

Aerobic Oxidative Trifluoromethylation of Arenes Catalyzed by Phosphovanadomolybdic Acids

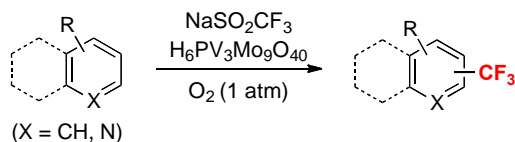
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The trifluoromethyl (CF₃) group is becoming of increasing importance in pharmaceuticals, agrochemicals, polymers, and liquid crystals because the physical and chemical properties of molecules, such as metabolic stability, membrane permeability, and bioactivity, can be remarkably modified by installation of CF₃ group(s). Therefore, the development of efficient trifluoromethylation methods has attracted considerable attention. Recently, significant progress has been achieved in radical-based C–H trifluoromethylation using various kinds of CF₃ sources.^[1] Sodium trifluoromethanesulfinate (NaSO₂CF₃) is one of the most preferable trifluoromethylation reagents because it is relatively stable, easy-to-handle, and inexpensive. Although efforts have been devoted to develop the catalytic direct C–H trifluoromethylation of (hetero)arenes using NaSO₂CF₃ as the source of CF₃ radicals, the previously reported systems typically require superstoichiometric amounts of organic and inorganic oxidants. The NaSO₂CF₃-based trifluoromethylation of (hetero)arenes using O₂ as the terminal oxidant has been remained unexplored until now.

In this study, we report for the first time that phosphovanadomolybdic acids can act as efficient catalysts for oxidative direct C–H trifluoromethylation of (hetero)arenes using NaSO₂CF₃ as the CF₃ radical source and O₂ as the terminal oxidant (Scheme 1).^[2] In the presence of catalytic amounts of phosphovanadomolybdic acids, such as H₆PV₃Mo₉O₄₀, various kinds of structurally diverse (hetero)arenes, such as substituted benzenes, naphthalene, pyrazine, pyridine, quinolone, and thiophene, could be efficiently

converted into the corresponding trifluoromethylated products (Fig. 1). The reaction proceeded without dechlorination for 1,4-dichlorobenzene and 1,2-dichlorobenzene, and no hydration or hydrolytic decomposition proceeded for benzonitrile. Based on the several experimental results, we propose a radical-based reaction mechanism for the present trifluoromethylation.



Scheme. 1 Direct C–H trifluoromethylation of (hetero)arenes using NaSO₂CF₃ as the CF₃ source and O₂ as the terminal oxidant.

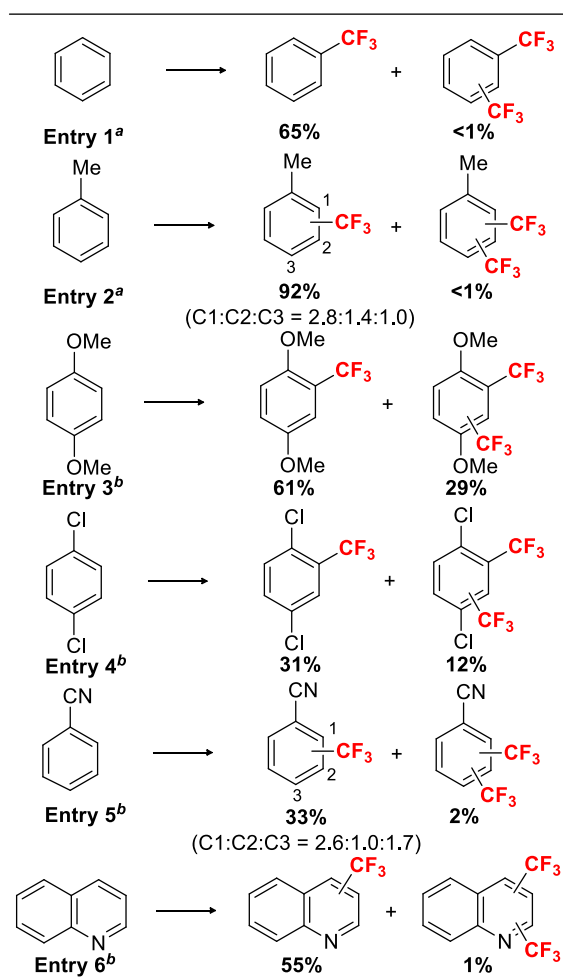


Fig. 1 Substrate scope for the H₆PV₃Mo₉O₄₀-catalyzed trifluoromethylation. ^a Yields were based on NaSO₂CF₃. ^b Yields were based on substrates.

REFERENCES

- [1] C. Alonso, E. Marigorta, G. Rubiales and F. Palacios, Chem. Rev., 115 (2015) 1847.
- [2] C. Li, K. Suzuki, K. Yamaguchi and N. Mizuno, New J. Chem., 2017, DOI: 10.1039/C6NJ03654F.