Synthetic Reactions by Complex Catalysts. X. Copper Catalyzed *N*-Ethylation of Piperidine with Ethylene

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Recently we have reported the copper catalyzed reactions of primary and secondary amines with isocyanide (Eq. (i)),[1] with carbon monoxide (Eq. (ii))[2] and with carbene from diazo compound (Eq. (iii)).[3]

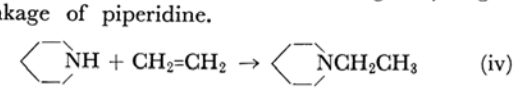
$$RR'NH + :C{\leftrightharpoons}N\text{-}R'' \rightarrow RR'NCH{=}N\text{-}R'' \quad \text{(i)}$$

$$RR'NH + :C{\equiv}O \rightarrow RR'NCHO \quad \text{(ii)}$$

$$RR'NH + :CHR'' \rightarrow RR'NCH_2R'' \quad \text{(iii)}$$

These reactions are the insertions of the carbon atoms having lone-pair electrons into the nitrogen-hydrogen linkage of amine. Copper-amine complex has been assumed to be essential in the catalysis of these reactions.

In the present paper, we wish to describe the preliminary results of the studies on copper catalyzed *N*-ethylation of piperidine with ethylene in which ethylene is inserted into the nitrogen-hydrogen linkage of piperidine.



In a 50 m*l* stainless steel pressure tube, 9.9 m*l* (100 mmol) of piperidine and a catalyst were placed, to which ethylene was compressed up to 50 atm at room temperature. The tube was closed and the content was heated at an indicated temperature without stirring and shaking. After cooling, excess ethylene was vented and the content of the pressure tube was subjected to distillation. The distillate (bp 105—130°C) was collected and analyzed by glpc. *N*-Ethylpiperidine was the sole product detected in glpc analysis. Some results of the reaction of piperidine with ethylene by copper halides catalysts are illustrated in Table 1.

TABLE 1. COPPER CATALYZED REACTION OF PIPERIDINE AND ETHYLENE[a]

No.	Catalyst mmol		Temp °C	Reaction time hr	Yield(%)[b] of *N*-ethylpiperidine
1	$CuCl_2 \cdot 2H_2O$	(20)	170	14	24
2	$CuCl_2$	(30)	190	15	49
3	CuCl	(15)	200	15	trace
4	CuCl	(30)	200	15	6
5	CuCl	(50)	200	15	38
6	CuI	(50)	200	15	16
7[c]	CuCl	(50)	230	14	7
8[d]	CuCl	(50)	230	14	9

a) 9.9 m*l* (100 mmol) of piperidine was used. Ethylene was compressed up to 50 atm at room temperature. The pressure tube was closed and heated.
b) Based on charged piperidine.
c) *n*-Hexane (10 m*l*) was used as solvent.
d) Benzene (10 m*l*) was used as solvent.

So far as we have examined, only copper compounds, especially copper chlorides, showed catalytic activity for this reaction. The chlorides of the other transition metals such as silver, gold, zinc, mercury, molybdenum, iron, cobalt and nickel were substantially ineffective under the reaction conditions of the copper catalyzed reaction. Furthermore, aluminum chloride, a strong Lewis acid, was also inactive for this reaction.

In the ethylation of piperidine by copper halide catalysts, a fairly large amount of catalyst is required and the product yield depends upon the catalyst amount (Nos. 3, 4 and 5). *n*-Hexane and benzene as the reaction solvent decrease the product yield (Nos. 7 and 8). The present finding affords a new method of ethylation of amine which is due to a specific catalyst nature of copper halides to form co-ordination complex with amine.

1) T. Saegusa, Y. Ito, S. Kobayashi, K. Hirota and H. Yoshioka, *Tetrahedron Letters*, **1966**, 6121.
2) T. Saegusa, S. Kobayashi, K. Hirota and Y. Ito, *ibid.*, **1966**, 6125.
3) T. Saegusa, Y. Ito, S. Kobayashi, K. Hirota and T. Shimizu, *ibid.*, **1966**, 6131.