reaction and contact with these vapors can cause burns.

Disposal: Residue should be rinsed thoroughly with water and discarded in a solid waste container.

References:

Shakhashiri, B. Z. In *Chemical Demonstrations: A Handbook for Teachers of Chemistry*; The University of Wisconsin Press: 1983; Vol. 1, p 77-78.

.Silverstein, T. P.; Zhang, Y. *J. Chem. Educ.* **1998**, *75*, 748. See also: *J. Chem. Educ.* **2006**, *83*, 701.

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Video:

http://www.youtube.com/watch?v=pqi50sjJVc0

http://www.youtube.com/watch?v=nqDHwd9rG0s