Briggs-Rauscher reaction

The skeleton of the global process of the Briggs-Rauscher reaction is as follows:

1. As soon as the solutions are mixed, iodate ion is reduced by hydrogen peroxide to produce iodous acid (HIO_2):

   $HIO_3 + H_2O_2 \rightarrow HIO_2 + O_2 + H_2O$

2. The **radical process (amber)** starts, producing hydroperoxide radicals ($HOO\cdot$) and, ultimately, hypoiodous acid (HIO):

   $IO_3^- + HIO_2 + H^+ \rightarrow 2IO_2\cdot + H_2O$

   $IO_2\cdot + Mn^{+2} + H_2O \rightarrow HIO_2 + Mn(OH)^{+2}$

   $Mn(OH)^{+2} + H_2O_2 \rightarrow Mn^{+2} + HOO\cdot + H_2O$

   $2HOO\cdot \rightarrow O_2 + H_2O_2$

   $2HIO_2 \rightarrow IO_3^- + H^+ + HIO$

3. The hypoiodous acid follows two different pathways, one of which results in iodine:

   3.a $HIO + H_2O_2 \rightarrow I^- + O_2 + H^+ + H_2O$

   3.b $HIO + I^- + H^+ \rightarrow I_2 + H_2O$

4. Iodine reacts <u>slowly</u> with malonic acid, according to the following equation:

   $I_2 + CH_2(CO_2H)_2 \rightarrow ICH(CO_2H)_2 + H^+ + I^-$

5. [HIO], [I_2], [I^-] increase significantly since:

   $IO_3^- + 2H_2O_2 + H^+ \rightarrow HIO + 2O_2 + 2H_2O$

is faster than:

   $I^- + HIO + H^+ \rightarrow I_2 + H_2O$

and than:

   $I_2 + CH_2(CO_2H)_2 \rightarrow ICH(CO_2H)_2 + H^+ + I^-$

6. As [I^-] increases, the reaction:

   $HIO_2 + I^- + H^+ \rightarrow 2HIO$

becomes faster than:

   $IO_3^- + HIO_2 + H^+ \rightarrow 2IO_2\cdot + H_2O$

   $IO_2\cdot + Mn^{+2} + H_2O \rightarrow HIO_2 + Mn(OH)^{+2}$

7. The radical process, therefore, stops and the excess of HIO from the reaction in Step 5 is consumed in the following **non-radical reactions (blue)**:

   $I^- + HIO + H^+ \rightarrow I_2 + H_2O$

   $I_2 + CH_2(CO_2H)_2 \rightarrow ICH(CO_2H)_2 + H^+ + I^-$

8. When [I^-] is sufficiently low, the reactions:

   $IO_3^- + HIO_2 + H^+ \rightarrow 2IO_2\cdot + H_2O$

   $IO_2\cdot + Mn^{+2} + H_2O \rightarrow HIO_2 + Mn(OH)^{+2}$

become faster than:

$HIO_2 + I^- + H^+ \rightarrow 2\ HIO$

and the **radical process (amber)** starts once again**.**

9. The sequence continues until the whole iodate anion and all the malonic acid have completely reacted.

This document is supporting material for the following article:

Farusi G (2009) Looking for antioxidant food. *Science in School* **13**: 39-43.
www.scienceinschool.org/2009/issue13/antioxidants