

## IUPAC Task Group on Atmospheric Chemical Kinetic Data Evaluation – Data Sheet I.A4.89 SO<sub>x</sub>18

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$$\Delta H^\circ(1) = -44 \text{ kJ}\cdot\text{mol}^{-1}$$

$$\Delta H^\circ(2) = -154 \text{ kJ}\cdot\text{mol}^{-1}$$

### Low-pressure rate coefficients Rate coefficient data

$k_{01}/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp./K	Reference	Technique/ Comments
<i>Absolute Rate Coefficients</i>			
$1 \times 10^{-12}$ at 70 Torr [N <sub>2</sub> ]	247-299	Hynes et al., 1988	PLP-LIF (a)
$6 \times 10^{-13}$ at 30 Torr [N <sub>2</sub> ]	259-318	Murrells et al., 1990	PLP-LIF (b)
$5.0 \times 10^{-32}$ [He]	298	Diau and Lee, 1991	PLP-LIF (c)
$8.9 \times 10^{-32}$ [He]	269		
$14.7 \times 10^{-32}$ [He]	249		

### Comments

- Photolysis of H<sub>2</sub>O<sub>2</sub> at 248 nm in mixtures of CS<sub>2</sub> and He, N<sub>2</sub>, air, or O<sub>2</sub>. Pressure range 87-920 mbar.
- Photolysis of H<sub>2</sub>O<sub>2</sub> at 248 nm or 266 nm in mixtures of CS<sub>2</sub> and He-N<sub>2</sub> or He-SF<sub>6</sub> mixtures. Pressure range 12-80 mbar. The effect of O<sub>2</sub> (0.7 - 20 mbar) on the rate coefficient was studied.
- Photolysis of H<sub>2</sub>O<sub>2</sub> at 248 nm in mixtures of CS<sub>2</sub> and added He or Ar (limited data set). Pressure range 12-360 mbar of Ar or He. Effect of CS<sub>2</sub> on the rate coefficient was studied.

### Preferred Values

$k_{01} = 1 \times 10^{-30}$  [N<sub>2</sub>] cm<sup>3</sup> molecule<sup>-1</sup> s<sup>-1</sup>, independent of temperature over the range 250-320 K.

#### Reliability

$$\Delta \log k_{01} = \pm 0.5.$$

#### Comments on Preferred Values

Because of the low thermal stability of HOCS<sub>2</sub>, experimental studies have to account for the re-dissociation of the adduct, in which the HO is thought to be bound to sulphur (McKee and

Wine, 2001). The preferred values are based on a combination of the data for  $M = N_2$  from Hynes et al. (1988) and Murrels et al. (1990), with a falloff representation (see below). The data and a falloff representation indicates that the low pressure limit is approached within 10% only at pressures below about 27 mbar (20 Torr). The strong temperature dependence ( $E/R = -1610$  K) of  $k_{01}$  for  $M = He$  derived in Diau and Lee (1991) is not consistent with the results from Hynes et al. (1998) in He, or Murrels et al. (1990) in  $N_2$ . Hynes et al. (1998) do however report a strong temperature dependence at  $680 \pm 20$  Torr  $N_2$  or  $O_2$  or air ( $k = 6.9 \times 10^{-14} \exp(1150/T) \text{ cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$ ). It appears that reaction (2) is slow, with a rate coefficient of  $k_2 < 2 \times 10^{-15} \text{ cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$  at 298 K (see below).

### High-pressure rate coefficients Rate coefficient data

$k_{\infty 1}/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp./K	Reference	Technique/ Comments
<i>Absolute Rate Coefficients</i>			
$5.8 \times 10^{-12}$ at 0.91 bar [ $N_2$ ]	250-270	Hynes et al., 1988	PLP-LIF (a)
$3.1 \times 10^{-12}$ at 0.88 bar [ $N_2$ ]	297		
$1.9 \times 10^{-12}$ at 150 Torr [Ar]	209	Bulatov et al., 1988	PLP-LIF (b)
$1.3 \times 10^{-12}$ at 1.01 bar [air]	295	Becker et al., 1990	PLP-LIF (c)

### Comments

- (a) See comment (a) for  $k_0$ .
- (b) Mixtures of  $O_2$ - $H_2O$ - $CS_2$ -Ar. The rates of  $HOCS_2$  formation and decomposition were measured, with an equilibrium constant of  $K_c = 2.6 \times 10^{-17} \text{ cm}^3 \text{ molecule}^{-1}$ .
- (c)  $H_2O_2$  was photolysed at 248 nm in mixtures of  $CS_2$  and  $N_2$ - $O_2$  or Ar- $O_2$ . The partial pressure of  $O_2$  was in the range 0.32-1013 mbar, at a total pressure of 1.01 bar. The rate coefficient was found to increase further when more  $O_2$  was added, with a value of  $2.79 \times 10^{-12} \text{ cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$  obtained at 996 mbar  $O_2$ .

### Preferred Values

$k_{\infty 1} = 2.5 \times 10^{-11} \text{ cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$ , independent of temperature over the range 250-300 K.

### Reliability

$\Delta \log k_{\infty 1} = \pm 0.5$  over the temperature range 250-300 K.

### Comments on Preferred Values

The preferred rate coefficient  $k_{\infty 1}$  is based on a falloff representation of the data from Hynes et al. (1988) and Murrels et al. (1990). The largest weight is given to the measurements near 250-260 K where decomposition of the adduct and the subsequent kinetics are of comparably minor influence in contrast to the room temperature experiments. A falloff curve with an estimated value of  $F_c = 0.44$  was employed for extrapolation (Cobos and Troe, 2003). Experiments at 1 bar total pressure are apparently still far below the high pressure limit. An extensive discussion of the complicated mechanism is given in Hynes et al. (1988), Murrels et al. (1990), Lovejoy et al.

(1990) and McKee and Wine (2001). Rate expressions combining adduct formation, dissociation, and subsequent reaction with O<sub>2</sub> have been proposed which are not reproduced here (see also data sheets on HOCS<sub>2</sub> + M and HOCS<sub>2</sub> + O<sub>2</sub>). More experiments separating the individual steps are required, as are temperature dependent studies at low pressures.

The following text-line combines the preferred values for the high and low pressure limiting rate coefficients to generate a single, cut-and-paste expression for calculation of *k*:

$$=((1e-30)*M*(2.5e-11))/((1e-30)*M+(2.5e-11))*10^{(\log_{10}(0.44)/(1+(\log_{10}((1e-30)*M/(2.5e-11))/(0.75-1.27*\log_{10}(0.44))))^2)}$$

The molecular density,  $M = 7.243 \times 10^{21} P(\text{bar})/T(\text{K})$

### Rate coefficient data *k*<sub>2</sub>

<i>k</i> <sub>2</sub> /cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	Temp./K	Reference	Technique/ Comments
<i>Absolute Rate Coefficients</i>			
<9.9 x 10 <sup>-15</sup>	251	Wine et al., 1980	FP-RF
<1.5 x 10 <sup>-15</sup>	297		
<1.6 x 10 <sup>-15</sup>	363		
≤2 x 10 <sup>-15</sup>	299	Murrells et al., 1990	PLP-LIF
<3 x 10 <sup>-15</sup>	330	Lovejoy et al., 1990	DF-LMR (a)

### Comments

- (a) Based on the observed HS radical yield of <50% of the HO radicals consumed and a total HO radical loss rate coefficient of 6 x 10<sup>-15</sup> cm<sup>3</sup> molecule<sup>-1</sup> s<sup>-1</sup>.

### Preferred Values

*k*<sub>2</sub> < 2 x 10<sup>-15</sup> cm<sup>3</sup> molecule<sup>-1</sup> s<sup>-1</sup> at 298 K.

#### Comments on Preferred Values

The upper limit to the preferred value for *k*<sub>2</sub> is based on the absolute rate coefficient studies of Wine et al. (1980) and Murrells et al. (1990), and is consistent with the study of Lovejoy et al. (1990) in which HS radical formation and HO radical decays were measured.

### References

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