New Approach on Agriculture, Forestry, Horticulture and Fishery
(Research and Applied) *https://www.kdpublications.in*

ISBN: 978-93-94570-42-9

Implications of Methylamine Residues in Bhopal Soil and Water under Diverse Climatic Factors

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Abstract:

It was determined to conduct this study invitro in context of the methylisocyanate catastrophe, in which methylamine, which has been reported as carcinogenic, was developed as a result of the hydrolysis of methylisocyanate (MIC). The methylamine sensitivity in water and soil were 0.14 and 0.25 ppm, respectively. The dissipation rate of methylamine in water and soil have been shown to be faster during the summer season, slower during the rainy season, and still slower during the winter season.

6.1 Introduction:

On December 3, over five lakh individuals were exposed to methyl isocyanate from UCIL (Union Carbide India Limited) pesticides factory in Bhopal, the capital city of Madhya Pradesh in the heart of India. Due to India's strategic position, the American company Union Carbide Corporation built a pesticide plant there. Sevin, a pesticide, was meant to be produced by the plant. According to an agreement between Union Carbide and the Indian Government, Union Carbide held a 50.9% stake in the company, and Indian investors held a 40.1% stake.

The Union Carbide India Limited was the name of the facility (UCIL). In 1979, UCIL began producing pesticides. While this insecticide was being made, Methyl Isocyanate, a hazardous substance, was also being made (MIC). Since MIC is a highly dangerous compound, it needed extensive upkeep. People who were sound asleep on December 4, 1984, around one in the morning, began to feel the change in the air as the MIC gas began engulfing the entire city of Bhopal. They attempted to flee for their lives but were unable to do so. Some people who managed to survive were unable to shield themselves from the impending infirmities. All of this occurred as a result of MIC gas leakage from tank E106. Additionally, there have previously been complaints about the plant's upkeep and the minor levels of MIC leakage.

The earlier leakage episodes had also resulted in a number of fatalities and serious injuries. But the authorities gave it no thought. There was no replacement for the worn-out machines. According to reports, about 3000 people died and more than 6 lac more suffered severe injuries. With ongoing respiratory issues among other challenges, the survivors made it through. Health problems were seen in new born who weren't even yet born at the time. In order to give the Bhopal tragedy victims better medical care, the Permanent Peoples' Tribunal urged in 1992 that an international commission be established. Later, a request for the same was made in 1993 by the Bhopal Group for Information and Action. In 1993, the International Medical Commission on Bhopal (IMCB) was established to offer medical aid to the survivors of the 1984 Bhopal tragedy.

6.2 Immediate Effects of the Bhopal Gas Tragedy:

The colourless liquid called methyl isocyanate (MIC) is used to make insecticides. It is quite poisonous. It needs regular care since it reacts strongly to water. In order to raise the pressure necessary for turning the liquid into a deadly gas, only a minimal amount of water is required. Three tanks of MIC were to be kept in storage at the UCIL, and its temperature had to be kept below zero celsius. Additionally, it had to be held under pressure using inert nitrogen. However, a few days prior to the tragedy, the tank E106 in which the MIC was stored could no longer withstand the pressure, which forced a temporary halt in production.

Even after becoming exhausted, the tank was unable to cease the production for an extended period of time. After some time, the production process was resumed. However, due to a lack of upkeep, on the night of December 2-3, 1984, water began to leak from the connecting pipe and mix with the MIC liquid. This led to a significant heating reaction, which produced pressure at a splitting rate and caused the release of the MIC gas. The dangerous gas began to affect adjacent residents as they started to evacuate. They began to experience breathing difficulties, eye discomfort, chemical burns on the skin, and lung contractions. They were subsequently rushed to the hospital, but the physicians couldn't properly treat them without knowing what caused the mishap in the first place. Methyl isocyanate is extremely poisonous. According to the American Conference of Government Industrial Hygienists, MIC exposure to a worker is safe up to a level of 0.02 ppm. By inhalation or consumption, it becomes dangerous as soon as the level reaches 0.4 ppm. Most people cannot detect it at 5 ppm, but they are warned because of symptoms.

The following are some exposure symptoms:

- Reddening of the eyes
- A difficulty breathing
- An irritation of the nose and throat
- Skin burning
- Coughing

When the exposure level exceeds 21 ppm, it may cause:

- Death
- Pneumonia - An illness that results in lung inflammation

- Lung edoema - A condition in which there is an excessive build-up of fluid in the lungs, making breathing difficult

When the hazardous gas methylisocyanate react with water, the first notable hydrolysis product generated is methylamine (Monomethyl amine, Amino-methane). When the poisonous methylisocyanate interacted in the atmosphere, it wreaked devastation to flora, wildlife, and living things. Almost no research has been carried on the sustainability of MIC hydrolysis chemical residues in Bhopal's water and soil. As a result, the current study recognizes the importance of knowing the degree of MIC hydrolyzed products dissipation, particularly in Bhopal's water and soil, in order to provide baseline data in the field of residue toxicology.

6.2.1 Material and Method:

The analysis was carried in vitro with Bhopal-specific soil and water. The water from the Upper Lake, which is a significant drinking water source for Bhopal city and its surrounding terrain, was collected in three environmental conditions over the years 2020-21. The persistence of Methylamine (MA) in water and soil was evaluated employing varying quantities of methylamine ranging from 2.50 to 3.75 ppm. Seasonal temperature fluctuations were also recorded, which would provide the data needed for persistence. The cleanup of final extract appropriate fractions was performed using a Nitrogen-Phosphorus detector in a Gas Chromatography Sigma 300 (Perkin Elmer, USA).

6.2.2 Results and Discussion:

For the persistence investigation in water and soil, the concentration ranges of Methylamine were 2.50 to 3.75 ppm and 5.00 to 7.50 ppm, respectively. The rate of methylamine dissipation in water was higher during the summer trial, lower during the rainy season, and slow during the winter season. The physico-chemical properties of the test water and soil were also investigated. (See Table 6.1) After 10 days, practically all of the doses showed 50% dissipation, as seen in the data (Table 6.2).

Lower doses had completely dissipated after 35 days. The physicochemical properties of test water may be to blame for the variability in data seen in Methylamine residues. Dissolved oxygen, total alkalinity and hardness, pH, Chemical Oxygen Demand, and temperature may have interfered with the degradation reaction that happened in the Lake water sampled. The residual data observed during and after 35 days was significant, which could have an impact on the Lake's ecosystem.

In an experiment conducted throughout the summer, followed by the rainy season, and finally the winter season, the nature of methylamine dissipation in soil reveals a faster rate. The extensive data on methylamine persistence in soil over three seasons is given in (table 6.3). After 35 days, the remnants had dropped below the detection level, according to the representative. The variance in data reported in methylamine residues could be related to seasonal physio-chemical features, specifically variations in pH, moisture, clay content, and abundance, which could have hampered decomposition in soil. The dissipation was also enhanced significantly by the seasonal shift in temperature.

In conclusion, when experiments were conducted in vitro, methylamine, which is the breakdown product of MIC, showed a significant decrease in residue in water and soil of Bhopal. Methylamine residues may have had a long-term negative impact on the flora, fauna, and all living systems.

Table 6.1: Physico-chemical parameters of test water and soil

Sr. No.	Physico-chemical parameters	RANGE	AVERAGE
1.	Temperature (^{0}c)	17.4-25.8	22.0
2.	Dissolved oxygen (mg//)	6.3-11.9	8.5
3.	Total alkalnity (mg//)	117.0-142.0	126.0
4.	Total hardness (mg//)	81.0-123.0	101.0
5.	Ph	7.2-9.1	8.4
6.	Chemical oxygen demand (mg//)	6.7-13.4	9.7

Soil:

1	pH	7.6-8.0	7.8
2	Electrical conductivity	0.50-0.58	0.54
3	Clay content	38%-42%	40.3%
4	Organic carbon	0.40-0.48%	0.44%
5	Moisture	3%-5%	4%

Table 6.2: Representative persistence of methylamine in water

Sr. No.	Conc. M. A. Applied (ppm)	Dissipation (days)						
		5 (ppm)	10 (ppm)	15 (ppm)	20 (ppm)	25 (ppm)	30 (ppm)	35 (ppm)
1	2.50	1.56	1.05	0.45	0.15	BDL	BDL	BDL
2	2.85	1.86	1.38	0.71	0.38	0.16	BDL	BDL
3	3.10	2.71	1.51	0.93	0.65	0.36	0.15	BDL
4	3.45	2.88	1.71	1.23	0.86	0.56	0.31	0.14
5	3.75	3.10	1.96	1.71	1.21	0.86	0.60	0.41
BDL < 0.14ppm								

Table 6.3: Representative persistence of methylamine in soil

Sr. No.	Conc. M. A. Applied (ppm)	Dissipation (days)						
		5 (ppm)	10 (ppm)	15 (ppm)	20 (ppm)	25 (ppm)	30 (ppm)	35 (ppm)
1	5.00	2.80	1.78	1.05	0.53	0.25	BDL	BDL
2	5.70	3.46	2.16	1.35	0.83	0.50	BDL	BDL
3	6.30	3.98	2.86	1.50	0.98	0.55	0.26	BDL
4	6.90	4.21	3.45	2.03	1.68	0.81	0.35	BDL
5	7.50	4.65	4.55	3.76	2.75	1.35	0.51	BDL
BDL < 0.25ppm								

6.3 References:

1. Saunders J. H. and Slocombe, R.J., *chem. Rev*., 43,203(1948).
2. Arnold, R. G., Nelson, J. A. and Verbanc, J.J., *chem. Rev*., 57, 47(1957).
3. Satchell, D.P.N. and satchell, R. C.C*hem. Soc. Rev*.,4,231(1975).
4. Themistocles, D. J. D. Anibal, L., Russell, L. J., Sureerat, S. and John, K. C., *studies of methylisocyanate chemistry in the Bhopal incident. J. Org. Chem.*, 51, No. 20, 3781-3788(1986).
5. Rye, W. A., *J. Occup. Med*., 15, 306 (1973).
6. BRMA, *British Rubber Manufacture Association Limited*, Birmingham, (1977).
7. Berstein, L.A. Aller. *Clin. Immunol*, 70, 24 (1982).
8. Fuselli, S. Benedett, G. and mastrangeli, R., *Atmos. Environ*., 16(2), 2943-2946 (1982).
9. Sen Gupta, R., Sarkar, A. and Kureishy, T.W., *Water Res.*, 25(2), 179-183 (1991).
10. Edward Broughton, *The Bhopal disaster and its after math a review* (2005)
11. Amina sheriff, Disaster, PP savani university (2020)
12. Britannica T.E., Bhopal distaster, National centre for Bio technology Information-pubmed central (2020)
13. Wikipedia, T.F. (n.d.) Bhopal disaster (2020).