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# A new, mild preparation of sulfonyl chlorides

Grzegorz Blotny*

*Department of Chemistry and Biochemistry, University of Maryland Baltimore County, 1000 Hilltop Circle, Baltimore, MD 21250, USA*

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**Abstract**—A new method was developed for the preparation of sulfonyl chlorides from sulfonic acids under neutral conditions using 2,4,6-trichloro-1,3,5-triazine as chlorinating agent. © 2003 Elsevier Science Ltd. All rights reserved.

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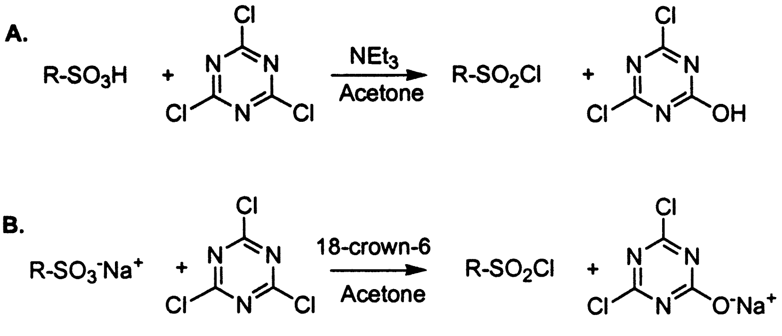
Sulfonyl chlorides are important intermediates in organic synthesis, and are widely used for the preparation of amides[1] and esters.[2] Generally, sulfonyl chlorides are prepared from the corresponding sulfonic acids by using thionyl chloride in dimethylformamide (DMF).[3] However, this process suffers from the tendency of the product to form a complex with DMF.[4] Other methods include the reaction of sulfonic acids with phosphoryl chloride[5] or phosphorous pentachloride,[6] both of which may require harsh conditions, such as heating at 170–180°C for many hours.[7] In addition, there are disadvantages that these methods necessitate an excess of chlorinating reagent and that highly toxic and corrosive byproducts are formed.

Here we present a new method for the preparation of sulfonyl chlorides that involves treatment of sulfonic acids with 2,4,6-trichloro-1,3,5-triazine (cyanuric chloride) in refluxing acetone under neutral conditions, a significantly milder procedure than those above. Cyanuric chloride is a commercially available, inexpensive reagent that has found increasing application in organic synthesis. 2,4,6-Trichloro-1,3,5-triazine and its derivatives have been used for the activation of carboxyl groups in the preparation of esters, amides and peptides,[8] alcohols and aldehydes,[9] as well as alkyl chlorides[10] and acyl azides.[11]

There is disagreement in the literature about the initial product of the reaction of carboxylic acids with cyanuric chloride. Some authors[8a,12] claim that the product is the acid chloride, whereas others[8d,9a,11,13] argue that acylated triazine is formed. We show here that in the case of sulfonic acids, the product is the acid chloride and not the acylated triazine. Furthermore, sulfonyl chlorides can be prepared in moderate to excellent yield by this reaction. The procedure consists of addition of 1 equiv. of cyanuric chloride to a mixture of 1 equiv. of dry sulfonic acid and 1 equiv. of triethylamine in dry acetone (Scheme 1, Method A) or addition of 1 equiv. of cyanuric chloride to 1 equiv. of dry sodium sulfonate and catalytic amount of 18-crown-6 in dry acetone



**Scheme 1.**

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*Keywords*: sulfonic acids; sulfonyl chlorides; cyanuric chloride; synthesis.

* Corresponding author. E-mail: blotny@umbc.edu

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(Scheme 1, Method B), followed by heating at reflux for 20 h. After cooling, the solution is filtered through a Celite pad. The acetone is removed under vacuum and the sulfonyl chloride is purified either by distillation or column chromatography with silica gel Merck 60 and an appropriate solvent system. The sulfonyl chlorides were identified by IR and $^1$H NMR data, and by comparison of melting or boiling points with those of authentic samples. The results are presented in Table 1.

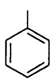
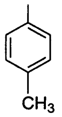
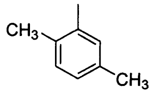
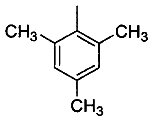
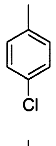
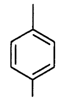
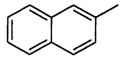
A likely mechanism for this reaction is presented in Scheme 2. Nucleophilic attack of the sulfonic acid anion on trichloro-s-triazine gives a delocalized carbanion, which yields the sulfonyl chloride and insoluble dichlorohydroxy-s-triazine.

In conclusion, we present a new, inexpensive and mild method for the preparation of sulfonyl chlorides, which employs 2,4,6-trichloro-1,3,5-triazine as chlorinating agent.

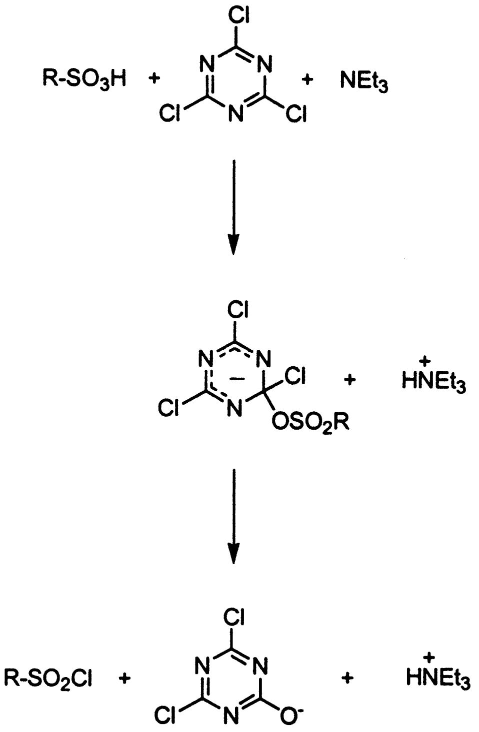
## Experimental

**General procedure for synthesis of sulfonyl chlorides**: **Method A**. To 20 mmol of sulfonic acid and 20 mmol of triethylamine in 40 mL of acetone was added 20 mmol of cyanuric chloride and the mixture was heated under reflux for 20 h. After cooling to room temperature the solution was filtered through a Celite pad. Solvent was removed (rotary evaporator) and the sulfonyl chloride was purified by distillation or column chromatography.

**Table 1.** Prepared sulfonyl chlorides R-$SO_2Cl$

| Entry | R | Method | Yield (%) |  | mp or bp (°C) |  |
|---|---|---|---|---|---|---|
|  |  |  | CC | Distill. | Found | Reported |
| 1 | $CH_3$- | A | — | 47 | $bp_{17}$ = 57 | $bp_{17}$ = 58[14] |
| 2 | $CH_3CH_2$- | B | — | 74 | $bp_{20}$ = 72 | $bp_{17}$ = 71-72[15] |
| 3 | $CH_3(CH_2)_2CH_2$- | B | — | 86 | $bp_{22}$ = 103-105 | $bp_{17}$ = 97-98[16] |
| 4 | $CH_3(CH_2)_3CH_2$- | B | — | 70 | $bp_{25}$ = 120 | $bp_{25}$ = 118-120[17] |
| 5 |  | A<br>B | 90<br>94<br>$R_f$=0.38[a] | 86<br>--- | $bp_{10}$ = 113-115 | $bp_{10}$ = 113-115[18] |
| 6 |  | A<br>B | 96<br>94<br>$R_f$=0.40[a] | 94<br>— | mp = 70-71<br>$bp_{17}$ = 148 | mp = 70-71[5]<br>$bp_{17}$ = 148[19] |
| 7 |  | A | 74<br>$R_f$=0.58[a] | 70 | $bp_{17}$ = 150-152 | $bp_{17}$ = 148-150[20] |
| 8 |  | A<br>B | 64<br>94<br>$R_f$=0.64[a] | —<br>— | mp =56-58[c] | mp = 56[21] |
| 9 |  | A<br>B | 76<br>96<br>$R_f$=0.66[a] | —<br>— | mp = 50-52[c] | mp = 51[22] |
| 10 |  | A<br>B | 66<br>70<br>$R_f$=0.62[b] | —<br>— | mp = 147-149[d] | mp = 147-149[23] |
| 11 |  | A<br>B | 88<br>89<br>$R_f$=0.40[a] | —<br>— | mp = 74-76[c] | mp = 75-76[24] |

[a] Column chromatography, hexane/AcOEt (9:1); [b] Column chromatography, AcOEt; [c] Recrystallized from hexane; [d] Recrystallized from benzene.



**Scheme 2.**

**Method B**. To 20 mmol of sodium sulfonate and 1 mmol of 18-crown-6 ether in 40 mL of acetone was added 20 mmol of cyanuric chloride and the procedure was followed as in Method A.

## Acknowledgements

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