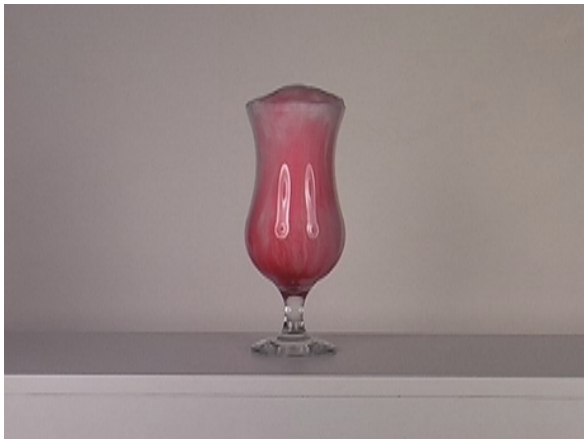
Strawberry Ice Cream



Equipment:

ice glass cup
measuring cylinders
Pasteur pipettes
empty mineral water bottle or 50-mL beaker
(optional: food grater
200-mL Erlenmeyer flask
cheese cloth or cotton tea filter
beaker)
wooden splint
lighter

Chemicals:

hydrogen peroxide solution (30 % w/w)
catalase solution (1 % w/w) or crude potato extract
(optional: peeled raw potato
deionized water
crushed ice)
red food dye
transparent dishwashing liquid
egg

Safety:

hydrogen peroxide solution (H_2O_2):

H302, H318
P102, P280, P305 + P351 + P338, P301 + P312, P501

Concentrated hydrogen peroxide solution causes severe skin burns and eye damage. Therefore, it is necessary to wear a lab coat, safety goggles and protective gloves. It is highly recommendable to work in a fume hood. Of course, you should never fill chemicals into beverage bottles in the laboratory. The only exceptions are chemical shows.

Procedure:

Preparation: If no catalase solution is available crude potato extract can be used instead: Approx. 20 g of a peeled raw potato are finely grated by means of a food grater. The paste is scraped into a 200-mL Erlenmeyer flask and 25 mL of ice-cooled deionized water are added. The flask is swirled in intervals for about 15 min. Subsequently, the suspension is filtered through a sheet of cheese cloth or a cotton tea filter into a chilled beaker.
Procedure: Dishwashing liquid, a little bit of egg white, 20 droplets of red food dye and approx. 1 mL of catalase solution are thoroughly mixed in the glass cup. Subsequently, 5 mL of hydrogen peroxide solution are added out of a mineral water bottle or a beaker.

Observation:

A foamy red and white substance rises in the glass cup. The mixture looks like a strawberry sundae. The amounts of the substances needed depend upon the size and shape of the cup; therefore, you have to find out the ideal proportions by "trial and error." The presence of an oxidizing gas such as oxygen can be detected by the glowing splint test.

Explication:

Hydrogen peroxide in aqueous solution exhibits a strong tendency to decompose into water and oxygen (disproportionation):

$$2\ H_2O_2|w \rightarrow 2\ H_2O|l + O_2|g$$

$\Sigma\mu^{\ominus}$: –268.2 > –474.4 kG

$\Longrightarrow$ chemical drive $\mathcal{A}^{\ominus}$: +206.2 kG

Necessary chemical potentials (T = 298 K, p = 100 kPa):

Substance	Chemical potential $\mu^{\ominus}$ [kG]
$H_2O_2\|w$	–134.1
$H_2O\|l$	–237.2
$O_2\|g$	0

The chemical drive of the reaction is positive, i.e. the reaction should take place spontaneously. The decomposition rate at room temperature is, however, immeasurably small. But the rate can be appreciably increased by the addition of a catalyst such as the enzyme catalase (*enzymatic catalysis*). The oxygen generated by the decomposition reaction creates bubbles in the soapy liquid thereby turning it into foam.
The cytoxin hydrogen peroxide is one of the by-products of many cellular reactions. Aerobic cells protect themselves against peroxide by the action of the enzyme catalase. Therefore, catalase is nearly ubiquitous among animal organisms, especially it is found in liver and red blood cells. But catalase also occurs in plant tissues, and is especially abundant in plant storage organs such as potato tubers, corms, and in the fleshy parts of fruits.
The detailed structure of catalase differs from one organism to another, but the general quaternary structure is analogous to hemoglobin in that catalase is tetrameric and each polypeptide chain, composed of more than 500 amino acids, contains an iron-centered porphyrin ring. However, in contrast to hemoglobin, catalase utilizes Fe(III). This iron can formally be oxidized to Fe(V) in the oxidation-reduction cycle responsible for the catalytic activity, but the processes at the active site of the enzyme are not understood very well.

Disposal:

The foamy substance can be disposed of down the drain with running water.