proceeds by simultaneous bimolecular and termolecular reaction paths:

$$-d(Fe^{II})/dt = k_b(Fe^{II})P_{O2} + k_t(Fe^{II})^2P_{O2}.$$

At 159°, $k_b = 1.93 \times 10^{-3}$ atm $^{-1}$ sec. $^{-1}$, $k_t = 1.60 \times 10^{-3}$ M^{-1} atm $^{-1}$ sec $^{-1}$; the respective activation energies were measured as 13.4 (±2) and 16.3 (±2) kcal. At 30.5°, only the termolecular path is observed (contrary to the predictions of the high temperature activation energies);

$k_t = 2.78 \times 10^{-6}$ M^{-1} atm $^{-1}$ (1 F H_2SO_4).

The variation of rate with SO_4^- indicates independent reactions,

$2\ Fe^{++} + O_2 \xrightarrow{(1/2)k_u} 2\ Fe^{III} + H_2O_2$, and

$FeSO_4 + Fe^{++} + O_2 \xrightarrow{(1/2)k_s} 2\ Fe^{III} + H_2O_2$, where

$k_u = 1.4 \times 10^{-6}$ $k_s = 3.1 \times 10^{-5}$ M^{-1} atm $^{-1}$ sec $^{-1}$, and

$K_{FeSO_4} = 1.1$ M^{-1}.

The reaction rate increases a small amount with increasing pH. Catalysis by Cu^{++} follows the rate law $-d(Fe^{++})/dt = 4k_9(Fe^{II})(Cu^{++})$ and is probably initiated by

$$Fe^{II} + Cu^{++} \xrightarrow{k_9} Fe^{III} + Cu^{I}.$$

In 0.23 F H_2SO_4, 0.35 F Na_2SO_4, $k_9 = 1.9 \times 10^{-3}$ M^{-1} sec $^{-1}$.

The rate-determining step for the bimolecular path is presumably either:

$$(1a)\ Fe^{II} + O_2 \rightarrow Fe^{III} + HO_2, \text{ or}$$
$$(1b)\ Fe^{II} + O_2 \rightarrow Fe^{IV} + H_2O_2;$$

for the termolecular path it is $2\ Fe^{II} + O_2 \rightarrow 2\ Fe^{III} + H_2O_2$.

There is evidence that the bimolecular path, the termolecular path and the Cu^{++} catalyzed path are all accelerated by complexing anions, X, and to an extent depending on the affinity of X for Fe^{+++}. Furthermore, strong complexers favor the occurrence of the bimolecular path."