

## TRIBUTYLTIN CYANIDE: A FACILE CYANATING AGENT OF ACYL CHLORIDES

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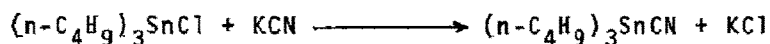
**Summary:** Tributyltin cyanide was prepared from tributyltin chloride and potassium cyanide, and was found to be an efficient cyanation agent for acyl chlorides to give acyl cyanides in excellent yields.

Acyl cyanides are an important class of compounds; some of them show significant biological activity in agricultural use.<sup>1)</sup> Furthermore, they are versatile intermediates in organic syntheses which allow numerous transformations to such compounds as  $\alpha$ -ketoacids, 1-amino-2-ethanol derivatives, and a wide range of heterocyclic compounds.<sup>2)</sup> They are also useful as mild and selective acylating agents.<sup>3)</sup>

All of the methods reported for synthesis for acyl cyanides<sup>2b,4)</sup> and cyanofornates<sup>5)</sup> are commonly based on cyanation of acyl chlorides or acid anhydrides. Very recently, Herrmann and Simchen reviewed the synthetic methods for acyl cyanides, and reported that trimethylsilyl cyanide is an efficient cyanation agent.<sup>6)</sup>

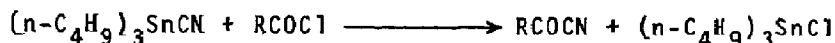
In connection with another project,<sup>7)</sup> we had an opportunity to prepare tributyltin cyanide and found that this is much superior to trimethylsilyl cyanide for cyanation of acyl chlorides which is the subject of the present communication.

Synthesis of Tributyltin Cyanide: There are several methods available for trialkyltin cyanide synthesis.<sup>8)</sup> However, we believe that the following is the best for its simplicity, high yield, and availability of starting materials.



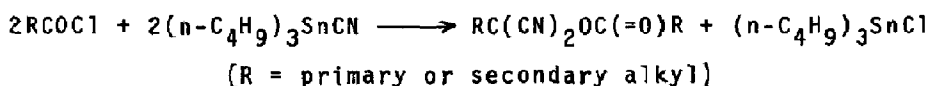
Tributyltin chloride (3.98 ml, 14.7 mmol) was added to potassium cyanide (1.89 g, 29 mmol) in 9 ml of acetonitrile containing 18-crown-6 (194 mg, 0.74 mmol).<sup>9)</sup> After vigorous stirring at 80°C for 7 hr, the filtrate of the reaction mixture was refrigerated at -27°C to afford tributyltin cyanide as colorless crystals, 3.9 g, 83%. Recrystallization from acetonitrile gave an analytical sample.<sup>10)</sup> Tributyltin cyanide is hygroscopic, but can be stored unchanged for a long period under a dry atmosphere.

Cyanation of Acyl Chlorides with Tributyltin Cyanide: 2-Thenoyl cyanide synthesis exemplifies the recipe of cyanation of acid chlorides. To 624 mg (1.99



mmol) of tributyltin cyanide was added 304 mg (1.05 eq) of 2-thenoyl chloride and the mixture was stirred at 75°C until it became homogeneous (ca. 5 min). Ir spectrum showed the CN absorption band of tributyltin cyanide had completely disappeared whilst a new CN stretching band assignable to acyl cyanide was observed. Short-path distillation (Kugelrohr, 120°C/16 torr) gave 299 mg crude product which was likely contaminated with tributyltin chloride. The crude material partly solidified, and was purified through recrystallization from a 2.5 ml mixture of 3:1 pentane-chloroform. Essentially the same procedure was followed for other acyl chlorides. In several instances, separation of tributyltin chloride and acyl cyanide was effected by silica gel chromatography. Identity of the product structures was confirmed by mp or bp, ir and pmr spectra, analysis, and comparison with authentic samples prepared via different routes. These results are listed in the table 1 together with pertinent data to the product structures.

As is seen in the table 1, the present method offers a facile synthesis of acyl cyanides from tertiary alkyl, aryl, heterocyclic, and olefinic acyl chlorides, and it appears much superior to other syntheses in terms of yield, mildness, speed, and simplicity. Tributyltin chloride can be recovered and used repeatedly for another preparation of tributyltin cyanide. It is also worthy of note that by-production of acyl cyanide dimers (RC(CN)<sub>2</sub>OC(=O)R) was not observed from these acyl chlorides. Extensive dimer formation from aroyl chlorides was noted in PTC assisted cyanation with KCN.<sup>11)</sup> However, as was the case with thallium cyanide,<sup>4)</sup> the present method promoted dimer formation from primary and

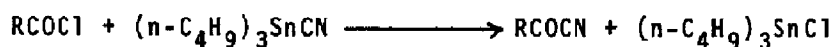


secondary alkyl acyl chlorides. Thus, the treatment of acetyl chloride with the tin cyanide at room temperature for 5 min afforded exclusively acetyl cyanide dimer. The results of dimer formation are summarized in table 2

Ethyl chloroformate, albeit less reactive than the other acid halides, was also susceptible to cyanation with tributyltin cyanide; the yield of ethyl cyanofornate was 57% after a 2.5 hr reaction at 70°C.

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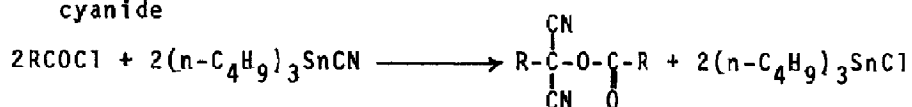
Table 1. Acyl cyanide synthesis from acyl chlorides and tributyltin cyanide



RCOCl R =	Time min	Temp °C	Yield <sup>a)</sup> %	Ir, cm <sup>-1</sup>		Mp or bp <sup>b)</sup> °C
				CO	CN	
C <sub>6</sub> H <sub>5</sub> -	20	75	91.5	1677	2220	33.0-33.4
p-CH <sub>3</sub> OC <sub>6</sub> H <sub>4</sub> -	20	75	96.6	1675	2220	58.1-59.0
p-CH <sub>3</sub> C <sub>6</sub> H <sub>4</sub> -	20	75	99.6	1670	2225	49.5-50.0
p-BrC <sub>6</sub> H <sub>4</sub> -	5	75	- (85.5)	1668	2220	62.5-64.0
2-Thienyl	5	75	85.9(80.7)	1648	2220	54.0-55.0
2-Furyl	10	75	- (82.6)	1664	2232	125/16 torr
C <sub>6</sub> H <sub>5</sub> CH=CH-	20	75	- (47.8)	1656	2220	114.5-115.2
(CH <sub>3</sub> ) <sub>3</sub> C-	10	30	- (92.2)	1712	2224	135/760 torr

a) Estimated by glc analysis using internal standards. Yields for isolated pure samples are shown in parentheses. b) Bp is for short-path distillation.

Table 2. Acyl cyanide dimer synthesis from acyl chlorides and tributyltin cyanide



RCOCl R =	Time min	Temp °C	Yield <sup>a)</sup> %	Ir, cm <sup>-1</sup>		Mp or bp <sup>b)</sup> °C
				CO	CN	
CH <sub>3</sub> -	5	20	93.3	1770	2250	130/15 torr
C <sub>2</sub> H <sub>5</sub> -	5	20	71.8	1775	2251	135/15 torr
(CH <sub>3</sub> ) <sub>2</sub> CH-	5	20	91.1	1772	2252	135-150/15 torr
C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> -	20	20	75.3	1769	2256	131.4-133.0

a) Isolated yields determined on recrystallized or distilled material. b) Bp is for short-path distillation.

## References and notes

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