Supporting Information for:

A Continuous Flow Generator of Organic Hypochlorites for the Neutralization of Chemical Warfare Agent Simulants

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1. Continuous flow setups

1.1. Microfluidic setup parts

All microfluidic setups were assembled with commercially available parts.

1.1.1. Pumps

ThalesNano microHPLC® pumps (wetted parts: SS 316, ruby and sapphire) or Chemyx Fusion 6000® High Force syringe pumps equipped with stainless steel syringes (6 or 20 mL) with Dupont™ Kalrez® Spectrum™ AS-568 O-rings (0.549 x 0.103”) were utilized to handle the liquid feeds.

1.1.2. PFA tubing and coils

PFA coil reactors and collection lines were constructed from PFA tubing (high purity PFA; 1.58 mm outer diameter, 750 µm internal diameter).

1.1.3. Connectors, ferrules and mixers

Connectors, ferrules and mixers were purchased from IDEX/Upchurch (details in Table S1).

1.1.4. Back-pressure regulators

A dome-type BPR from Zaiput Flow Technologies (BPR-10) connected to a compressed gas cylinder (nitrogen) was utilized to set the working pressure.

1.1.5. Check-valves

Check-valves (IDEX/Upchurch Scientific) were inserted between the pumps and the reactor.

1.1.6. Liquid-liquid membrane separator

The in-line liquid-liquid separator was obtained from Zaiput Flow Technologies (SEP-10) and equipped with a hydrophobic membrane (1 µm pore size).

1.2. Mesofluidic setup parts

1.2.1. Pumps

The liquid feeds were handled with Chemyx Fusion 6000® High Force syringe pumps equipped with stainless steel syringes (6 or 20 mL) with Dupont™ Kalrez® Spectrum™ AS-568 O-rings (0.549 x 0.103”).

1.2.2. Mesofluidic reactor

The flow reactor setups were manufactured by Corning SAS. The experiments relied on a Corning® Advanced-Flow™ Lab Reactor (2 fluidic module, 2.7 mL internal volume for each module, 5.4 mL total internal volume).

1.2.3. Thermoregulatory devices

The reactor was maintained at reaction temperature with a LAUDA Integral XT 280 thermostat (THERM 180 thermofluid).

1.3. Summary of part numbers & vendors

Standard fluidic elements and connectors were purchased from IDEX/Upchurch Scientific or from Swagelok (Table S1).

Table S1. Connectors, ferrules and unions

Item	Details	Vendor	Reference
Connectors	One-Piece Fingertight, PEEK, 10-32 Coned, for 1/16” OD	IDEX/ Upchurch Scientific	F-120X
	Super Flangeless Nuts, natural PEEK 1/4-28 thread for 1/16” OD tubing	IDEX/ Upchurch Scientific	P-255X
	Super Flangeless Ferrule Tefzel (ETFE) and SS ring 1/4-28 thread for 1/16” OD tubing	IDEX/ Upchurch Scientific	P-259X
Union	Natural polypropylene standard low pressure union 1/4-28	IDEX/ Upchurch Scientific	P-620
Mixer	Arrow-head, natural PEEK 1/4-28 thread for 1/16" o.d. tubing, 0.02" through hole	IDEX/ Upchurch Scientific	P-712
Check-valve	Check-valve inline cartridge 1.5 psi	IDEX/ Upchurch	CV-3001

		Scientific	
Dome-type BPR	Dome-type BPR, metal-free, with adjustable set point	Zaiput Flow Techn.	BPR-10
Membrane separator	Liquid-liquid membrane separator	Zaiput Flow Techn.	SEP-10
Tubing	High-purity PFA tubing, 1.58 mm outer diameter, 750 µm internal diameter	VICI (Valco Ins. Co. Inc.)	JR-T-4002-M25
	High-purity 1/8” and 1/4” PFA tubing, including appropriate PFA connections	Swagelok	PFA-T2-030-100 PFA-T4-047-100,

1.4. Detailed schemes for continuous flow setups

1.4.1. Continuous flow generation of organic hypochlorites (microfluidic setup)

See manuscript for experimental details.

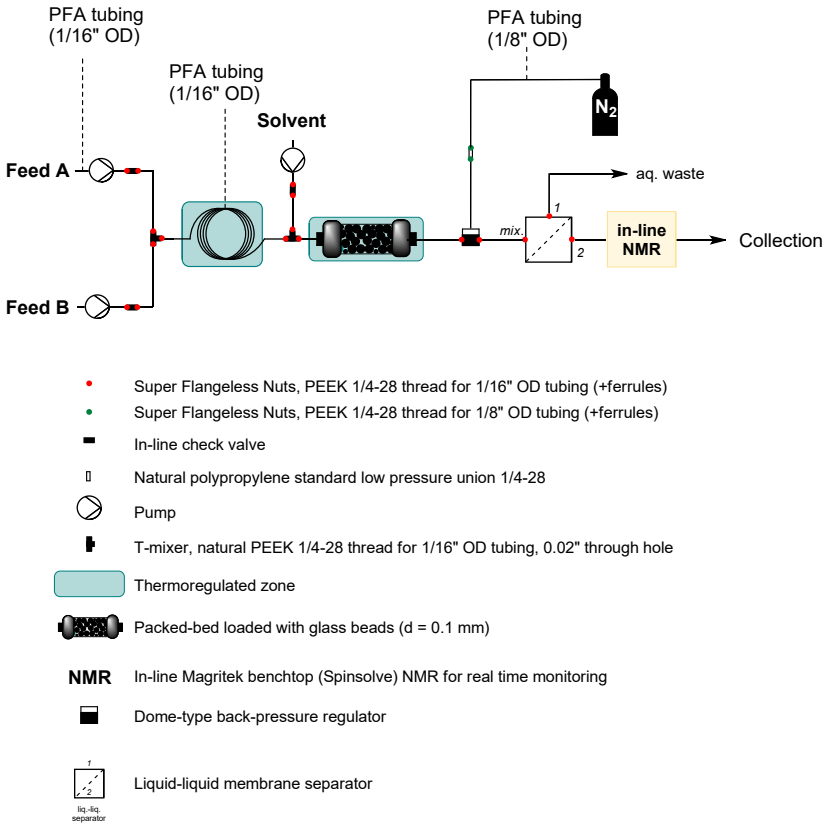


Figure S1. Detailed setup for the continuous flow preparation of organic hypochlorites.

1.4.2. Continuous flow setup dedicated to the oxidation (neutralization) of thioethers (or CWA simulants)

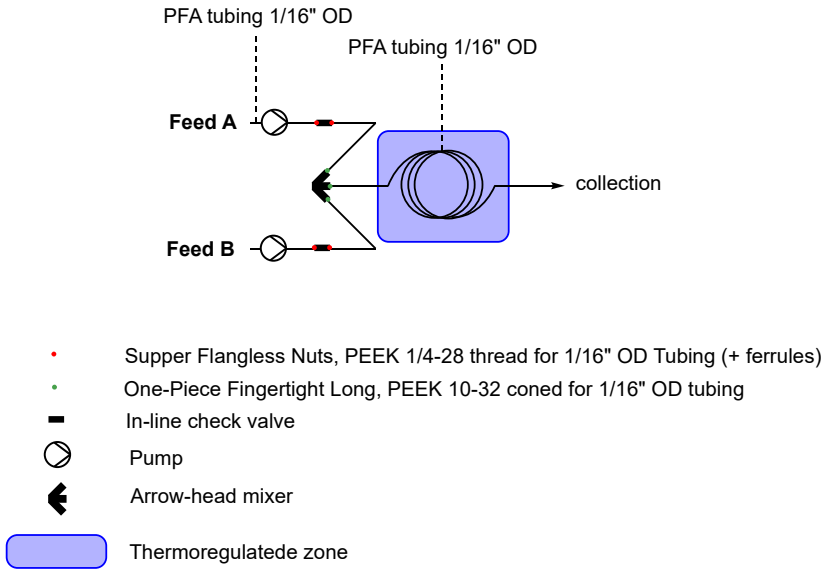


Figure S2. Detailed setup for the continuous flow oxidation of thioethers.

1.4.3. Mesofluidic neutralization of CWA simulants (Lab scale)

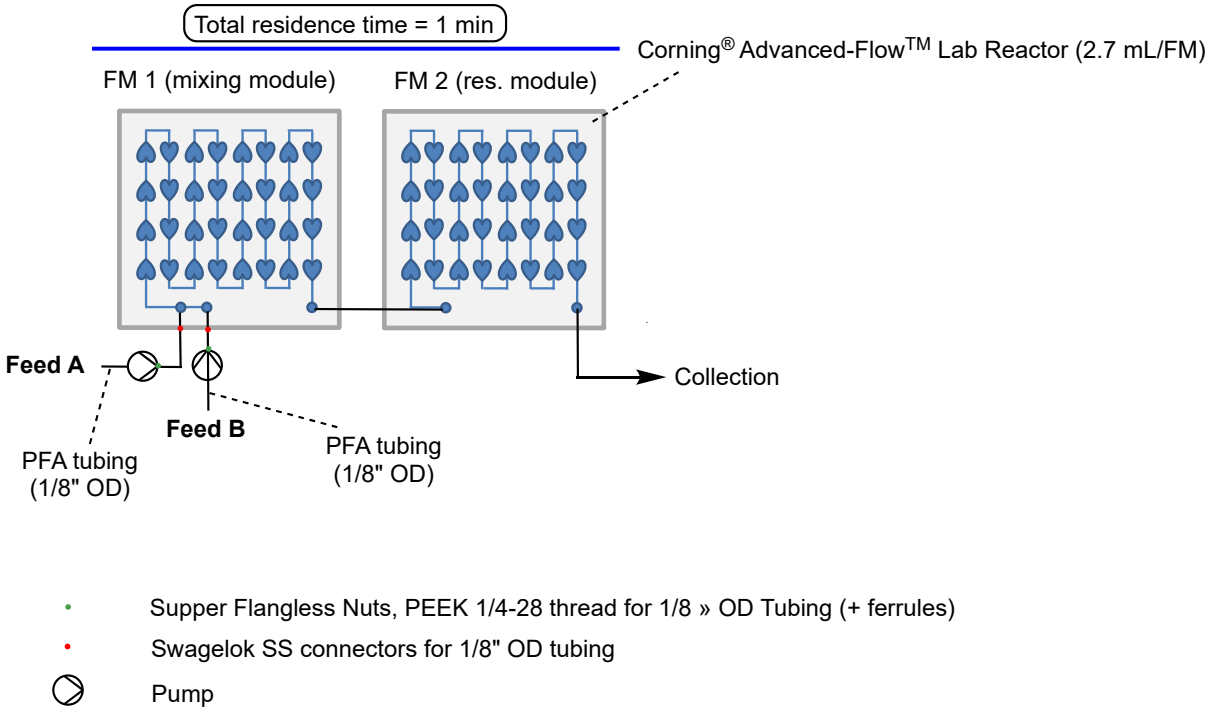


Figure S3. Detailed continuous flow setup for the neutralization of CWA simulants (Lab scale).

2. Additional experimental details

2.1. Chemicals

Chemicals, purities, CAS numbers and suppliers are provided in Table S2.

Table S2. Solvents, chemicals and suppliers

Solvents	Purity (%)	CAS number	Supplier
Methanol	>99	67-56-1	VWR
Ethanol	99	64-17-5	VWR
Isopropanol	99	67-63-0	VWR
Tert-butanol	99	75-65-0	Across
MTBE	>99	1634-04-4	VWR
Acetonitrile	≥99.8%	75-05-8	VWR
Dichloromethane	≥99.5%	75-09-2	VWR
Chemicals	Purity (%)	CAS number	Supplier
Thioanisole (methyl phenyl sulfide)	>99%	100-68-5	TCI
Thioanisole sulfoxide (methyl phenyl sulfoxide)	>98%	1193-82-4	TCI
Thioanisole sulfone (methyl phenyl sulfone)	>97%	3112-85-4	TCI
Dipropyl sulfide	>98%	111-47-7	TCI
Dipropyl sulfone	>99%	598-03-8	TCI
Diphenyl sulfide	>98%	139-66-2	TCI
Diphenyl sulfoxide	>99%	945-51-7	TCI
Diphenyl sulfone	>99%	127-63-9	TCI
Dibenzothiophene sulfide	98%	132-65-0	Alfa Aesar
Dibenzothiophene sulfone	>98%	1016-05-3	TCI
2-Chloroethylethyl sulfide	>98%	693-07-2	TCI
2-Chloroethylethyl sulfone	95%	25027-40-1	Sigma Aldrich
Ethyl vinyl sulfide	>93%	627-50-9	TCI
Ethyl vinyl sulfone	98%	1889-59-4	Sigma Aldrich
Methyl vinyl sulfone	95%	3680-02-2	Alfa Aesar
2-Chloroethylphenyl sulfide	>98%	5535-49-9	TCI
2-Chloroethylphenyl sulfone	98%	938-09-0	abcr
Phenyl vinyl sulfone	99%	5535-48-8	Sigma Aldrich

2.2. Additional details on experimental methods

2.2.1. Details on instrumental methods

Conversion and selectivity were determined by GC-FID or by HPLC-DAD using the following methods:

GC method: The GC-FID oven program consisted of the following steps: a 3 min hold at 40 °C, a 12 °C min^{-1} ramp to 240 °C, and a 1 min hold at 240 °C. The temperature of the injector was set at 250 °C and the temperature of the FID detector was set at 240 °C. Prior to analysis unless specified otherwise, the sample was homogenized, 50 µL of the sample was mixed with 1 mL of MeCN in a 1.5 mL Eppendorf® vial. Conversions and selectivity for compounds **1d** and **CEES** were determined using this method.

HPLC method:

Eluent: A: Water + 0.1% HCOOH (v:v)
B: Acetonitrile
Gradient Table:

Time [min]	A [%]	B [%]
0	100	0
20	20	80
23	20	80
25	100	0
31	100	0

Flow: 1 mL min^{-1}
Injection Volume: 10 µL
Column: C18, 100 × 4.6 mm, 3 µm
Oven Temperature: 40 °C
Diode Array Detector: 180-800 nm

Conversions and selectivity for compounds **1a**, **1b**, **1c** and **CEPS** were determined using this method.

2.2.2. Hypochlorite titration procedure:

Iodometric back-titration with $Na_2S_2O_3$ was used to monitor the exact hypochlorite feed concentration. The thiosulfate solution was standardized against $K_2Cr_2O_7$. The following protocol was used for standardization: 50 g of $Na_2S_2O_3 – 5H_2O$ were dissolved in 1000 mL of water and served as standardized solution (approx. 0.2 M). 0.25 g of $K_2Cr_2O_7$ were accurately weighted and dissolved in 25 mL of deionized water. Then, 10 mL of HCl 3 M and 2 g of KI, were added to the solution and the resulting mixture was stirred for 15 min. The mixture was then diluted with 100 mL of water and 4-5 drops of starch was added as titrating indicator. The resulting solution was titrated with the 0.2 M $Na_2S_2O_3$ solution. This protocol was repeated 3 times to obtain the average concentration of the titrating solution.

The following method was used for the determination of hypochlorite concentration: 4 mL of the hypochlorite solution were added to a mixture containing 15 mL of water, 15 mL of MeCN, 1 mL of HCl (3N), 2 g of KI and 3 drops of starch (used as titrating indicator). The resulting mixture turned black and was vigorously stirred for 5 min in dark before being titrated.

2.2.3. Batch procedure for the synthesis of organic hypochlorites:

54 g (0.32 mol, 1.05 equiv.) of $NaOCl{\cdot}5H_2O$ was dissolved in 150 mL of deionized water and placed under stirring an ice/water bath. The batch reactor was covered with aluminum foil to prevent any degradation. Then, a solution of 0.312 mol (1 equiv.) of R-OH and 58 mL (0.327 mol, 1.05 equiv.) of acetic acid was added to the stirred mixture. The medium was left stirring for 30 min at 0 °C. The organic hypochlorite was extracted with 120 mL of MTBE, washed with 50 mL of aqueous 10% Na_2CO_3 and 50 mL of brine (EtOCl, MeOCl). The resulting organic phase was finally dried over $CaCl_2$.

2.2.4. ^{1}H NMR examination of the hypochlorite exchange between *t*BuOCl and MeOCl

Procedure: 200 mg (6.25 mmol, 1 equiv.) of MeOH were added to 0.6 mL of $CDCl_3$ and placed in a NMR tube. Then 0.67 g (6.25 mmol, 1 equiv.) of ***t*BuOCl** were added in the tube and the resulting medium was mixed for 10 s. ^{1}H NMR experiments were conducted every 10 min for 1 h.

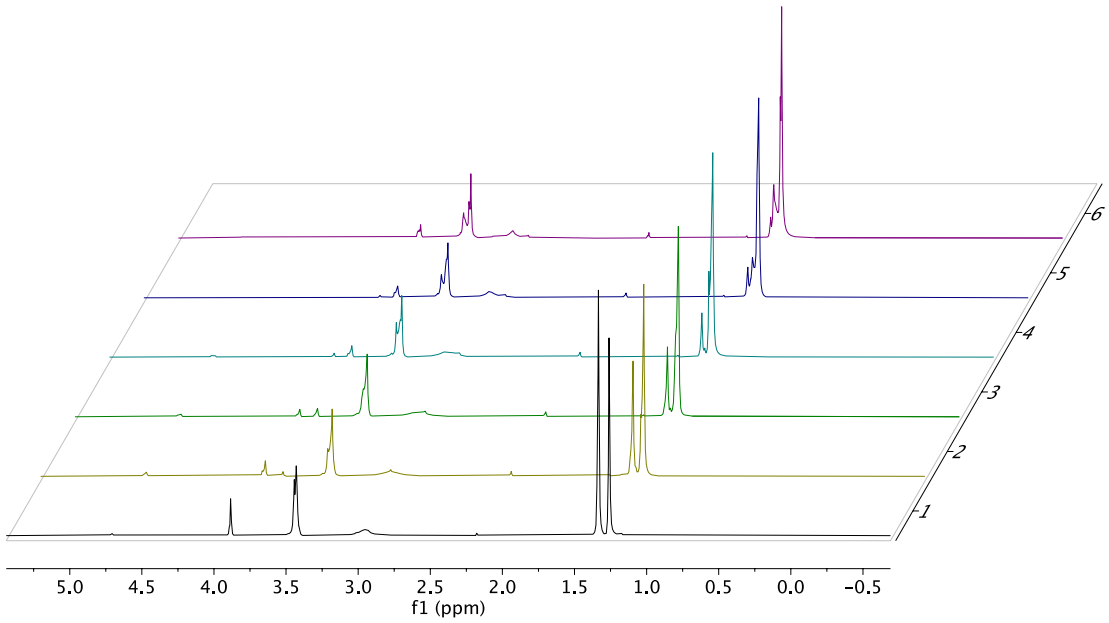


Figure S4. Stacked ^{1}H NMR spectra showing the hypochlorite exchange between ***t*BuOCl** and **MeOCl**. Spectrum 1 was recorded within a few seconds of addition of ***t*BuOCl**. Subsequent spectra were recorded at intervals of 10 min.

3. Detailed data for the reaction optimization using thioanisole (1a)

3.1. Batch experiments

3.1.1. Oxidation of thioanisole (**1a**) with *t*BuOCl performed in MTBE

Procedure: 0.93 mg of thioanisole (**1a**) (7.5 mmol, 1 equiv.) were dissolved in 15 mL of MTBE and placed under stirring at 0 °C in an ice/water bath. Then 0.98 mg of *t*BuOCl (8.25 mmol, 1.1 equiv.) were added dropwise during 15 s to the stirring mixture. Samples were taken at time intervals and were quenched by dilution in pure acetonitrile.

Table S3. Impurity profile and relative conversion and selectivity (%) of each compound after 4 and 40 min of reaction time.

Impurity profile	*4 min (%Area)*	*40 min (%Area)*
1a	31.5	35.9
2a	47.1	31.2
6a	0.9	0.0
3a	3.6	3.8
4a	1.2	1.2
5a	2.9	6.4
7a	0.0	0.0
Others	12.7	21.5

Sample	**Conversion**	**Selectivity**
4 min	68.5%	68.9%
40 min	64.1%	48.6%

3.1.2. Oxidation of thioanisole (**1a**) with *t*BuOCl performed in MTBE with 10% MeOH

Procedure: 0.93 mg of thioanisole (**1a**, 7.5 mmol, 1 equiv.) were dissolved in 13.5 mL of MTBE and 1.5 mL of MeOH. The mixture was placed under stirring in an ice/water bath. Then 0.98 mg of *t*BuOCl (8.25 mmol, 1.1 equiv.) were added dropwise during 15 s to the stirring mixture. Samples were taken at time intervals and were quenched by dilution in pure acetonitrile.

Table S4. Impurity profile and relative conversion and selectivity (%) of each compound after 4 and 40 min of reaction time.

Impurity profile	*4 min (%Area)*	*40 min (%Area)*
1a	23.3	25.5
2a	67.3	64.2
6a	0.8	0.6
3a	7.9	8.9
4a	0.7	0.8
5a	0.0	0.0
7a	0.0	0.0
Others	0.0	0.0

Sample	**Conversion**	**Selectivity**
4 min	76.7%	87.8%
40 min	74.5%	86.2%

3.1.3. Oxidation of thioanisole (1a) with tBuOCl performed in MTBE with 40% MeOH and 1 equivalent of pyridine

Procedure: 0.93 mg of thioanisole (**1a**, 7.5 mmol, 1 equiv.) and 0.59 mL of pyridine (8.25 mmol, 1 equiv.) were dissolved in 7.5 mL of MTBE and 7.5 mL of MeOH. The mixture was placed under stirring in an ice/water bath. Then 0.98 mg of *t*BuOCl (7.5 mmol, 1.1 equiv.) were added dropwise during 15 s to the stirring mixture. Samples were taken at time intervals and were quenched by dilution in pure acetonitrile.

Table S5. Impurity profile and relative conversion and selectivity (%) of each compound after 4 and 40 min of reaction time.

Impurity profile	*4 min (%Area)*	*40 min (%Area)*
1a	20.3	18.5
2a	40.3	29.4
6a	0.8	0.7
3a	4.2	4.9

4a	0.8	0.7
5a	1.8	3.5
7a	0.0	0.0
Others	31.8	42.3

Sample	Conversion	Selectivity
4 min	79.7%	50.6%
40 min	81.5%	36.1%

3.1.4. Oxidation of thioanisole (**1a**) with tBuOCl performed in MTBE with 50% MeOH in presence of 2 equivalents of TEMPO

Procedure: 0.93 mg of thioanisole (**1a**, 7.5 mmol, 1 equiv.) and 2.34 g of TEMPO (15 mmol, 2 equiv.) were dissolved in 7.5 mL of MTBE and 7.5 mL of MeOH. The mixture was placed under stirring in an ice/water bath. Then 0.98 mg of *t*BuOCl (7.5 mmol, 1.1 equiv.) were added dropwise during 15 s to the stirring mixture. Samples were taken at time intervals and were quenched by dilution in pure acetonitrile.

Table S6. Impurity profile and relative conversion and selectivity (%) of each compound after 4 and 40 min of reaction time.

Impurity profile	*4 min (%Area)*	*40 min (%Area)*
1a	20.6	19.5
2a	55.4	57.6
6a	8.1	6.6
3a	0.0	0.0
4a	0.0	0.0
5a	0.0	0.0
7a	0.0	0.0
Others	16.0	16.3

Sample	Conversion	Selectivity
4 min	79.4%	69.7%

40 min	80.5%	71.6%

3.2. Experiments performed under continuous flow conditions

3.2.1. Variations in temperature

Procedure: Feed solutions of thioanisole (**1a**) diluted in MeOH (0.5 M) and *t*BuOCl diluted in MTBE (0.55 M) were both injected at 1.2 mL min^{-1} through a PEEK arrowhead micromixer and reacted in a PFA capillary coil (0.4 mL internal volume) to obtain a residence time 10 s at 25, 0 and -78 °C, respectively. The reactor effluent was diluted in acetonitrile and analyzed by HPLC-DAD.

Table S7. Impurity profile and relative conversion and selectivity (%) of each compound at 0 °C, r.t. and -78 °C.

Impurity profile	*0 °C (%Area)*	*rt (%Area)*	*-78 °C (%Area)*
1a	7.1	20.4	55.5
2a	91.5	78.1	44.5
6a	0.2	0.2	0.0
3a	1.2	1.3	0.0
4a	0.0	0.0	0.0
5a	0.0	0.0	0.0
7a	0.0	0.0	0.0
Others	0.0	0.0	0.0

Sample	**Conversion**	**Selectivity**
Ice bath	92.9%	98.5%
Room temperature	79.6%	98.1%
Dry ice & acetone bath	44.5%	100.0%

3.2.2. Variations in equivalent of tBuOCl

Procedure: Feed solution of thioanisole (**1a**) diluted in MeOH (0.5M) and *t*BuOCl diluted in MTBE (0.75, 1.1 and 2.1 equiv.) were both injected at 1.2 mL min^{-1} through a PEEK arrowhead

micromixer and reacted in a PFA capillary coil (2.4 mL internal volume) to obtain a residence time 60 s at 0 °C. The reactor effluent was diluted in acetonitrile and analyzed by HPLC-DAD.

Table S8. Impurity profile and relative conversion and selectivity (%) of each compound for different equivalency of *t*BuOCl.

Impurity profile	*0.75 equiv. (%Area)*	*1.1 equiv. (%Area)*	*2.1 equiv. (%Area)*
1a	38.3	0.7	0.1
2a	60.4	90.1	30.2
6a	0.0	1.4	6.1
3a	0.8	7.2	25.4
4a	0.0	0.5	37.8
5a	0.0	0.0	0.0
7a	0.0	0.0	0.0
Others	0.6	0.2	0.4

Sample	**Conversion**	**Selectivity**
0.75 equiv	61.7%	97.8%
1.1 equiv	99.3%	90.8%
2.1 equiv	99.9%	30.3%

3.2.3. Variations in concentration

Procedure: Feed solutions of thioanisole (**1a**) diluted in MeOH (0.5, 1 and 2 M) and *t*BuOCl diluted in MTBE (0.55, 1.1 and 2.1 M) were both injected at 1.2 mL min^{-1} through a PEEK arrowhead micromixer and reacted in a PFA capillary coil (2.4 mL internal volume) to obtain a residence time 60 s at 0 °C. The reactor effluent was diluted in acetonitrile and analyzed by HPLC-DAD. Note: the equivalents of tBuOCl were kept at 1.1 equiv with respect to **1a** in each experiment.)

Table S9. Relative conversion and selectivity (%) of each compound for different concentrations of thioanisole **1a** (1.1 equiv of tBuOCl).

Impurity profile	*0.5 M (%Area)*	*1 M (%Area)*	*2 M (%Area)*
1a	0.7	7.7	19.2

2a	90.1	78.5	38.7
6a	1.4	2.9	1.9
3a	7.2	8.6	15.0
4a	0.5	1.7	15.3
5a	0.0	0.0	0.0
7a	0.0	0.0	0.0
Others	0.2	0.7	0.0

Sample	**Conversion**	**Selectivity**
0.5 M	99.3%	90.8%
1 M	92.3%	85.1%
2 M	80.8%	49.3%

3.2.4. Variations in residence time (constant flow rates, variation in internal volumes only)

Procedure: Feed solutions of thioanisole (**1a**) diluted in MeOH (0.5 M) and *t*BuOCl diluted in MTBE (0.55 M) were both injected at 1.2 mL min^{-1} through a PEEK arrowhead micromixer and reacted in a PFA capillary coil (0.4, 1.2 and 2.4 mL internal volume) to obtain residence times of 10, 30 and 60 s, respectively at 0 °C. The reactor effluent was diluted in acetonitrile and analyzed by HPLC-DAD.

Table S10. Impurity profile and relative conversion and selectivity (%) of each compound for different residence times (variations of the reactor length).

Impurity profile	*10 s (%Area)*	*30 s (%Area)*	*60 s (%Area)*
1a	7.1	0.4	0.7
2a	91.5	90.6	90.1
6a	0.2	0.8	1.4
3a	1.2	7.9	7.2
4a	0.0	0.2	0.5
5a	0.0	0.0	0.0
7a	0.0	0.0	0.0

Others	0.0	0.1	0.2

Sample	Conversion	Selectivity
10 s	92.9%	98.5%
30 s	99.6%	90.9%
60 s	99.3%	90.8%

3.2.5. Variation on the flow rate (constant internal volume, variations in residence time only).

Procedure: Feed solutions of thioanisole (**1a**) diluted in MeOH (0.5 M) and *t*BuOCl diluted in MTBE (0.55 M) were both injected at flow rates of 1.2, 0.4 and 0.2 mL min^{-1} through a PEEK arrowhead micromixer and reacted in a PFA capillary coil (0.4 mL internal volume) to obtain residence times of 10, 30 and 60 s, respectively at 0 °C. The reactor effluent was diluted in acetonitrile and analyzed by HPLC-DAD.

Table S11. Impurity profile and relative conversion (%) of each compound for different residence times (variations of the flow rates).

Impurity profile	*1.2 mL/min (%Area)*	*0.4 mL/min (%Area)*	*0.2 mL/min (%Area)*
1a	7.1	18.1	27.8
2a	91.5	80.6	61.0
6a	0.2	0.4	0.3
3a	1.2	0.9	0.7
4a	0.0	0.0	0.0
5a	0.0	0.0	0.0
7a	0.0	0.0	0.0
Others	0.0	0.0	0.0

Sample	Conversion	Selectivity
1.2 mL/min	92.9%	98.5%
0.4 mL/min	81.9%	98.4%
0.2 mL/min	72.2%	83.9%

3.2.6. Variations in solvent used for dilution of **1a**

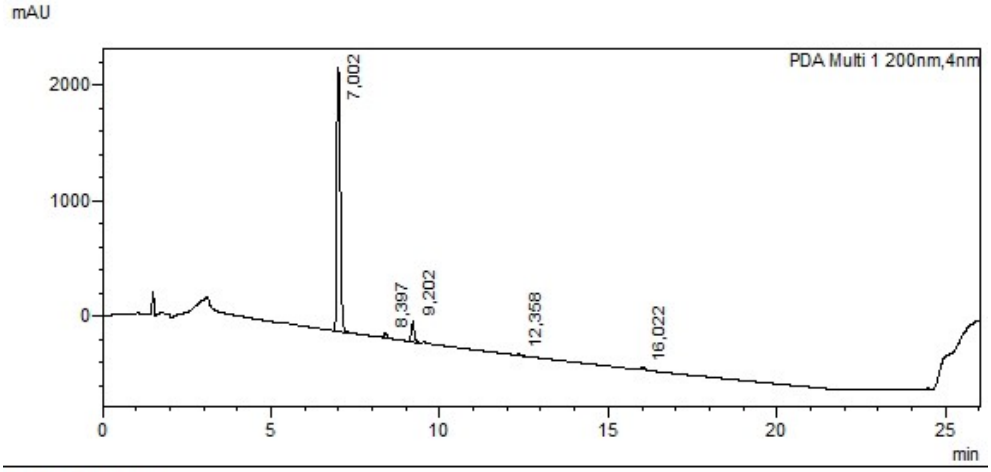
Procedure: Feed solutions of thioanisole (**1a**) diluted in either MeOH, EtOH, *i*PrOH or *t*BuOH (0.5 M) and *t*BuOCl diluted in MTBE (0.55 M) were both injected at 1.2 mL min^{-1} through a PEEK arrowhead micromixer and reacted in a PFA capillary coil (2.4 mL internal volume) to obtain a residence time of 60 s at 0 °C. The reactor effluent was diluted in acetonitrile and analyzed by HPLC-DAD.

Table S12. Impurity profile and relative conversion and selectivity (%) of each compound for different reaction solvent.

Impurity profile	*MeOH (%Area)*	*EtOH (%Area)*	*iPrOH (%Area)*	*tBuOH (%Area)*
1a	0.7	36.8	12.9	34.7
2a	90.1	24.8	64.1	40.7
6a	1.4	5.4	0.0	5.3
3a	7.2	26.8	5.7	10.2
4a	0.5	6.2	1.0	1.5
5a	0.0	0.0	0.1	1.4
7a	0.0	0.0	0.0	0.0
Others	0.2	0.0	16.2	6.1

Sample	**Conversion**	**Selectivity**
MeOH	99.3%	90.8%
EtOH	63.2%	39.3%
iPrOH	87.2%	74.2%
tBuOH	65.3%	62.3%

3.2.7. Representative HPLC chromatogram for the oxidation of **1a**.



<Peak Table>

PDA Ch1 200nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Area%
1	7,002	16725785	2284985	0,000		91,435
2	8,397	261288	46921	0,000		1,428
3	9,202	1034132	173868	0,000		5,653
4	12,358	75870	12599	0,000		0,415
5	16,022	195398	28628	0,000		1,068
Total		18292473	2547001			100,000

Figure S5. HPLC chromatogram of the oxidation of **1a** under the optimized conditions. (Flow rate: 1.2 mL min^{-1}; Residence time: 60 s; Feed solutions: thioanisole (**1a**) 0.5 M in MeOH, and tBuOCl 0.55 M in MTBE.)

3.2.8. Competition experiment

Procedure: A feed solution 0.5 M in each **1a**, **2a**, and **6a** in MeOH and *t*BuOCl diluted in MTBE (0.55 M) were both injected at 1.2 mL min^{-1} through a PEEK arrowhead micromixer and reacted in a PFA capillary coil (2.4 mL internal volume) to obtain a residence time of 60 s. The reactor effluent was diluted in acetonitrile and analyzed by HPLC-DAD.

The results of this experiment were contrasted to those obtained using a feed solution containing only 0.5 M thioanisole (**1a**).

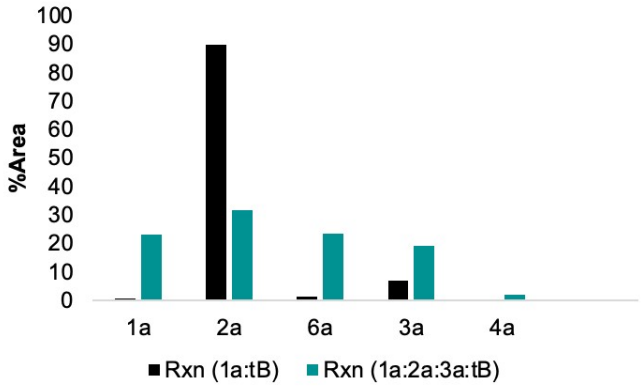


Figure S6. Comparison of the results obtained using a feed 0.5 M in each of **1a**, **2a**, and **6a** with those obtained using a feed solution 0.5 M in only **1a**.

4. Detailed data for the oxidation of other sulfides

4.1. Detailed data for the oxidation of diphenylsulfide (1b)

Conversion, selectivity, and impurity profiles were obtained using HPLC-DAD. The identity of compounds **2b** was determined by comparing the retention time of the commercial compound. The relative conversions were monitored at 235 nm.

Procedure: Feed solutions of diphenylsulfide (**1b**) diluted in MeOH (0.5 M) and *t*BuOCl diluted in MTBE (0.5 M for 1 equiv. and 0.55 M for 1.1 equiv.) were both injected at 0.4 mL min^{-1} through a PEEK arrowhead micromixer and reacted in a PFA capillary coil to obtain a residence time of 60 s at 0 °C. The reactor effluent was diluted in acetonitrile and analyzed by HPLC-DAD.

Table S13. Relative conversion and selectivity for the oxidation of **1b** when using 1 and 1.1 equivalents of *t*BuOCl.

Entry	Equiv. of *t*BuOCl	Conv. (%)	Sel. (%)
1	1	97	99
2	1.1	99	99

4.2. Detailed data for the oxidation of dibenzothiophene (1c)

Conversion, selectivity, and impurity profiles were obtained using HPLC-DAD. The identity of compounds **2c** was determined by comparing the retention time with the commercial compound. The relative conversions were monitored at 240 nm.

Procedure: Feed solutions of dibenzothiophene (**1c**) diluted in MeOH:DCM (0.5 M) and *t*BuOCl diluted in MTBE (0.5 M for 1 equiv. and 0.55 M for 1.1 equiv.) were both injected at 0.4 mL min^{-1} through a PEEK arrowhead micromixer and reacted in a PFA capillary coil to obtain a residence time of 60 s at 0 °C. The reactor effluent was diluted in acetonitrile and analyzed by HPLC-DAD.

Table S14. Relative conversion and selectivity for the oxidation of **1c** when using 1 and 1.1 equivalents of *t*BuOCl.

Entry	Equiv. of *t*BuOCl	Conv. (%)	Sel. (%)
1	1	72	99
2	1.1	99	99

4.3. Detailed data for the oxidation of dipropylsulfide (1d)

Conversion, selectivity, and impurity profiles were obtained using GC-FID. The identity of compounds **1d**, **2d** and **6d** was determined by comparing the retention times of the commercial compounds. The identity of **3d**, **7d** and **8** was determined using GC-MS analysis (see Figure S11).

Procedure: Feed solutions of dipropylsulfide diluted in MeOH (0.5 M) and *t*BuOCl diluted in MTBE (0.55 M) were both injected at 0.4 mL.min^{-1} through a PEEK arrowhead micromixer and

reacted in a PFA capillary coil to obtain a residence time of 60 s at 0 °C. The reactor effluent was diluted in acetonitrile and analyzed by GC-FID.

Table S15. Conversion and selectivity (%) for each compound at 1.1 and 1.2 equivalents of *t*BuOCl.

Impurity profile	*1.1 equiv (%Area)*	*1.2 equiv (%Area)*
1d	2.3	2.2
2d	93.9	87.5
6d	1.8	4.9
3d	1.2	4.4
7d	0.5	0.7
8	0.3	0.4
Others	0.0	0.2

Sample	**Conversion**	**Selectivity**
1.1 equiv	97.7%	96.1%
1.2 equiv	97.8%	89.4%

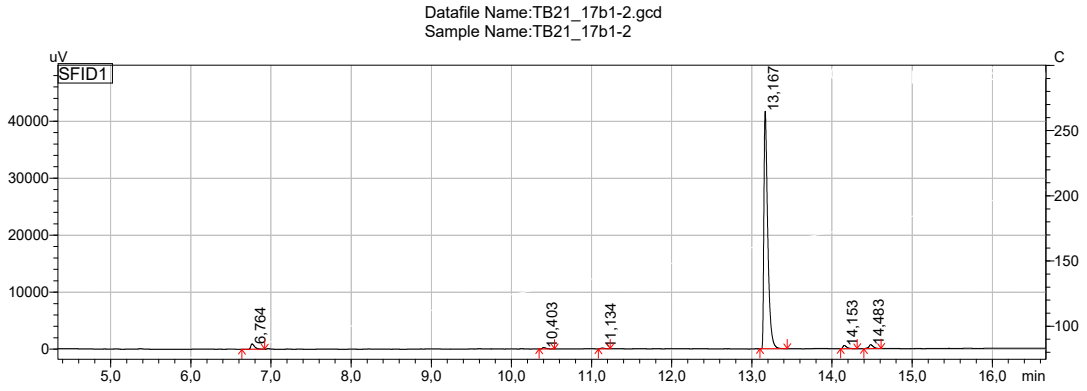


Figure S7. GC-FID chromatogram for the oxidation of **1d** under optimized conditions. (Flow rate: 1.2 mL min^{-1}; Residence time: 60 s; Feed solutions: dipropylsulfide (**1d**) 0.5 M in MeOH, and tBuOCl 0.55 M in MTBE.)

Table S16. Values corresponding to the GC-FID chromatogram for the oxidation of **1d** in Figure S7.

Peak#	Ret. Time	Area	Height	Area%
1	6.764	3351	963	2.258
2	10.403	752	243	0.506
3	11.134	514	142	0.347
4	13.167	139343	41449	93.897
5	14.153	1793	555	1.208
6	14.483	2646	701	1.783
Total		148400	44052	100000

4.4. Detailed data for the neutralization of CEES (microfluidic conditions)

Conversion, selectivity, and impurity profiles were obtained using GC-FID. The identity of compounds **CEES**, **CEESO** and **CEESO2** was determined by comparing the retention times of the commercially compounds. The identity of both diastereomers of **CEESOCl**, and diethylsulfinate **(9)** was determined using GC-MS analysis (see Figure S12).

Procedure: Feed solutions of **CEES** diluted in MeOH (0.5 M) and *t*BuOCl diluted in MTBE (0.55 and 0.6 M) were both injected at 0.2 mL min^{-1} through a PEEK arrowhead micromixer and reacted in a PFA capillary coil (0.4 mL internal volume) to obtain a residence time of 60 s at 0 °C. The reactor effluent was diluted in acetonitrile and analyzed by GC-FID.

Table S17. Impurity profile and relative conversion and selectivity (%) for each compound at 1.1 and 1.2 equivalents of *t*BuOCl.

Impurity profile	*1.1 equiv (%Area)*	*1.2 equiv (%Area)*
CEES	6.7	1.9
CEESO	88.3	89.8
CEESO2	0.0	0.07
CEESOCl	0.2	0.6
CEESOCl (dr)	1.1	2.6
9	0.5	1.3
Others	3.1	3.8

Sample	Conversion	Selectivity
1.1 equiv	93.3%	94.7%

1.2 equiv	98.1%	91.6%

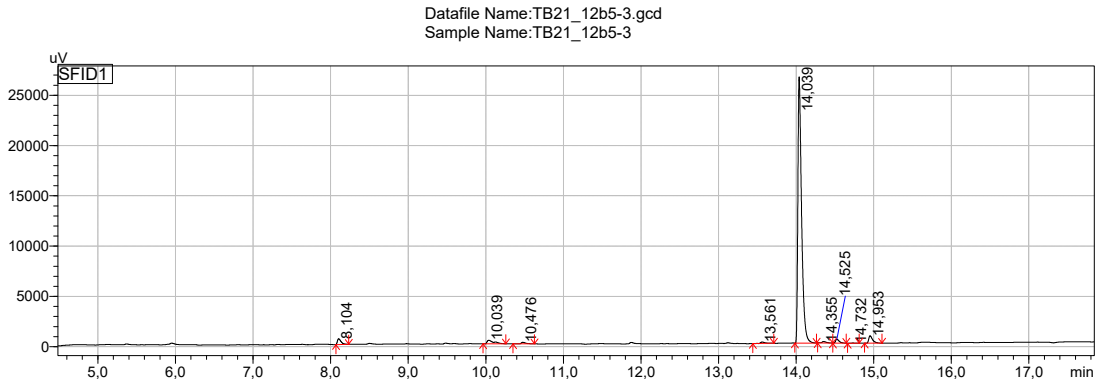


Figure S8. GC-FID chromatogram of the oxidation of **CEES** under optimized conditions (Flow rate: 1.2 mL min^{-1}; Residence time: 60 s; Feed solutions: **CEES** 0.5 M in MeOH, and tBuOCl 0.6 M in MTBE.)

Table S18. Values corresponding to the GC-FID chromatogram for the oxidation of **CEES** in Figure S8.

Peak#	Ret. Time	Area	Height	Area%
1	8,104	1864	577	1,925
2	10,039	2145	347	2,216
3	10,476	552	154	0,570
4	13,561	508	133	0,525
5	14,039	87378	26319	90,262
6	14,355	537	131	0,555
7	14,525	1231	380	1,272
8	14,732	69	21	0,071
9	14,953	2521	729	2,604

4.5. Detailed data for the neutralization of CEPS (microfluidic conditions)

The identity of compounds **CEPS**, **CEPSO** and **CEPSO2** was determined by comparing the retention times of the commercially compounds. The identity of both diastereomers of **CEPSOCl** was determined by synthesizing the reference compound and comparing the HPLC retention time. The identity of **CEPSOCl2** was determined by HPLC-MS.

Procedure: Feed solutions of **CEPS** diluted in MeOH (0.5 M) and *t*BuOCl diluted in MTBE (0.55, 0.6 and 1 M) were both injected at 0.2 mL min^{-1} through a PEEK arrowhead micromixer and

reacted in a PFA capillary coil (0.4 mL internal volume) to obtain a residence time of 60 s at 0 °C. The reactor effluent was diluted in acetonitrile and analyzed by HPLC-DAD.

Table S19. Impurity profile, relative conversion and selectivity (%) for each compound at 1.1, 1.2 and 2 equivalents of *t*BuOCl.

Impurity profile	*1.1 equiv (%Area)*	*1.2 equiv (%Area)*	*2 equiv (%Area)*
CEPS	6.6	5.5	1.8
CEPSO	84.0	84.7	30.9
CEPSO2	0.0	0.0	0.0
CEPSOCl	6.3	6.8	59.6
CEPSOCl (dr)	0.5	0.5	5.1
$CEPSOCl_2$	0.0	0.0	1.1
Others	2.7	2.6	1.5

Sample	**Conversion**	**Selectivity**
1.1 equiv	*93.4%*	*89.9%*
1.2 equiv	*94.5%*	*89.6%*
2 equiv	*98.2%*	*31.5%*

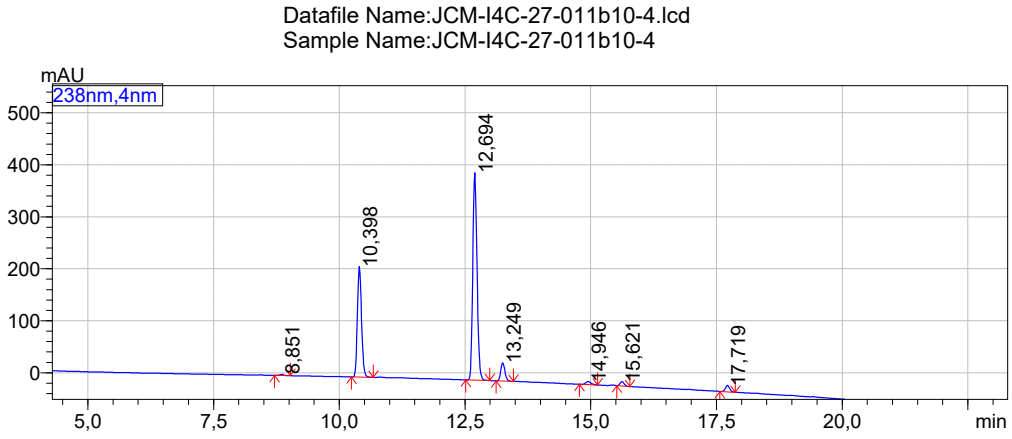


Figure S9. HPLC chromatogram of the oxidation of **CEPS** according the following conditions: Flow rate: 1.2 mL min^{-1}; Residence time: 60 sec; Feed solutions: **CEPS** 0.5 M in MeOH, and tBuOCl 1 M in MTBE.

Table S 20. Values corresponding to the HPLC-DAD chromatogram for the oxidation of **CEPS** in Figure S9.

Peak#	**Ret. Time**	**Area**	**Height**	**Area%**
1	8,851	11680	2047	0,296
2	10,398	1217018	212787	30,889
3	12,694	2348657	398943	59,610
4	13,249	201903	35042	5,124
5	14,946	41065	5852	1,042
6	15,621	46805	8464	1,188
7	17,719	72888	12076	1,850
Total		3940017	675210	100,000

4.6. Detailed data of the neutralization of CEES with tBuOCl (mesofluidic conditions)

Procedure: Feed solution of **CEES** diluted in MeOH (0.5 M) and *t*BuOCl diluted in MTBE (0.6 M) were both injected at 2.7 mL min^{-1} in a Corning® Advance-Flow™ Lab Reactor composed of two fluidic modules (5.4 mL total internal volume) to obtain a residence time of 60 s at (0 ± 2) °C. The reactor effluent was diluted in acetonitrile and analyzed by GC-FID.

Table S21. Impurity profile, relative conversion and global selectivity for each identified compounds when using 1.2 equivalent of *t*BuOCl on CEES.

Impurity profile	*1.2 equiv (%Area)*
CEES	1.2
CEESO	95.0
CEESO2	0.0
CEESOCl	0.7
CEESOCl (dr)	1.7
9	0.0
Others	1.4

Sample	Conversion	Selectivity
1.2 equiv	98.8%	96.4%

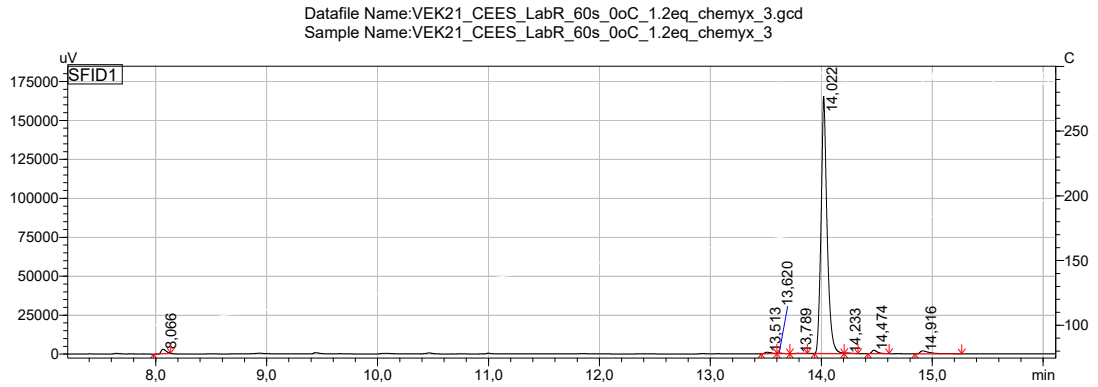


Figure S10. GC-FID chromatogram for the oxidation of **CEES** in mesofluidic scale (Lab Reactor) For exact reaction conditions, see the paragraph on procedure above.

Table S22. Values corresponding to the GC-FID chromatogram for the oxidation of **CEES** shown in Figure S10.

Peak#	Ret. Time	Area	Height	Area%
1	8.066	8392	2810	1.277
2	13.513	3057	888	0.465
3	13.620	455	201	0.069
4	13.789	601	182	0.091
5	14.022	625626	164593	95.227
6	14.233	1158	288	0.176
7	14.474	7327	2187	1.115
8	14.916	10370	1865	1.578
Total		656985	173013	100000

4.7. Detailed data of the neutralization of **CEPS** with tBuOCl (mesofluidic conditions)

Procedure: Feed solutions of **CEPS** diluted in MeOH (0.5 M) and *t*BuOCl diluted in MTBE (0.6 and 0.7 M) were both injected at 2.7 mL min^{-1} in a Corning® Advance-Flow™ Lab Reactor composed of two fluidic modules (5.4 mL total internal volume) to obtain a residence time of 60 s at (0 ± 2) °C. The reactor effluent was diluted in acetonitrile and analyzed by HPLC-DAD.

Table S23. Relative conversion and selectivity (%) for each identified compounds when using 1.2 and 1.4 equivalents of *t*BuOCl.

Impurity profile	*1.2 equiv (%Area)*	*1.4 equiv (%Area)*
CEPS	3.3	2.2

CEPSO	93.5	77.3
CEPSO2	0.0	0.0
CEPSOCl	2.3	18.7
CEPSOCl (dr)	0.1	1.3
$CEPSOCl_2$	0.0	0.0
Others	2.7	0.5

Sample	**Conversion**	**Selectivity**
1.2 equiv	96.7	96.7
1.4 equiv	97.8	79.0

With **CEPS**, the conversion with 1.2 equiv. ***t*BuOCl** reached 97% with 97% selectivity toward **CEPSO**; increasing the excess ***t*BuOCl** to 1.4 equiv. pushed the conversion up to 98% with 79% selectivity toward **CEPSO**, the major impurity becoming its mono-chlorinated sulfoxide **CEPSOCl** (up to 20%), yet the overall neutralization selectivity remained excellent (>99%).

5. Characterization of compounds

5.1. GC-MS Analysis of **1d** sample (identification of impurities)

Procedure: 0.59 g (5 mmol, 1 equiv.) of dipropylsulfide was dissolved in 15 mL of MTBE:MeOH (1:1) and stirred at 0 °C. Then 1.1 g of *t*BuOCl (10 mmol, 2 equiv.) was added dropwise and the medium was left stirred for 10 min. Afterwards, 50 μL of the resulting solution were diluted in acetonitrile and analyzed by GC-MS.

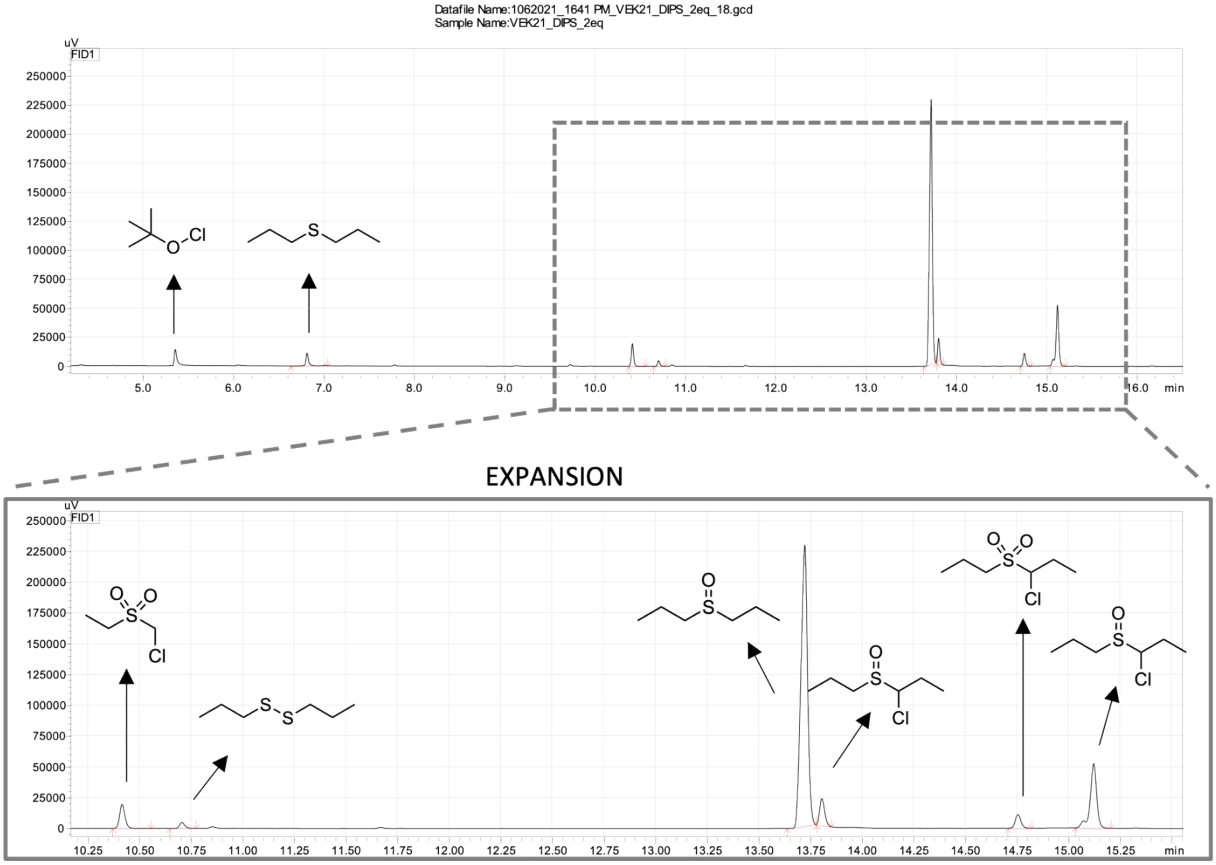


Figure S11. Identification of all the major peaks obtained in oxidation procedures for **1d**.

5.2. GC-MS analysis of **CEES** sample (identification of impurities)

Procedure: 0.62 g (5 mmol, 1 equiv.) of **CEES** was dissolved in 15 mL of MTBE:MeOH (1:1) and stirred at 0 °C. Then 1.1 g of *t*BuOCl (10 mmol, 2 equiv.) was added dropwise and the medium was left stirred for 10 min. Afterwards, 50 μL of the resulting solution were diluted in acetonitrile and analyzed by GC-MS.

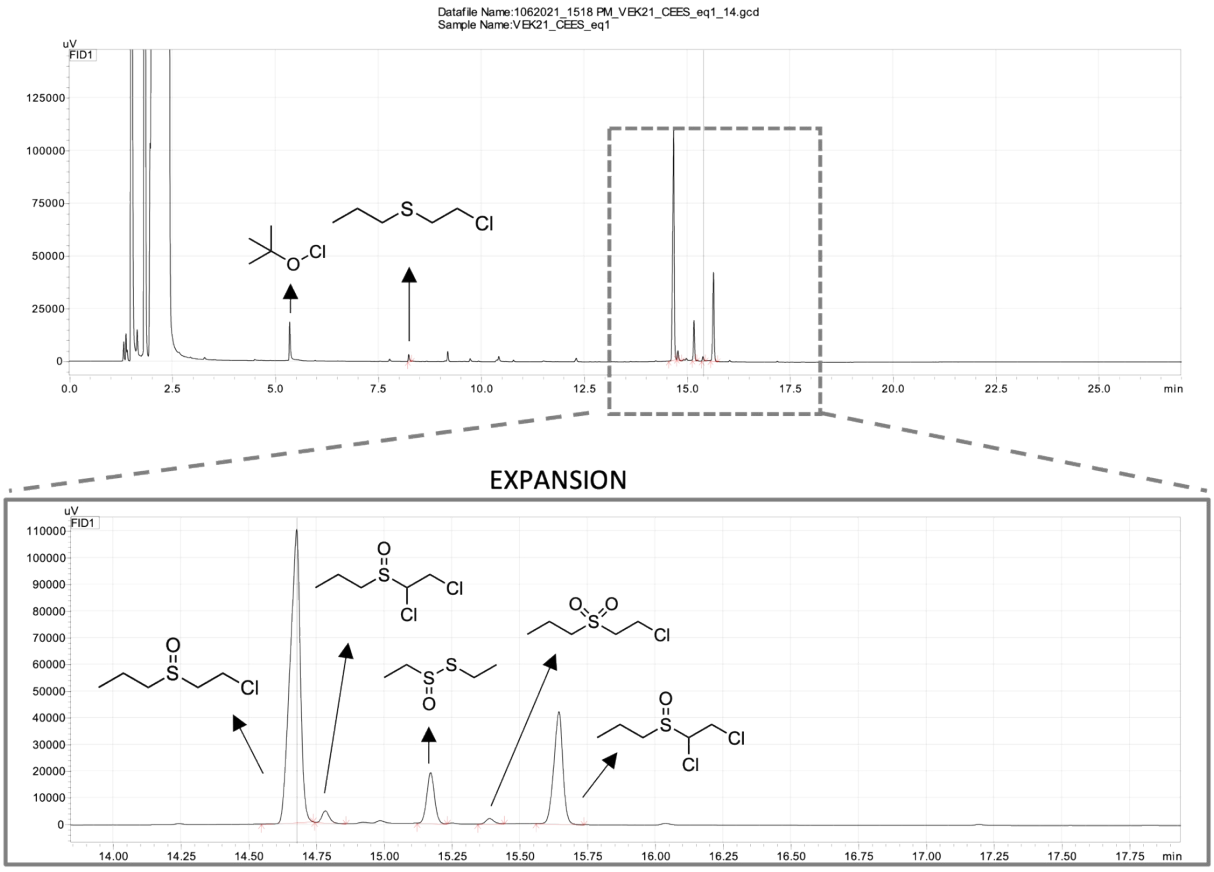


Figure S12. Identification of all the major peaks obtained in oxidation procedures for **CEES**.

5.1. Batch procedure for the preparation of CEPS related compounds

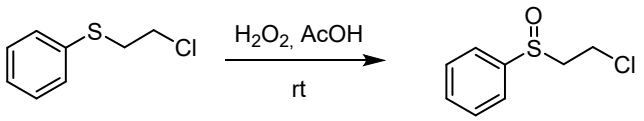


Figure S13. Synthetic scheme for the preparation of 2-chloroethyl phenyl sulfoxide (CEPSO).

Procedure: 2-Chloroethyl phenyl sulfide (400 mg, 2.3 mmol) were dissolved in acetic acid (1 mL). Hydrogen peroxide (30%) (213 µL, 1.1 equiv.) was added dropwise under magnetic stirring. After 6 h, the reaction was checked by HPLC. Conversion was determined to be 90% and 20 µL were added to the reaction. It was left overnight. After 12 h, HPLC showed full conversion. Reaction mixture was extracted three times with brine and DCM. Organic phase was dried with $NaSO_4$, filtered and evaporated using rotary evaporation. A clear liquid was obtained. Yield: 398.3 mg, 91.1%

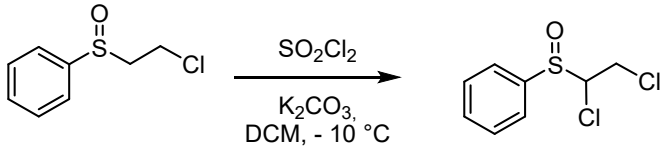
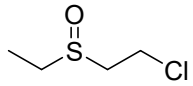
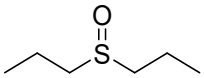
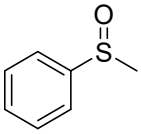
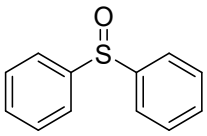
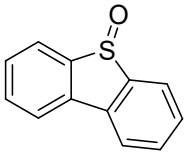
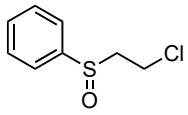
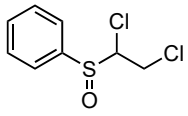


Figure S14. Synthetic scheme for the preparation of ((1,2-dichloroethyl)sulfinyl)benzene (CEPSOCl)

Procedure: To a stirred solution of chloroethyl phenyl sulfoxide (100 mg, 0.53 mmol) in DCM (1.5 ml) containing potassium carbonate (~1 mg) (suspension), was added dropwise sulfuryl chloride (51.4 µL, 0.64 mol). The solution was kept at approx. -5 °C using dry ice in a methanol/water bath. The progress of the reaction was followed by the HPLC. When the starting material had disappeared (about 2 h), the reaction mixture was poured on ice and extracted three times with DCM. The combined organic layer was dried over sodium sulfate, and the solvent was filtered and evaporated. CEPSOCl was obtained as a pale yellow. The compound was further purified using column chromatography (CombiFlash NEXTGEN), using petroleum ether and a gradient from 0% to 20% ethyl acetate. Eluent monitored at 254 nm. Yield: 68.9 mg, 58.3%. Cfr. ref S5.

5.2. Structural identity of compounds (NMR characterization)

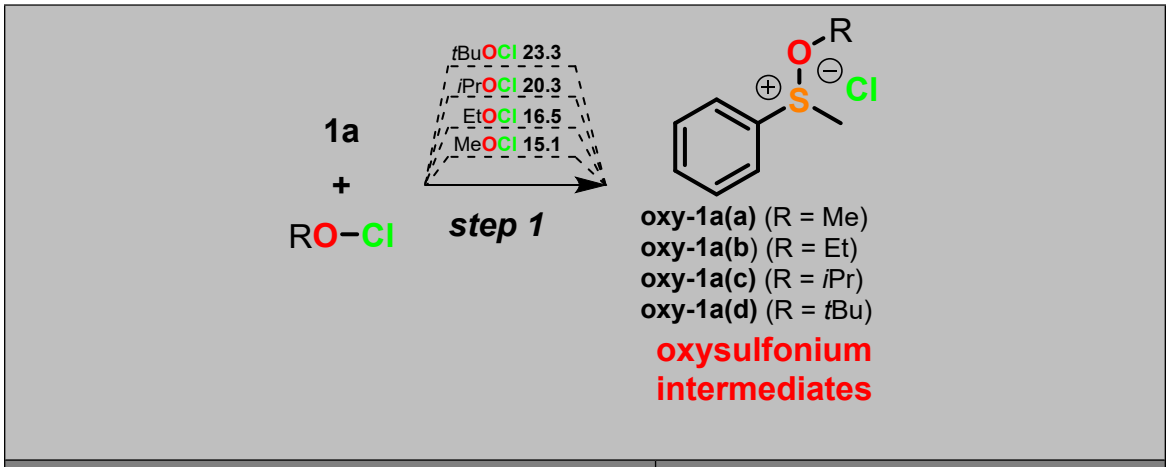
 C_4H_9ClOS 140,01	**CEESO**. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 3.96 (m, 2H), 3.21 (m, 2H), 2.91 (m, 2H), 1.37 (t, J = 7.5 Hz, 3H) ppm. The NMR data match those reported in the literature. [S1] **ESI HRMS** *m/z* $C_4H_{10}O^{35}Cl^{32}S^+$ $[M+H]^+$: calcd 141.01354; found 141.01366.
 $C_6H_{14}OS$ MW 134,24	Dipropyl sulfoxide (**2a**). ^{1}H NMR (MeOD, 400 MHz): δ = 2.66 – 8.62 (m, 4H), 1.74 – 1.63 (m, 4H), 1.00 – 0.96 (t, J = 7.4 Hz, 6H) ppm. The NMR data match what is reported in the literature. [S2]
 C_7H_8OS MW 140,20	Phenyl methyl sulfoxide (**2d**). ^{1}H NMR ($CDCl_3$, 43 MHz): δ = 7.69 – 7.62 (m, 5H), 2.79 (s, 3H) ppm. The NMR data matches the commercial reference and what is reported in the literature. [S3]
 $C_{12}H_{10}OS$ MW 202,27	Diphenyl sulfoxide (**2e**). ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 7.54 – 7.51 (m, 4H), 7.35 – 7.34 (m, 6H) ppm. The NMR data matches the commercial reference and what is reported in the literature. [S4]
 $C_{12}H_8OS$ MW 200,26	Dibenzothiophene (**2f**). ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 7.98 (d, J = 7.6 Hz, 2H), 7.81 (d, J = 7.6 Hz, 1H), 7.70 – 7.63 (m, 3H), 7.57 – 7.52 (m, 2H) ppm. The NMR data matches what is reported in the literature. [S3]

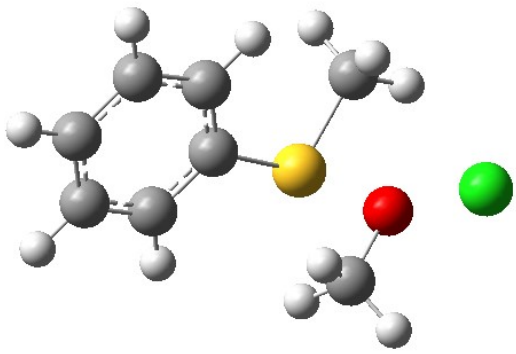
 C_8H_9ClOS MW = 188.67	2-chloroethyl phenyl sulfoxide (**CEPSO**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 – 7.60 (m, 2H), 7.60 – 7.48 (m, 3H), 3.97 (dt, *J* = 11.6, 7.5 Hz, 1H), 3.66 (ddd, *J* = 11.5, 6.7, 5.6 Hz, 1H), 3.17 (ddd, *J* = 7.8, 6.3, 1.9 Hz, 2H). The NMR data matches what is reported in the literature. [S5]
 $C_8H_8Cl_2OS$ MW = 223.11	((1,2-dichloroethyl)sulfinyl)benzene (**CEPSOCl**). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 – 7.64 (m, 2H), 7.64 – 7.50 (m, 3H), 4.68 (td, *J* = 7.0, 1.2 Hz, 1H), 4.19 (ddd, *J* = 12.0, 7.0, 1.1 Hz, 1H), 3.62 (ddd, *J* = 12.0, 6.9, 1.1 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 138.73, 132.34, 129.35, 125.38, 76.01, 42.66.

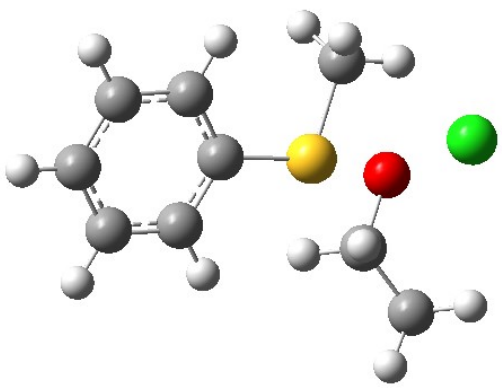
6. Computational study

6.1. Oxidation of thioanisole (1a) with organic hypochlorites

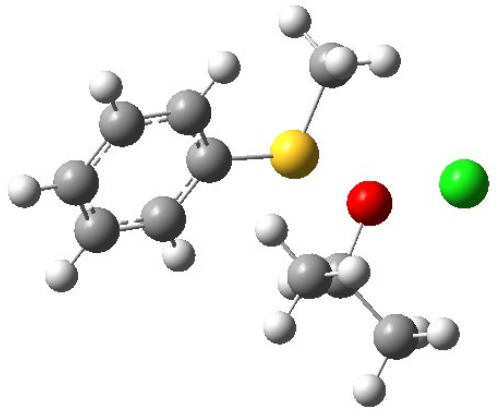
6.1.1. Step 1: formation of oxysulfonium intermediates with MeOCl, EtOCl, iPrOCl and tBuOCl

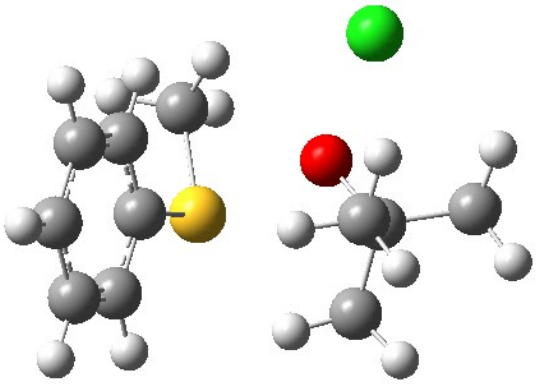


TS(1a-MeOCl) [toward oxy-1a(a)]	**B3LYP/6-311+g(d,p)** (Hartree)
	H = -1245.031327 G = -1245.086756
22 S 0.000000 0.000000 0.000000 O 0.000000 0.000000 2.344378 Cl 0.999753 0.000000 4.174144 C -1.344710 0.364591 2.721019 C 1.806623 0.020168 0.085263	

C -0.460619 1.692225 -0.237397 C 0.408028 2.765464 -0.012829 C -0.061062 4.066429 -0.169812 C -1.386207 4.304847 -0.535506 C -2.248967 3.231001 -0.753180 C -1.792594 1.924978 -0.608441 H -3.279026 3.407257 -1.040579 H -2.463806 1.093072 -0.788939 H 1.435074 2.599889 0.282029 H 0.613665 4.897395 0.001176 H -1.743082 5.321526 -0.651672 H 2.142308 0.613574 0.932774 H 2.104662 -1.018777 0.228690 H 2.221309 0.393991 -0.850772 H -1.980705 0.283968 1.838162 H -1.731341 -0.323446 3.474921 H -1.376891 1.393138 3.086790	
TS(1a-EtOCl) [toward oxy-1a(b)]	**B3LYP/6-311+g(d,p)** (Hartree)
	H = -1284.337634 G = -1284.395280

25 S 0.000000 0.000000 0.000000 C 0.000000 0.000000 1.767145 C 1.748904 0.000000 -0.464294 O 0.004005 -2.338120 -0.420811 Cl 0.851186 -4.044323 -1.251488 C -1.251827 -2.780111 0.146047 C -1.246330 0.196072 2.382090 C -1.344236 0.159964 3.769161 C -0.209807 -0.066060 4.548056 C 1.026841 -0.258899 3.931513 C 1.139994 -0.233650 2.544660 H -2.308284 0.313539 4.240073 H -2.128749 0.386147 1.781321 H 2.106156 -0.392058 2.085494 H 1.912138 -0.434688 4.531868 H -0.287667 -0.089427 5.628732 H 2.244990 -0.893633 -0.091472 H 1.760416 -0.006855 -1.554489 H 2.234605 0.904600 -0.098848 H -1.100649 -3.767718 0.585107 H -1.463473 -2.113675 0.988057 C -2.382397 -2.776907 -0.862203 H -2.172882 -3.461450 -1.688287 H -3.312345 -3.096594 -0.381482 H -2.535868 -1.775129 -1.272984	
TS(1a-*i*PrOCl) [toward oxy-1a(c)]	**B3LYP/6-311+g(d,p)** (Hartree)

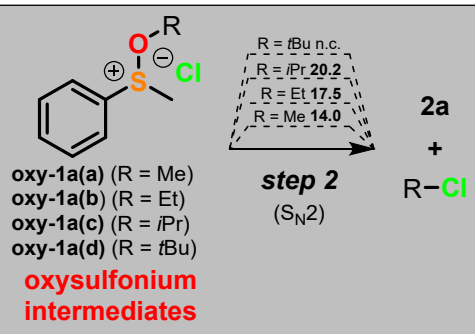
	H = -1323.639238 G = -1323.699145
28 S 0.000000 0.000000 0.000000 C 0.000000 0.000000 1.764431 C 1.744402 0.000000 -0.469904 O -0.000797 -2.205225 -0.398816 Cl 1.086850 -3.881886 -1.288161 C -1.132981 -2.783292 0.305149 C -1.240394 0.232284 2.377117 C -1.345126 0.169374 3.762697 C -0.222555 -0.115529 4.538646 C 1.009814 -0.339923 3.923331 C 1.128665 -0.292047 2.538727 H -2.303900 0.348610 4.234678 H -2.111111 0.468970 1.776164 H 2.086723 -0.484936 2.076202 H 1.884364 -0.562487 4.523411 H -0.305627 -0.160081 5.618071 H 2.226396 -0.906355 -0.111174 H 1.753492 0.006801 -1.559723 H 2.232610 0.897254 -0.090420 H -1.659401 -1.923662 0.730832	

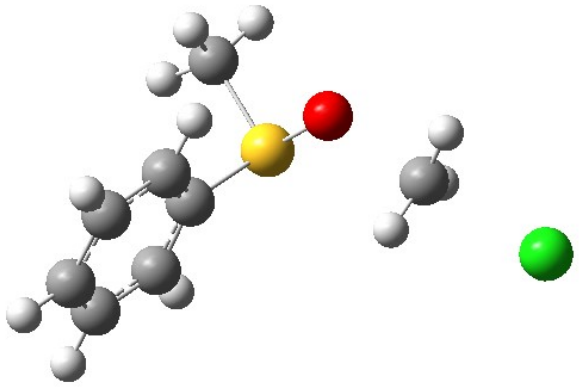
C -2.100536 -3.473945 -0.647342 H -1.659906 -4.380181 -1.066328 H -3.014552 -3.747241 -0.111351 H -2.370139 -2.806528 -1.469622 C -0.681727 -3.646958 1.476376 H 0.026036 -3.098590 2.101997 H -1.545291 -3.915925 2.091940 H -0.204729 -4.564239 1.127162	
TS(1a-*t*BuOCl) [toward oxy-1a(d)]	**B3LYP/6-311+g(d,p)** (Hartree)
	H = -1362.939226 G = -1363.003193
31 S 0.370390 0.697165 1.653060 C 1.647111 0.279572 0.500449 C 0.037625 2.447451 1.340780 O -1.420778 0.251262 0.177734 Cl -2.427461 1.370867 -1.390994 C -1.791779 -1.152969 0.054274 C 2.418368 -0.851718 0.798949 C 3.390208 -1.278728 -0.099650 C 3.601469 -0.581752 -1.289498	

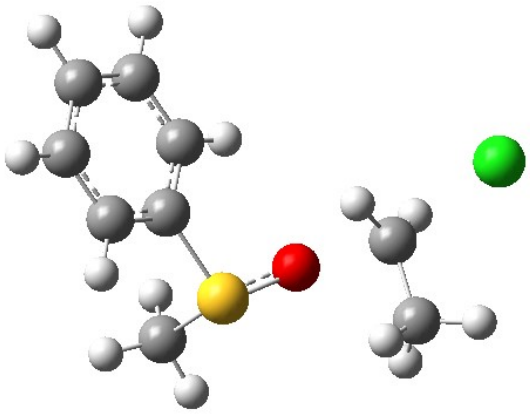
C	2.834675	0.547529	-1.577712	
C	1.852545	0.980444	-0.692120	
H	3.985671	-2.153631	0.134036	
H	2.261882	-1.391235	1.725870	
H	1.254237	1.846365	-0.938910	
H	2.993933	1.092047	-2.501367	
H	4.360924	-0.915055	-1.987181	
H	-0.356047	2.589551	0.337522	
H	-0.718528	2.738930	2.070234	
H	0.946851	3.027797	1.498530	
C	-1.139314	-1.739784	-1.196902	
H	-0.054622	-1.614850	-1.153971	
H	-1.360921	-2.807738	-1.276472	
H	-1.512013	-1.242664	-2.094486	
C	-3.318304	-1.297625	0.032835	
H	-3.583281	-2.356931	0.083292	
H	-3.761612	-0.789858	0.893283	
H	-3.740820	-0.875930	-0.878552	
C	-1.283077	-1.902984	1.304617	
H	-1.642946	-2.933159	1.248044	
H	-0.194627	-1.929664	1.341000	
H	-1.668420	-1.450079	2.219070	

6.1.2. Step 2: S_N2 displacement towards sulfoxide **2a**

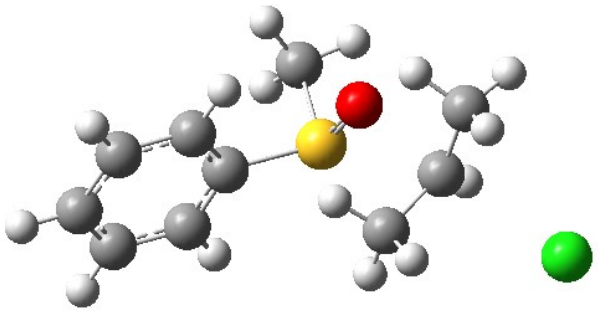
Computed on intermediates **oxy-1a(a)**, **oxy-1a(b)** and **oxy-1a(c)**



TS(oxy-1a(a)-2a)	**B3LYP/6-311+g(d,p)** (Hartree)
	H = -1245.235003 G = -1245.050924
22 C 0.000000 0.000000 0.000000 O 0.000000 0.000000 1.954698 Cl 0.132152 0.000000 -2.403598 H 1.016425 -0.349144 0.030197 H -0.802622 -0.711940 -0.075851 H -0.200995 1.054499 -0.064415 S -1.276324 0.603953 2.652055 C -2.324749 -0.798917 3.064880	

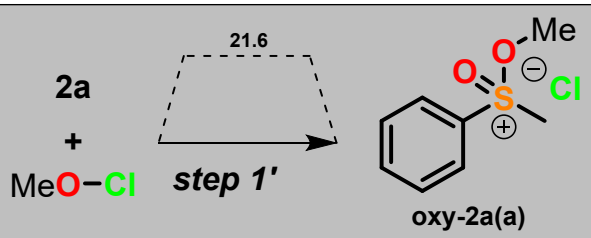
C -3.703258 -0.614536 3.002628 C -4.535769 -1.685178 3.326014 C -3.984204 -2.912954 3.686954 C -2.598413 -3.081508 3.728626 C -1.754566 -2.019796 3.418588 C -0.646066 1.027304 4.292958 H -5.611111 -1.559278 3.285768 H -4.123328 0.340376 2.707691 H -0.678501 -2.141770 3.439724 H -2.174762 -4.040288 4.003449 H -4.634555 -3.745138 3.930355 H -0.145133 0.154429 4.711009 H 0.044798 1.860872 4.165456 H -1.496862 1.327091 4.907063	
TS(oxy-1a(b)-2a)	**B3LYP/6-311+g(d,p)** (Hartree)
	H = -1284.354456 G = -1284.412804
25 S 0.000000 0.000000 0.000000 C 0.000000 0.000000 1.811145	

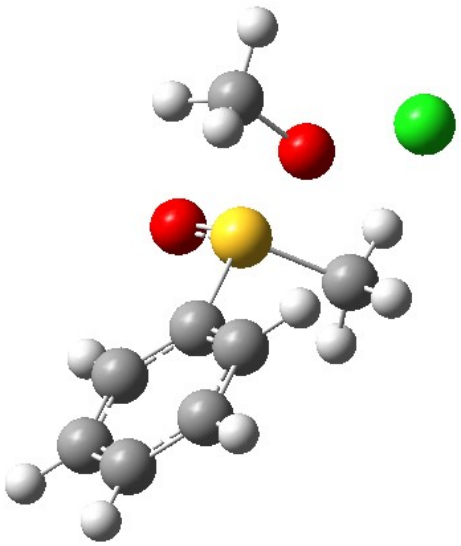
C 1.779211 0.000000 -0.308832 O -0.489165 1.446240 -0.351775 C -1.089449 1.767768 -2.282987 Cl -1.121052 2.648240 -4.639279 C -2.345007 0.970219 -2.279826 C 2.420261 -1.229003 -0.443886 C 3.793982 -1.242657 -0.676922 C 4.496862 -0.042893 -0.786412 C 3.831975 1.177360 -0.663471 C 2.460404 1.207265 -0.421217 H -1.108098 2.808035 -2.006634 H -0.155523 1.365166 -2.631544 H 4.310052 -2.189587 -0.782717 H 1.866643 -2.158846 -0.372188 H 1.929344 2.146689 -0.331353 H 4.378929 2.108233 -0.757396 H 5.563740 -0.058736 -0.976977 H 0.551001 0.874175 2.158227 H -1.041595 0.028949 2.130815 H 0.475510 -0.925052 2.141436 H -2.836215 1.064639 -1.308426 H -3.036476 1.367336 -3.024418 H -2.162650 -0.081834 -2.501129	
TS(oxy-1a(c)-2a)	**B3LYP/6-311+g(d,p)** (Hartree)

	H = -1323.662878 G = -1323.725986
28 S 0.000000 0.000000 0.000000 O 0.000000 0.000000 1.559551 C 1.940367 0.000000 2.508786 Cl 4.352011 0.933230 3.057188 C 1.362350 0.209482 3.857686 C 2.355634 -1.363229 2.090017 C -1.550571 0.834354 -0.429400 C -0.420794 -1.684049 -0.498711 C -1.052470 -2.535195 0.401755 C -1.359445 -3.830237 -0.008989 C -1.036143 -4.252510 -1.299133 C -0.397339 -3.385627 -2.185108 C -0.076626 -2.089599 -1.785199 H 2.108430 0.840885 1.862267 H -0.138044 -3.717931 -3.183407 H 0.432150 -1.414365 -2.464343 H -1.289349 -2.196155 1.402627 H -1.849249 -4.508705 0.679695 H -1.276410 -5.262166 -1.611725 H -2.368456 0.342087 0.096740 H -1.449751 1.875562 -0.121763	

H -1.679922 0.769072 -1.510932 H 0.428986 -0.357876 3.931190 H 2.036267 -0.196969 4.614790 H 1.167919 1.260168 4.066232 H 3.158769 -1.709894 2.744216 H 1.519193 -2.054204 2.222191 H 2.707632 -1.395438 1.059291	

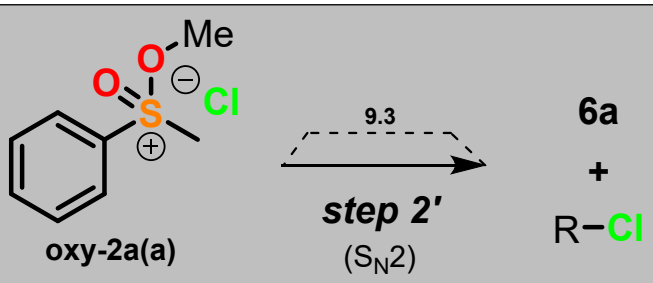
6.1.3. Step 1': overoxidation of 2a with MeOCl

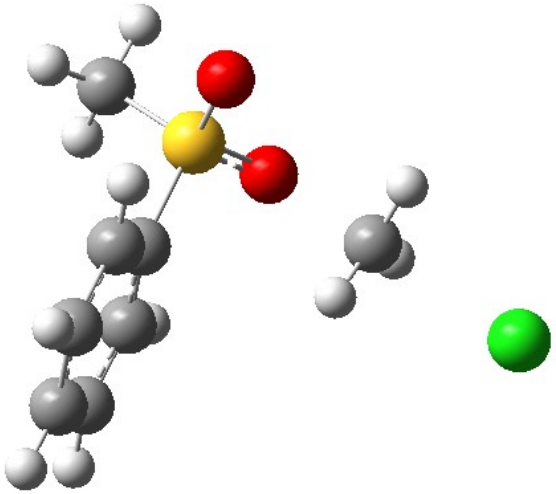


TS(2a-MeOCl) [toward oxy-2a(a)]	**B3LYP/6-311+g(d,p)** (Hartree)
	H = -1320.230966 G = -1320.286854

23 S 0.000000 0.000000 0.000000 C 0.000000 0.000000 1.802935 C 1.752091 0.000000 -0.407881 O -0.438788 -2.098605 -0.073518 Cl -0.410934 -3.987133 0.917627 O -0.608074 1.294123 -0.489507 C -0.557184 -2.490836 -1.470099 C 2.287684 1.130720 -1.016767 C 3.642592 1.128464 -1.341693 C 4.428964 0.011550 -1.063746 C 3.867046 -1.115475 -0.461221 C 2.514959 -1.134920 -0.134141 H 4.478811 -1.984834 -0.251372 H 2.067240 -2.010440 0.318712 H 1.663901 1.990437 -1.226090 H 4.080090 2.001172 -1.811895 H 5.481748 0.016077 -1.321073 H 0.473084 0.925675 2.131502 H -1.040323 -0.053643 2.122746 H 0.555049 -0.875274 2.136713 H -1.440899 -3.115254 -1.594332 H -0.685318 -1.596281 -2.081361 H 0.340796 -3.021066 -1.789032	

6.1.4. Step 2': S_N2 displacement towards sulfone **6a**

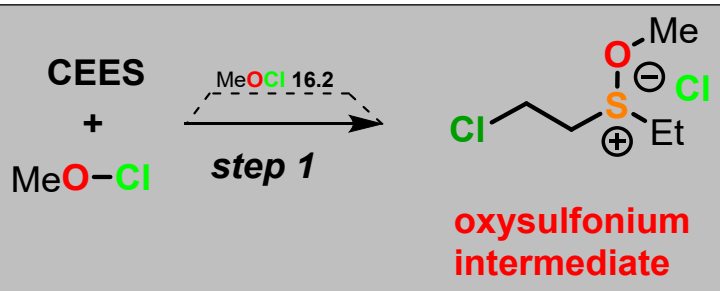


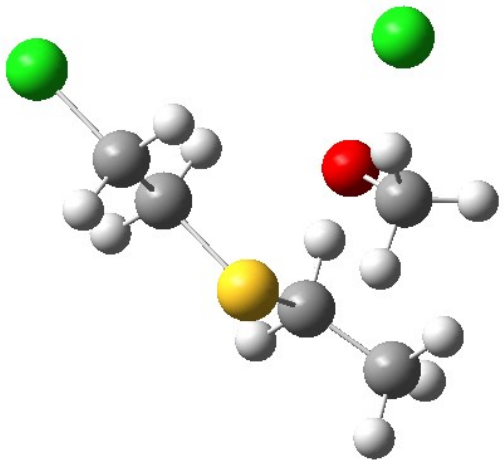
TS(oxy-2a(a)-6a)	**B3LYP/6-311+g(d,p)** (Hartree)
	H = -1320.271319 G = -1320.327595
23 Cl 0.000000 0.000000 0.000000 C 0.000000 0.000000 2.551074 S 1.125731 0.000000 5.252943 O -0.135120 -0.024540 4.394513 C 0.509634 -0.139222 6.919190 C 2.039654 -1.482983 4.892741 C 1.335118 -2.665061 4.663838 C 2.061859 -3.821798 4.405721 C 3.456808 -3.781713 4.379372 C 4.138148 -2.587528 4.609734	

C	3.430268	-1.417792	4.872221	
O	1.994838	1.174725	5.108894	
H	1.537958	-4.751497	4.220082	
H	0.252425	-2.682000	4.674959	
H	3.945055	-0.482390	5.049905	
H	5.220739	-2.562190	4.584349	
H	4.015370	-4.687815	4.175536	
H	1.377169	-0.180949	7.578760	
H	-0.090504	0.752364	7.106092	
H	-0.088627	-1.047065	6.988875	
H	-1.050147	-0.206964	2.444182	
H	0.343987	1.015999	2.459741	
H	0.701829	-0.808633	2.436700	

6.2. Oxidation of CEES

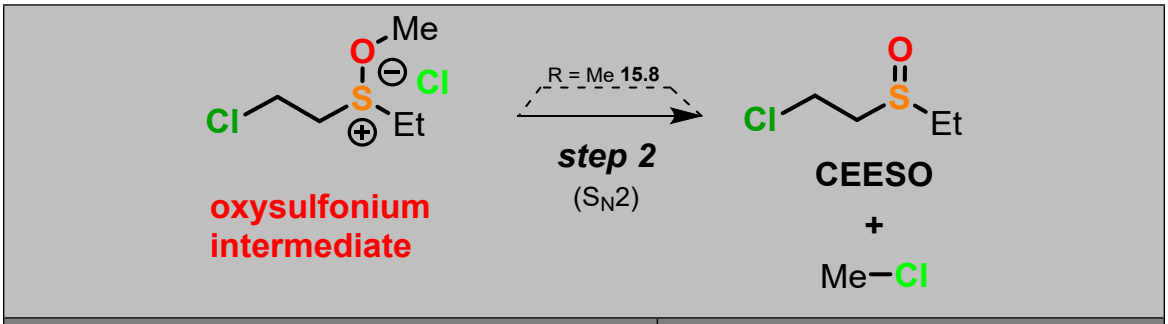
6.2.1. Step 1: formation of the oxysulfonium intermediate with MeOCl



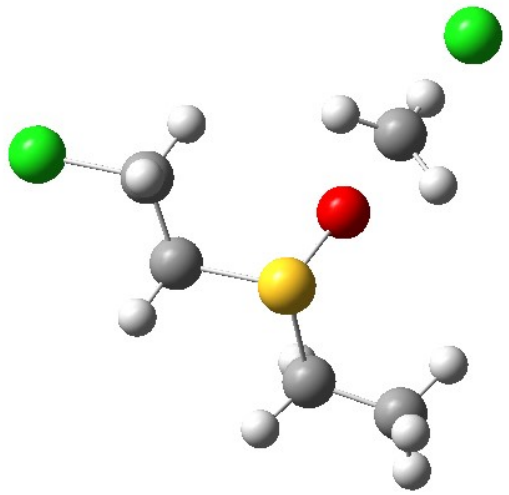
TS(CEES-MeOCl)	**B3LYP/6-311+g(d,p)** (Hartree)
	H = -1591.522362 G = -1591.576431
21 S 0.000000 0.000000 0.000000 C 0.000000 0.000000 1.829727 C 1.803810 0.000000 -0.316158 O -0.044755 -2.349916 0.105631 C -0.846673 -2.806008 -1.012116 Cl 0.496165 -4.110917 1.012442 C 2.081327 -0.234192 -1.793459 C -1.398828 -0.313245 2.317436 Cl -1.420296 -0.318382 4.144754	

H 2.231271 -0.789888 0.302680 H 2.193636 0.963747 0.018283 H -1.721350 -3.352565 -0.653741 H -1.184028 -1.929460 -1.562799 H -0.251234 -3.433237 -1.678059 H 0.709796 -0.760449 2.154076 H 0.330760 0.981841 2.171502 H -1.726125 -1.302672 2.008989 H -2.124879 0.437468 2.013565 H 3.161654 -0.210450 -1.960241 H 1.711011 -1.208872 -2.119245 H 1.628123 0.539586 -2.418720	

6.2.2. Step 2: SN2 displacement towards sulfoxide CEESO

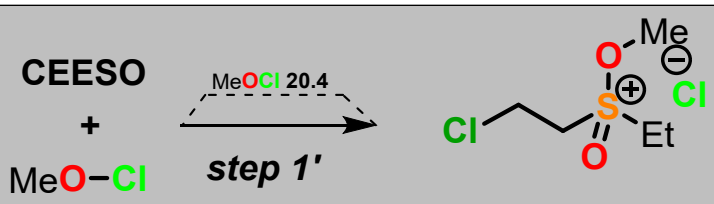


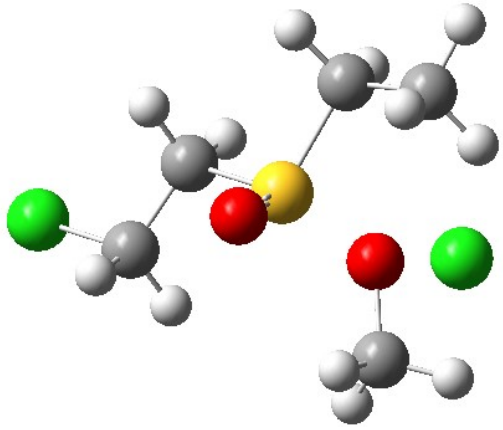
TS(oxysulfonium-CEESO)	**B3LYP/6-311+g(d,p)** (Hartree)

	H = -1591.546077 G = -1591.602595
21 S 0.000000 0.000000 0.000000 C 0.000000 0.000000 1.831638 C 1.803411 0.000000 -0.286430 O -0.458964 -1.453340 -0.396563 C -2.150248 -1.550823 -1.372865 Cl -4.213903 -1.775368 -2.587733 C 2.108951 -0.045421 -1.774318 C -1.417692 -0.196208 2.329276 Cl -1.417698 -0.203662 4.151349 H 2.199507 -0.862813 0.252478 H 2.162295 0.919448 0.182691 H -2.712547 -1.068795 -0.593271 H -1.775367 -0.981640 -2.204213 H -2.058453 -2.622304 -1.376661 H 0.663408 -0.802681 2.156579 H 0.406389 0.970215 2.125524 H -1.827266 -1.155622 2.024851 H -2.080211 0.611792 2.027595	

H 3.193780 -0.053414 -1.904779 H 1.707911 -0.949242 -2.237592 H 1.710588 0.828327 -2.295298	

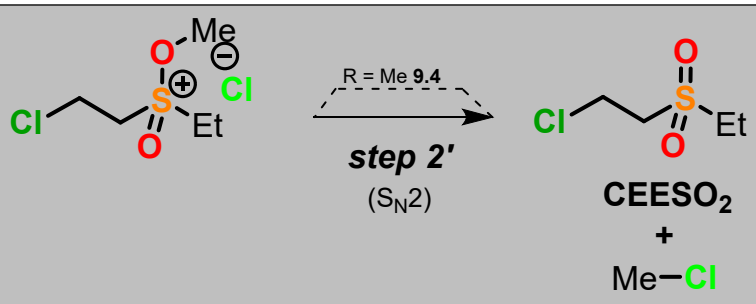
6.2.3. Step 1': overoxidation of CEESO with MeOCl



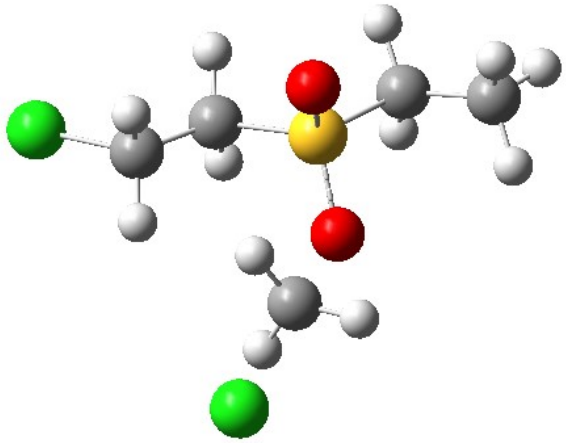
TS(CEESO-MeOCl)	**B3LYP/6-311+g(d,p)** (Hartree)
	H = -1666.725388 G = -1666.784474
22 S 0.000000 0.000000 0.000000 C 0.000000 0.000000 1.822373 C 1.787456 0.000000 -0.379675 O -0.362249 -2.101107 -0.264376 Cl 0.008835 -4.132052 0.287564 C -1.237427 -2.262486 -1.416922	

O	-0.616685	1.280266	-0.519852	
C	-1.423077	-0.002395	2.354610	
C	1.982270	-0.066066	-1.880853	
Cl	3.765315	-0.059234	-2.248179	
H	0.563236	0.888321	2.117554	
H	0.553180	-0.900011	2.097531	
H	-2.143197	-2.787682	-1.114039	
H	-1.517986	-1.278035	-1.794537	
H	-0.718055	-2.808335	-2.204593	
H	2.186517	-0.878853	0.128436	
H	2.192019	0.915084	0.056540	
H	1.564352	0.799915	-2.387676	
H	1.584754	-0.984122	-2.307426	
H	-1.380967	-0.002234	3.446309	
H	-1.970901	0.887045	2.037683	
H	-1.967877	-0.892972	2.034477	

6.2.4. Step 2: SN2 displacement towards sulfoxide CEESO2



TS(oxysulfonium-CEESO$_2$)	**B3LYP/6-311+g(d,p)** (Hartree)
	H = -1666,763954 G= -1.666,821164



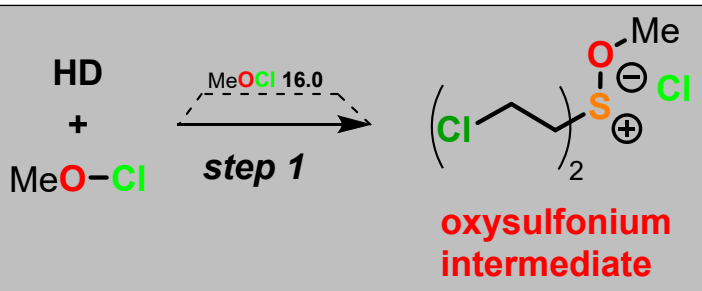
22

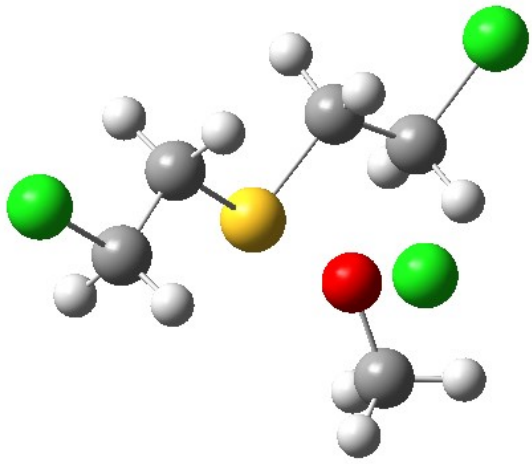
C	0.000000	0.000000	0.000000
O	0.000000	0.000000	1.495943
S	1.372392	0.000000	2.283731
C	2.248099	-1.542092	1.897065
C	3.231580	-1.370319	0.751136
O	2.198947	1.183979	2.063441
C	0.740789	-0.142570	3.965953
C	-0.134475	1.050106	4.314839
Cl	-0.678963	0.850357	6.032699
Cl	0.145363	-0.113813	-3.230541
H	-1.038977	0.193430	-0.243166
H	0.641278	0.799545	-0.358339
H	0.317021	-0.978945	-0.343852
H	1.639253	-0.200994	4.584536
H	0.201056	-1.091066	3.993946
H	1.456781	-2.268277	1.700851
H	2.744174	-1.793691	2.838535
H	3.994728	-0.628715	0.988340
H	3.723924	-2.335635	0.612748

H 2.741607 -1.100915 -0.184118 H 0.412742 1.987910 4.264436 H -1.030534 1.092917 3.702941	

6.3. Oxidation of HD

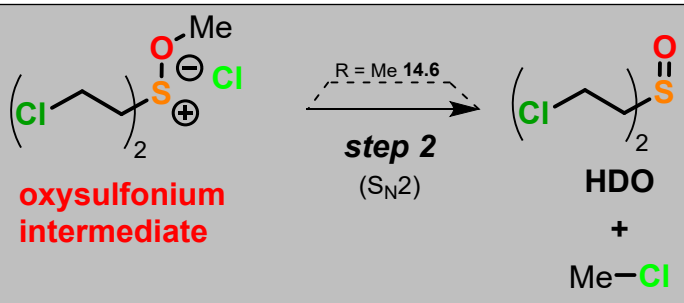
6.3.1. Step 1: formation of the oxysulfonium intermediate with MeOCl



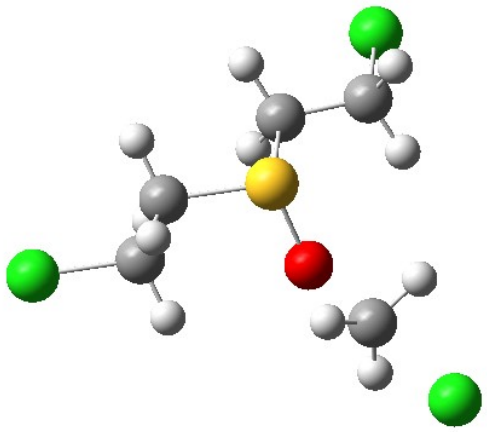
TS(HD-MeOCl)	**B3LYP/6-311+g(d,p)** (Hartree)
	H = -2051.155883 G = -2051.216340
21 S 0.000000 0.000000 0.000000 C 0.000000 0.000000 1.830453 C 1.804851 0.000000 -0.304516 O -0.064344 -2.210099 0.031732	

C	-0.941260	-2.641752	-1.043244
Cl	0.502127	-4.095702	0.868903
C	-1.375205	-0.414364	2.315073
C	2.048361	-0.205974	-1.786275
Cl	-1.412303	-0.344334	4.134938
Cl	3.839334	-0.155012	-2.111684
H	2.230387	-0.811116	0.285371
H	2.198491	0.958626	0.036473
H	-1.800292	-3.176231	-0.634430
H	-1.299219	-1.765479	-1.582723
H	-0.394010	-3.281637	-1.736552
H	0.762539	-0.706349	2.156501
H	0.257424	1.007024	2.160997
H	1.704726	-1.180195	-2.124757
H	1.606880	0.581367	-2.393615
H	-1.603325	-1.440195	2.039539
H	-2.159131	0.256960	1.970336

6.3.2. Step 2: S_N2 displacement towards sulfoxide HDO

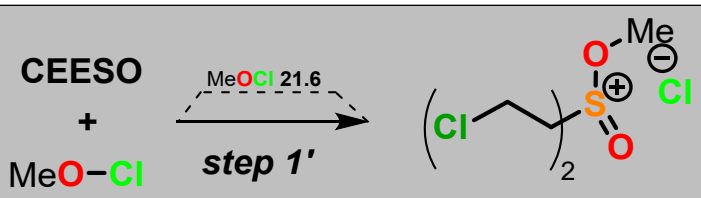


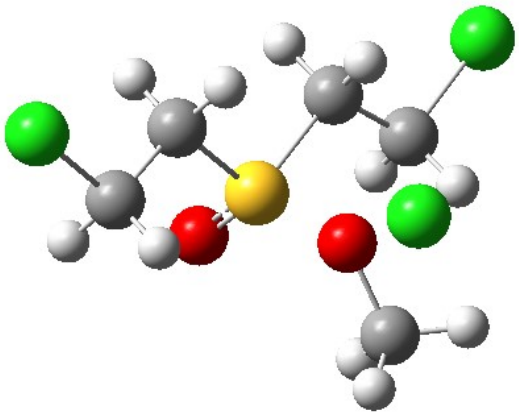
TS(oxysulfonium-HDO)	**B3LYP/6-311+g(d,p)** (Hartree)

	H = -2051.178259 G = -2051.238325
21 C 0.000000 0.000000 0.000000 O 0.000000 0.000000 1.937546 Cl 0.132528 0.000000 -2.422636 S -1.387951 -0.279356 2.623230 C -1.771108 1.265286 3.531261 C -2.057167 2.366220 2.529785 Cl -2.429067 3.904086 3.430874 C -0.966831 -1.323175 4.066166 C -0.512654 -2.685551 3.581931 Cl -0.093215 -3.711343 5.025922 H -0.907251 1.489435 4.158742 H -2.642720 1.036918 4.148490 H -0.190298 -1.056189 -0.066742 H -0.808904 0.702631 -0.096274 H 1.013285 0.359609 0.018463 H -0.188910 -0.798439 4.622402 H -1.882606 -1.383779 4.657544 H -1.195432 2.582998 1.903630	

H -2.928823 2.152032 1.915232 H 0.388338 -2.625024 2.977255 H -1.295689 -3.215616 3.044624	

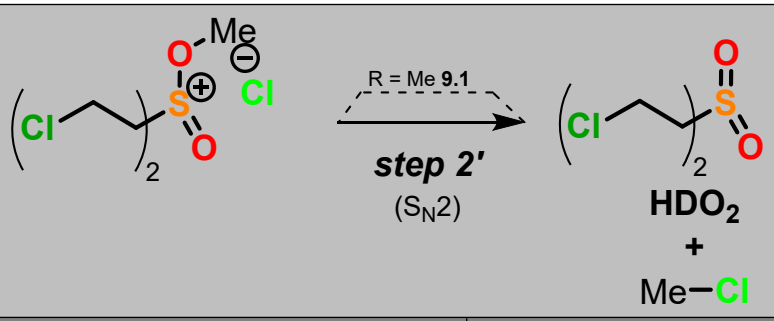
6.3.3. Step 1': overoxidation of HDO with MeOCl



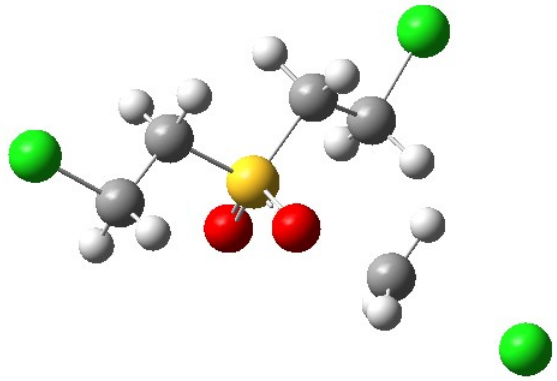
TS(TS(HDO-MeOCl)	**B3LYP/6-311+g(d,p)** (Hartree)
	H = -2126.356930 G = -2126,419985
22 S 0.000000 0.000000 0.000000 C 0.000000 0.000000 1.825165 C 1.793860 0.000000 -0.362585 O -0.352404 -2.059445 -0.137191 Cl -0.002450 -4.054664 0.637478	

C	-1.081424	-2.347277	-1.366779	
O	-0.620624	1.273338	-0.517671	
C	-1.421137	-0.172444	2.324304	
Cl	-1.406817	-0.177700	4.143149	
C	1.998977	-0.062997	-1.863241	
Cl	3.784102	-0.036798	-2.211654	
H	0.441231	0.951706	2.126242	
H	0.642199	-0.832452	2.114565	
H	-1.991434	-2.893909	-1.121998	
H	-1.360232	-1.409525	-1.849656	
H	-0.450474	-2.924751	-2.041905	
H	2.187149	-0.879312	0.148345	
H	2.189129	0.916700	0.079051	
H	1.575341	0.798593	-2.372787	
H	1.616203	-0.985724	-2.293024	
H	-2.065198	0.650434	2.025187	
H	-1.847118	-1.123184	2.015481	

6.3.4. Step 2: S_N2 displacement towards sulfoxide HDO_2



TS(oxysulfonium-HDO_2)	**B3LYP/6-311+g(d,p)** (Hartree)

	H = -2126.393301 G = -2126.454440
22 C 0.000000 0.000000 0.000000 O 0.000000 0.000000 1.819126 Cl 0.143819 0.000000 -2.573704 S -1.274210 0.084892 2.653054 O -2.223807 -1.022704 2.493273 C -2.097606 1.675141 2.340149 C -0.662282 0.217545 4.351347 C 0.238324 -0.961178 4.677009 Cl 0.773259 -0.804380 6.404764 C -3.035777 1.584892 1.148537 Cl -3.900477 3.175388 0.989516 H -1.562097 0.243366 4.969136 H -0.138406 1.173822 4.402376 H 1.006629 -0.378062 -0.047293 H -0.811673 -0.686997 -0.171743 H -0.159324 1.056289 -0.133212 H -1.296661 2.402823 2.204544 H -2.640237 1.883154 3.265200 H -3.800794 0.826747 1.288601	

H -2.513039 1.429091 0.209374 H -0.283230 -1.911560 4.597372 H 1.139081 -0.966049 4.070521	

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S5 K. Wojciechowskl, *Org. Prep. Proced. Int.*, 1988, **20**, 493–496