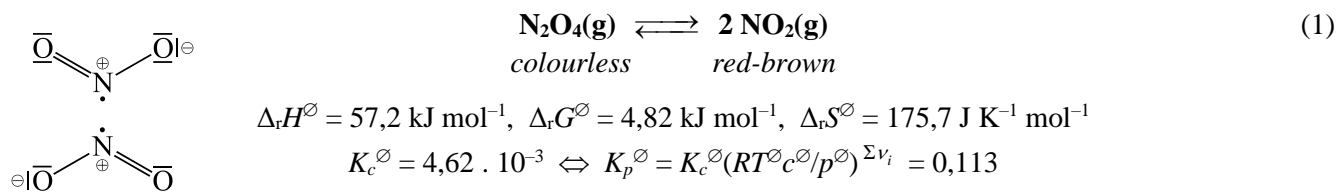


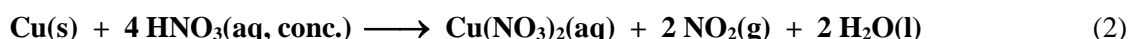
## Influence of temperature on the composition of gaseous mixture

Decomposition of the dimer  $\text{N}_2\text{O}_4$  to the monomer  $\text{NO}_2$  is an endothermic reaction.



With increasing temperature, the dimer decomposes. At atmospheric pressure and temperature  $100^\circ\text{C}$  the mixture contains 90 %  $\text{NO}_2$  and at  $140^\circ\text{C}$  is the dissociation almost 100 %.

In laboratory, we could prepare nitrogen dioxide  $\text{NO}_2$  usually by the reaction of copper with concentrated nitric acid.



### Úloha

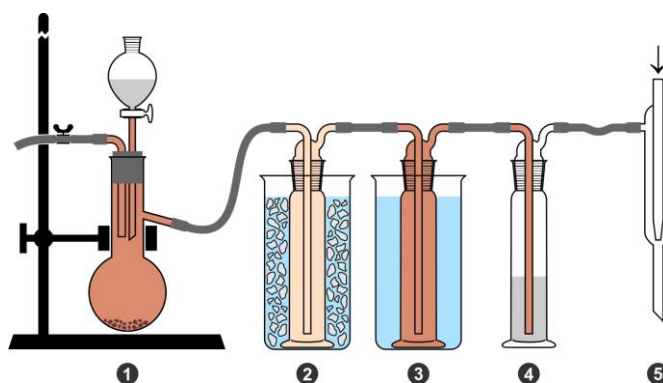
Prepare nitrogen dioxide and observe colour changes of the mixture  $\text{NO}_2 / \text{N}_2\text{O}_4$  depending on temperature.

### Chemikálie

- copper,  $\text{Cu}$ , small pieces or thin wire,
- nitric acid,  $\text{HNO}_3$ , concentrated,  $w(\text{HNO}_3) = 0,65$ ,
- sodium hydroxide,  $\text{NaOH}$ , granules,
- ice bath: mixture ice + water +  $\text{NaCl}$ .

### Postup

**Warning:** The nitrogen oxides eliminating in the reaction are very toxic. Moreover, nitric acid vaporizes forming aggressive fumes with air humidity. Nitrogen oxides must therefore be absorbed in the diluted solution of sodium hydroxide.



- 1 – gas generator = reactor + dropping funnel,  
 2 – beaker with ice and  $\text{NaCl}$ ,  
 3 – beaker with hot water,  
 4 – absorber = washing bottle with  $\text{NaOH}$  solution,  
 5 – water pump.

Set up an apparatus according to the figure, consisting of gas generator ① Do not forget to close the safety valve on the tube leading from the fraction flask. Using rubber tubes connect two empty washing bottles ② and ③ located in big beakers. At the end of the apparatus connect gas absorber ④ containing 3 g of sodium hydroxide dissolved in  $30 \text{ cm}^3$  of water. Absorber must be connected to a water pump to remove unreacted nitrogen oxides.

Add 3 g of copper to a fraction flask and  $10 \text{ cm}^3$  of concentrated nitric acid to a dropping funnel. Drop slowly concentrated nitric acid from the dropping funnel to the fraction flask. The red-brown nitrogen oxide starts to generate. When both washing bottles are filled up with red-brown gas, open slightly the screw clamp on the gas generator.

Add an ice mixture (ice +  $\text{NaCl}$ ) to the first beaker ②. Pour slowly boiling water into the second bottle. Colour of gas in both bottles should differ in a while.

When the experiment is finished, open fully the screw clamp and switch on the water pump. Toxic gas will be removed from the apparatus through the absorber. Wash unreacted copper with plenty of water and dry it with piece of filter paper.