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A PREPARATION OF ENAMINES

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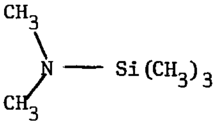
Although a number of reliable methods are available for the synthesis of enamines[2], difficulties are often encountered in the preparation of dimethylaminoenamines due primarily to the high volatility of dimethylamine (b.p. 7°). We wish to report here a general, mild method for the synthesis of a variety of enamines which has advantages over known methods, and which is particularly useful in preparing dimethylaminoenamines.[3]



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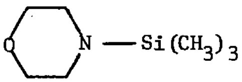

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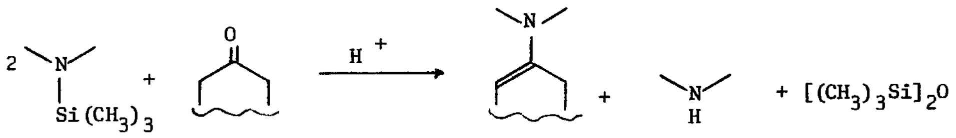
Trimethylsilyl derivatives of secondary amines (e.g. trimethylsilyldimethylamine, b.p. 85° (1) and trimethylsilylmorpholine, b.p. 160° (2)) are readily prepared from the amine and trimethylchlorosilane.[4] Treatment of an aldehyde or ketone with 2-3 equivalents of silylamine in the presence of a trace of p-toluenesulfonic acid, without added solvent, and usually at room temperature, gives high yields of the corresponding enamines (Table I).



Equation 1

One advantage of this method is that the presence of excess silylamine obviates the normal requirements for water removal by azeotropic distillation or by addition of an insoluble drying agent. When less than two equivalents of silylamine are used, enamine synthesis is not complete, presumably due to competition for trimethylsilylamine by intermediate trimethylsilanol and other oxygen-containing intermediates in the reaction cycle (equation 1).[5] A second advantage in the method is that no heating is necessary for derivatizing unhindered ketones and aldehydes. However, heating the reaction is possible and permits enamine formation in equally high yield without an acid catalyst. The only selectivity we have observed to date is that 2-methylcyclohexanone forms its enamines sluggishly, requiring both acid catalysis and heat, resulting in only modest yields.

1-Dimethylaminocyclohexene:

To a mixture of 3.92 g (0.04 mole) of cyclohexanone and 14.04 g (0.12 mole) of trimethylsilyldimethylamine (1) was added 0.15 g of anhydrous p-toluenesulfonic acid. The mixture was allowed to stand for 24 hr at ambient temperature. Infrared analysis revealed the complete absence of carbonyl absorption. The mixture was fractionally distilled to afford 4.41 g (88%) of 1-dimethylaminocyclohexene which was homogeneous by glc (6 ft. SE-30 Column, 150^{o}) and nmr.

TABLE I Preparation of Enamines Using 2-3 Equivalents of Silylamine and p-Toluenesulfonic Acid Catalyst at Room Temperature.

	Isolated Yield of Enamine	
Carbonyl Compound	Trimethylsilyl-morpholine (2)	Trimethysilyl-dimethylamine (1)
cyclohexanone	87	88
cyclopentanone	92	85
2-methylcyclohexanone[a]	54	
isobutyraldehyde	76	88
n-butyraldehyde	76	78

[a] This reaction requires heating at 90° for 7 hr.

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References

1. Undergraduate Research Participants supported by the Fordham University Research Council.
2. "Enamines, Synthesis, Structure and Reactions", A.G. Cook, ed., Dekker, N.Y., 1969.
3. After the exploratory experiments in this area were performed (R.P. Szajewski, Fordham University, 1971) a patent appeared (T.G. Selin, C.A., 76, 45258a 1972) reporting synthesis of several ketone enamines utilizing dialkylaminosilanes.
4. (a) R.A. Pike and R.L. Schank, J. Org. Chem., 27, 2190 (1962).

   (b) Trimethylsilyldiethylamine is, in fact, commercially available (Pierce and Aldrich).
5. At present we can only speculate as to the mechanism of this enamine preparation.