**The Belousov-Zhabotinsky Oscillating Reaction**

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The oscillation reactions are among the most challenging and fascinating chemical reactions. You can identify them as the concentration of the reactants and products of the mixture periodically changes with time. Hence, they are not moving evenly towards their final concentration. In some of these reactions, you may observe a continuous sequence of colour change. In the others, the mixture systematically gives out gas, fizzing and bubbling. All of these chemical reactions occur under the conditions far from equilibrium. The second common feature of the oscillation reactions is that they involve autocatalysis, meaning the product of the reaction step acts as the catalyst for it, speeding up the reaction without getting used up. The scientists were intrigued by the complexity of the oscillation reactions, immersed into studying them and producing new models.

The classic modern model of the oscillating reaction is Belousov-Zhabotinsky reaction, where potassium bromate, malonic acid and manganese (Ⅱ) sulfate -1-water are the reagents. If these components are mixed, then the colour of the solution changes between colourless and red until the reagents are consumed. Manganese (Ⅱ) sulfate -1-water acts as a catalyst in this reaction.

The catalyst ion is most often cerium, but it can also be manganese, or complexes of iron, ruthenium, cobalt, copper, chromium, silver, nickel and osmium.

The overall reaction is:

$$3\ CH_2(COOH)_2(aq) + 4\ BrO_3\text{-}(aq) \rightarrow 4Br{-}(aq) + 9CO_2\,(g) + 6H_2O(l)$$

The oxidation of the malonic acid by the bromate(V) ions is **catalysed** by manganese (II) ions, and the manganese (III) ions are produced as intermediates.

The red colour is thought to be due to the existence of $Mn^{3+}$ ions which are known to be red/purple in colour or the bromate (Ⅴ) ions. The full mechanism is highly complex and not well understood and have been studied over the past 30 years or so.

The simplified mechanism of the reaction is:

$$Br\text{-}\,(aq) + BrO_3\text{-}\,(aq) + 2H^+(aq) \rightarrow HBrO_2(aq) + HBrO(aq)$$

$$Br\text{-}\,(aq) + HBrO(aq) + H^+(aq) \rightarrow Br_2\,(aq) + H_2O\,(l)$$

**References**

[1] Belousov-Zhabotinsky reaction by G. Dupuis and N. Berland, *Encyclopedia of Nonlinear Science* NL 3600, ed. Alwyn Scott, Taylor and Francis New-York (2004).
[2] Belousov–Zhabotinsky reaction, https://en.wikipedia.org/wiki/Belousov%E2%80%93Zhabotinsky_reaction