COMMUNICATIONS TO THE EDITOR

Hazards with Ammonia and Mercury

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In the January, 1963, issue of the *A.I.Ch.E. Journal*, an article entitled "The Viscosity of Ammonia: Experimental Measurements for the Dense Gaseous Phase and a Reduced State Correlation for the Gaseous and Liquid Regions," by Hiroshi Shimotake and George Thodos, appeared in which viscosity values were obtained in a transient capillary type of viscometer. The experimental procedure required that ammonia be compressed over mercury. When this study was initiated in 1958, there was concern about the possible explosive effects of this system of ammonia in contact with mercury. A cursory literature search was conducted to obtain information on this subject, but nothing was mentioned and the investigation was started in which pressures up to 5,000 lb./sq.in. and temperatures as high as 200°C. were attained. It was not until after this study had been completed that the possible hazard was learned. This information is contained on page 71 of the text, "High Pressure Technology" [McGraw-Hill, New York (1956)] by E. W. Comings in which the following is mentioned:

> Under pressure mercury forms a compound with ammonia consisting of several molecules of ammonia per atom of mercury. This compound apparently is not explosive; however, as the pressure is lowered the ratio of ammonia to mercury decreases and a compound similar to fulminate is formed. This has been known to detonate and is a serious hazard. The hazard is greatest when a system containing mercury and ammonia is being depressurized or the ammonia removed.

Kenneth E. Walker of the du Pont Company has communicated to the author that they have found in their research work that there is a serious hazard in having ammonia in contact with mercury. Specifically he pointed out that "under certain conditions, which are not well understood, a compound is formed which is shock sensitive and explodes with considerable violence." This hazard has also been reported by others. For instance, the Matheson Gas Data Book, published by the Matheson Company, Incorporated, in 1961, states: "Ammonia can combine with mercury to form explosive compounds, therefore, instruments containing mercury that will be exposed to ammonia should not be used."

A. M. J. F. Michels, E. M. L. Dumoulin, and J. H. Gerver [*Rec. trav. chim.*, **76**, 5-12 (1957)] have reported the results of an experimental study entitled "The Reaction of Ammonia on Mercury in the Presence of Traces of Water." These investigators concluded that an explosive compound results at high pressures only in the presence of small quantities of water. This compound has been identified to be an aminomercury oxide and is explosive. Their study corroborates the results of R. G. Roberts [*Science*, **94**, 591 (1941)] who found that pure ammonia does not react with well-purified mercury, even at high pressures and temperatures, and perhaps explains why no explosion was encountered in the study of Shimotake and Thodos in which the ammonia used was most likely completely dry.

This information is brought to the attention of *Journal* readers so that no one in the future attempts to duplicate the procedure described by Shimotake and Thodos without extreme caution. In experimental studies involving the contact of ammonia with mercury, the ammonia should be completely dried by contact with sodium wire. This situation is documentary evidence of the need to exercise extreme caution in experimental studies where complete experimental background is not available.

Hysteresis in Liquid Mixing Systems

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Experiments with a conventional liquid mixing system, consisting of a cylindrical tank equipped with four vertical baffles and a six blade-flat blade turbine impeller, have demonstrated the existence of a hysteresis effect when the rotating impeller is slowly raised from near the bottom of the tank. Under these conditions a metastable axial flow pattern characteristic of propeller agitation exists over a range of impeller heights. This was visually demonstrated with a suspension of small solid particles in the liquid. This axial flow pattern reverts to the normal radial flow pattern again when the impeller is raised above a certain height.

When the rotating impeller is lowered below the standard height of one third the diameter of the tank, the normal radial flow pattern and power output persists over part of the range where the axial, propeller type of flow

TABLE 1. PHYSICAL PROPERTIES OF THE LIQUIDS USED

Liquid	Temperature, T, °F.	Density, e, lb./cu. ft.	Viscosity, μ, cm./sec.
Cylinder oil	73	55.2	2,750
Gulf Paragon no. 84 oil	75	57.2	955
Castor oil	70	59.4	840
Mobil Society of Automotive Engineers No. 50/50 lubricating oil	77	54.9	480
Mobil Society of Automotive Engineers No. 20/20 lubricating oil	82	54.5	103