Selective and Mild Deacylation of Hindered Acylarenes with Aqueous Trifluoroacetic Acid

Takashi KEUMI*, Toshio MORITA, Yōko INUI, Naomi TESHIMA, Hidehiko KITAJIMA

Department of Applied Chemistry, Faculty of Engineering, Fukui University, Bunkyo, Fukui 910, Japan

Sterically hindered acylarenes are deacylated to arenes in quantitative yields on heating in boiling 85% trifluoroacetic acid. Hindered arenecarboxylic acids undergo decarboxylation under the same conditions to give arenes in high yields.

It is known that sterically hindered aromatic ketones and carboxylic acids can undergo hydrodeacylation in the presence of conc. sulfuric acid[1], polyphosphoric acid[2], or Friedel-Crafts catalysts[3]. However, the reaction of polymethylacylarenes with these catalysts is accompanied by some side reactions such as sulfonation[4,5], disproportionation[6], or isomerization[7] of alkyl groups in substrates or products. For example, in the presence of excess aluminum chloride at 100 °C acetyldurene was converted into acetylprehnitine (89%), aromatic hydrocarbons (10%), and diacetyldurene (10%)[6]. Treatment of pentamethylacetophenone with conc. sulfuric acid at room temperature gives a mixture of durene (1.7%), hexamethylbenzene (36.2%), and pentamethylbenzene (10%)[8]. On the other hand, deacylation of alkyl-substituted acylpyrroles has been achieved via the acetal using ethanedithiol/boron trifluoride or ethylene glycol/*p*-toluenesulfonic acid[9]. Further, the perfluororesin sulfonic acid "Nafion-H" is an efficient catalyst for the deacylation of hindered aromatic ketones in excess hot toluene or anisole[10]; however, this procedure implies the problem of isolating the products from excess toluene or anisole. In addition, polymerized products may result from ketene formed during the deacetylation.

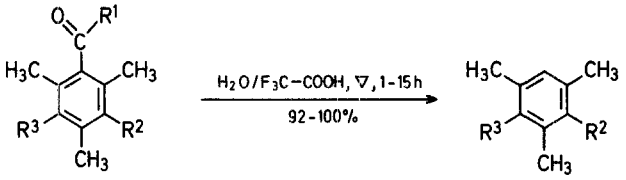
We have previously described the transacylation between polymethylacylbenzenes and some arenes in boiling trifluoroacetic acid[8]. We report now that trifluoroacetic acid

Table. Deacylation or Decarboxylation of Polymethylacylarenes or Polymethylbenzoic Acids, respectively, with 85% Aqueous Trifluoroacetic Acid

1	R^1	R^2	R^3	Reaction Time [h]	Product	Yield of 2 [%]		m.p. [°C] or b.p. [°C]	
						G.L.C.[a]	Isolated[b]	Found	Reported[12]
a	CH_3	CH_3	CH_3	2	**2a**	100	93	49–50°	53°
b	i-C_3H_7	CH_3	CH_3	1	**2a**	99	90	49–50°	53°
c	C_6H_5	CH_3	CH_3	15	**2a**	100	95	49–50°	53°
d	4-Cl-C_6H_4	CH_3	CH_3	15	**2a**	100	90	49–50°	53°
e	4-M_3C—C_6H_4	CH_3	CH_3	15	**2a**	100	90	49–50°	53°
f	OH	CH_3	CH_3	2	**2a**	100	92	49–50°	53°
g	OH	CH_3	H	15	**2b**	100	94	194°	195–197°
h	CH_3	CH_3	H	15	**2b**	95	90	194°	195–197°
i	i-C_3H_7	CH_3	H	15	**2b**	100	91	194°	195–197°
j	CH_3	H	H	15	**2c**	92	70	162°	165°
k	OH	H	H	15	**2c**	100	77	162°	165°

[a] G.L.C. was performed on a column of 3 m packed with 3% Dexil GC on Chromosorb W at 250°C.
[b] All products were identified by ^{1}H-N.M.R.

containing a small amount of water promotes the selective deacylation of hindered acylarenes (**1**) to arenes (**2**).

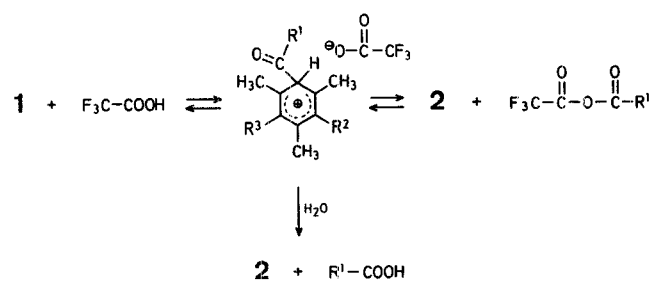


1a-k **2a-c**

In the deacetylation of pentamethylacetophenone (**1a**) to pentamethylbenzene (**2a**) in boiling trifluoroacetic acid, an equilibrium is reached after 2 h with the formation of 40% of **2a**. The addition of small amounts of water accelerates the formation of **2a** and the yield of **2a** increases with increasing amounts of water added. We found that trifluoroacetic acid with a water content of 15% works efficiently in the deacetylation of **1a** and we have therefore also carried out the deacylation (decarboxylation, respectively) of the other compounds **1** with 85% trifluoroacetic acid.

As can be seen from the results listed in the Table, the method works satisfactorily for sterically hindered alkyl aryl ketones, benzophenones, and benzoic acids. Side reactions have not been observed. Thus, the deacylation and decarboxylation method described here is more convenient than earlier reported ones.

As regards the mechanism of the deacylation reaction, it may be assumed that an *ipso*-protonated intermediate at the ring C-atom attached to the acyl group is first formed by protonation of **1** and that water then removes the acyl group of the intermediate. In the absence of water, trifluoroacetate anion works as a nucleophile for removal of the acyl group to give the hydrocarbon **2** and acyl trifluoroacetate. These latter compounds are known to acylate arenes in trifluoroacetic acid solution[11].



Pentamethylbenzene (2a) from Pentamethylacetophenone (1a); Typical Procedures:

Analytical-Scale Procedure: Pentamethylacetophenone (**1a**; 0.200 g, 1.5 mmol) is heated in a boiling mixture of trifluoroacetic acid (5 ml) and water (1 ml) for 2 h. The mixture is then poured into ice/water (~ 30 ml) containing dibenzofuran (0.150 g) as the internal standard for G.L.C. analysis. The mixture is extracted with ether (2 × 30 ml) and the extract is washed with water (30 ml), aqueous sodium carbonate (30 ml), and water (30 ml) and dried with sodium sulfate. After evaporation of the solvent, the residue is analyzed by G.L.C.

Preparative-Scale Procedure: Pentamethylacetophenone (**1a**; 0.500 g, 2.63 mmol) is heated in a boiling mixture of trifluoroacetic acid (8.5 ml) and water (1.5 ml) for 2 h. The mixture is then poured into ice/water (~ 50 ml). The precipitated colorless crystalline product **2a** is isolated by suction; yield: 0.362 g (93%); m.p. 49–50°C (Ref.[12], m.p. 53°C).

Received: December 20, 1984
(Revised form: March 27, 1985)

* Address for correspondence.

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