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## Chemical Transformation II

### Decomposition of $\text{H}_2\text{O}_2$ with KI



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### Abstract

With the addition of a catalyst, KI, and soap solution, assuming an  $E_a = 56$  KJ/mole and a temperature of  $20^\circ\text{C}$ , the rate of decomposition of  $\text{H}_2\text{O}_2$  to  $\text{H}_2\text{O}$  and  $\text{O}_2$  is increased by 2439 times. This reaction is similar to Chemical Transformation I, where we used  $\text{MnO}_2$  to catalyze the decomposition of hydrogen peroxide to create clouds of condensed water vapor.

## Materials

2L Erlenmeyer Flask	Dishwashing Liquid
Reaction tray	Potassium Iodide
Gloves	Safety Glasses
30% Hydrogen Peroxide	100 mL Graduated Cylinder
Food coloring	

## Safety

30% Hydrogen Peroxide is a strong oxidizer and very corrosive to the eyes, nose, throat and lungs. Contact with any type of combustables may cause fire. Contact with skin will cause burns. Getting it in the eyes can cause irreversible eye damage including blindness. Always wear gloves and safety goggles when working with this material. Potassium Iodide is a potential skin and eye irritant.

## Procedure

The reaction should be run on a large reaction tray, which can withstand high temperatures. The tray should be covered with a garbage bag as iodine produced in the foam may stain the floors and table. Carefully pour out 80 mL of 30% hydrogen peroxide into a graduated cylinder. Take the empty 2 L Erlenmeyer flask and carefully pour in the measured 80 mL of hydrogen peroxide. Add about 30 mL of dishwashing liquid. It is not necessary to mix. Add about ten drops of food coloring. In one quick action swiftly add 15 grams of KI and quickly move your hand from the opening of the flask.

## Discussion

This is an eye-catching demonstration which produces large quantities of foam which shoot out of the flask 2-3 feet into the air. Immediately after adding the KI the flask will heat up and become hot to the touch. Foam will shoot out of the flask and continue oozing out of the flask for about one minute. This reaction is similar to Chemical Transformation I, where we used  $\text{MnO}_2$  to catalyze the decomposition of hydrogen peroxide. In this reaction we changed the catalyst to KI and also added dishwashing liquid to our reaction vessel. The dishwashing liquid complexes with some of the  $\text{O}_2$  gas produced in the decomposition resulting in a foaming action rather than the giant cloud of condensed water vapor we saw in Chemical Transformation I. This is another great demonstration to illustrate the effect of the breakdown of  $\text{H}_2\text{O}_2$  to  $\text{H}_2\text{O}$  and  $\text{O}_2$ :



KI catalyzes the decomposition of hydrogen peroxide to oxygen and water. Since KI is a catalyst it is not consumed in the reaction.

Normally the activation energy for this reaction without any catalyst is around 75 KJ/mole (Moelwyn-Hughes). With the addition of KI we can actually lower this activation energy down to around 56 KJ/mole (Moelwyn-Hughes) and speed up the decomposition by about 2439 times at 20°C.

The calculations are simple using the Arrhenius equation:

$$k = A e^{-[E_a/RT]}$$

where  $E_a$  = activation energy in Joules/mole,

R = universal gas constant 8.3145 Joules/K-mole

T = absolute temperature in Kelvin (K) and A = collision frequency factor

$$k_{\text{catalyzed}} = A e^{-56,000/8.3145 \times 293}$$

$$k_{\text{uncatalyzed}} = A e^{-75,000/8.3145 \times 293}$$

$$k_{\text{catalyzed}} / k_{\text{uncatalyzed}} = e^{19,000/8.3145 \times 293} = 2439$$

The rate constant of the catalyzed v. uncatalyzed has increased by 2439 times.

Therefore, the rate of catalyzed is 2439 times the rate of the uncatalyzed.

## Disposal

The contents in the 2L flask is primarily foam which contains the catalyst KI that is not used up in the reaction. The reaction flask contents and any leftover solutions or solids should be combined into a properly labeled waste container. Dispose of following all local, state and federal regulations for disposal.

## References

L. R. Summerlin and J. L. Ealy, Jr. *Chemical Demonstrations, A Sourcebook for Teachers*, Washington D. C., **1985**, p. 71.

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Raymond Chang, *Chemistry*, McGraw Hill Publishers, 9<sup>th</sup> Edition, **2007**, p. 571.

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