Percent Potassium Chlorate In a Mixture

Once we are able to describe pure substances in terms of atoms and molecules, and in terms of compounds and elements, we can begin to understand chemical reactions in a quantitative manner. We then have the capability to predict product amounts and develop economical ways to produced the many synthetic substances we need. Furthermore, we have the ability to analyze substances based upon the amount of products formed in a reaction. This experiment is an illustration of just such a technique.

Potassium chlorate decomposes on heating, with ease in the presence of a catalyst, to produce potassium chloride and oxygen according to the equation below:

$$2\ KClO_3 \text{ -------> } 2\ KCl + 3\ O_2$$

Since the decomposition of 1 mole of potassium chlorate releases 1.5 moles of oxygen, one can determine the number of moles of potassium chlorate in a sample form the weight loss due to loss of oxygen. In this experiment, you will determine the percent potassium chlorate in a mixture containing an unreactive chloride. By converting the weight loss to moles of oxygen lost, we can calculate the moles of potassium chlorate in the starting material. From the moles of potassium chlorate we can convert to mass of potassium chlorate and then the % in the sample.

A catalyst, MnO_2, manganese (IV) oxide is added to the reaction mixture in order to speed up the reaction. Like all catalyst, the same amount of catalyst is present at the end of the reaction as in the beginning. Therefore, we will include the mass of the catalyst in with the mass of the test tube.

In a thermal decomposition such as this, the product must be heated to a constant weight before you can be sure the decomposition is complete. After the first heating, cooling and weighing, the sample must be heated again, cooled and reweighed. This process is continued until two successive weighing are within 5 mg of each other.

Procedure

Place 0.5 to 0.8 g of manganese (IV) oxide into a clean, dry, crucible. Place the crucible into the center of an appropriately-sized clay triangle, supported by a metal ring clamped to a ring stand. Heat the crucible and catalyst with a bunsen burner for about 3 minutes to drive off any moisture that may be in the catalyst or crucible. When the crucible is cooled to room temperature (5 minutes), measure the entire mass **to the nearest 0.001 g. Use the same balance for all future mass measurements in this experiment.**

Add about 2.0 to 2.5 grams of the unknown mixture to the crucible containing the catalyst and record the mass to the nearest 0.001 g.

Mix the contents of the crucible very carefully to obtain a somewhat uniform mixture. This can be done by simply rolling the crucible back and forth in your hand. Place the crucible back into the clay triangle. Heat the mixture gently at first to prevent ejection of an solid material or smoke from the mixture. When all evidence of reaction ceases, heat strongly for an additional 10 minutes, then allow the sample to cool to room temperature (10 minutes) and then weigh it.

Repeat this heating and cooling process until two successive weighing are within 0.005g of each other. Determine the percent $KClO_3$ of the sample.

Percent Potassium Chlorate

DATA SHEET: Name:________________

Unknown Number:

1. Mass of crucible + catalyst (after driving off moisture)
2. Mass of crucible + catalyst + mixture (before heating)
3. Mass after first heating
4. Mass after second heating
5. Mass after third heating (if needed)
6. Mass after final heating (if needed)

RESULTS:

7. Mass of oxygen lost by heating
8. Mass of potassium chlorate decomposed by heating
9. Mass of mixture
10. Percent potassium chlorate in mixture

Include calculations for steps 7-10 on the reverse side of this sheet.

Calculations:

QUESTIONS:

1. Calculate the percent oxygen by mass in each of the following compounds:
   lithium nitrate sodium bicarbonate

2. Would the calculated % $KClO_3$ in the unknown mixture be higher or lower if all the moisture was not removed from the catalyst in the first heating, before adding the unknown mixture? Explain your prediction.