Evaluation of sewage sludge quality and sludge treatment technologies for the reutilization potential in India

Ankur Rajpal[1], Vinay Kumar Tyagi[2], Pravin Kumar Mutiyar[3], Absar Ahmad Kazmi[1]

[1]Environmental Engineering Group, Indian Institute of Technology Roorkee, Uttarakhand, 247667, India
[2]Environmental Hydrology Division, National Institute of Hydrology, Roorkee, Uttarakhand, 247667, India
[3]National Mission for Clean Ganga, Ministry of Jal Shakti, New Delhi, Govt. of India.
Keywords: Sewage sludge, quality control indices, heavy metals, pathogens
Presenting author email: ankur.envt@gmail.com

Abstract

In India, sludge from STPs is usually disposed of on land as manure or dumped in open areas. However, heavy metals pathogens and hazardous organic contaminants in sewage sludge restrict its use as a soil amendment. Open dumping and/or direct utilization of dewatered sludge on land may create problems like odor nuisance, groundwater pollution, and other public health hazards. In India most common sludge treatment methods are anaerobic digestion, mechanical composting, solar sludge drying, and incineration are used to for disposal. Hence, to understand the fate of sludge on land application, the characterization of dewatered or treated sludge in terms of pathogens, vectors, and heavy metals is desired.

For the study purpose, treated sludges from twenty-two sewage treatment facilities were characterized to develop the quality control indices in India. In addition, techno economical evaluation of existing treatment technologies was performed in India. The findings revealed that except for K, all the dewatered sludge samples have pH, electrical conductivity, total organic carbon, TN, TP, and C:N ratios within the threshold range of the Indian Standard of Fertilizer Control Order (FCO-2009). The heavy metals concentrations meet USEPA Class B sludge quality criteria but failed to meet the limiting concentrations of heavy metals and pathogens specified by USEPA Class A sludge and FCO-2009 standards. Approximately 54% of the sludge samples fulfilled the vector attraction reduction criteria of USEPA criteria. This study used Fertilizer Index (FI) and Clean Index (CI) as a tool for categorizing sludge utilization into different classes (A, B, C and limited use classes LU-1, LU-2, LU-3) by their fertilizing potential, toxicity level, pathogen presence, and vector attraction reduction criteria. The findings revealed that all sludges belong to class C and lower category due to toxic metals, and pathogens.

The findings revealed that Total P (as P_2O_5), Total N, and K (as K_2O) in the sludge samples ranged from 0.9 - 5.7%, 1.2- 3.8%, and 0.1- 1.5%, respectively and all sludges belong to class C and lower category due to toxic metals, pathogens.

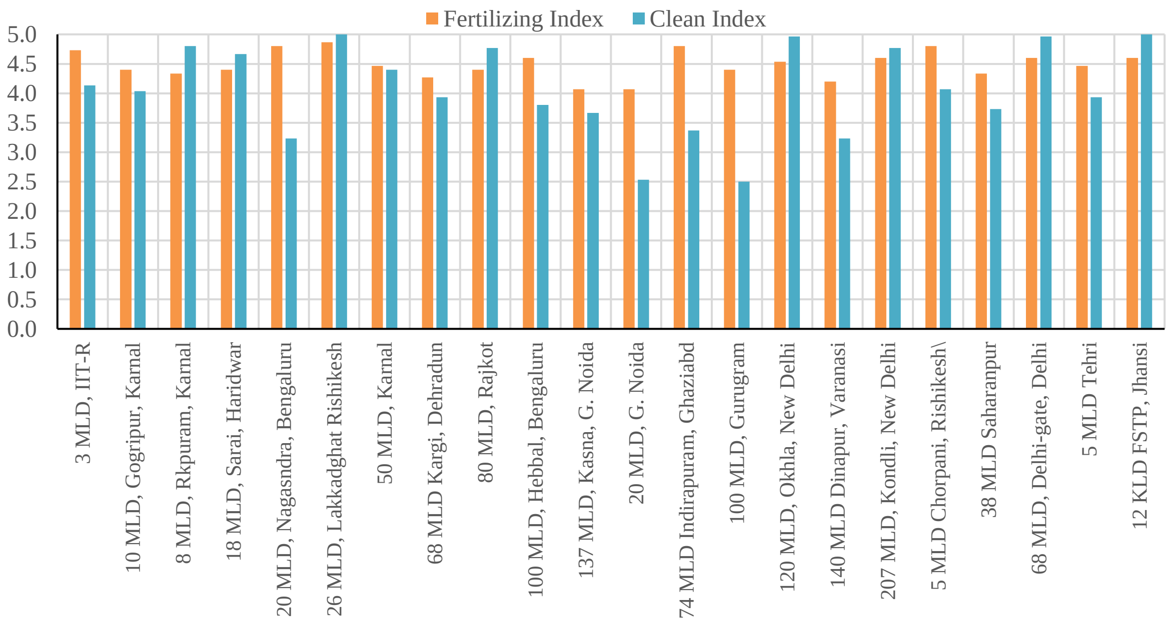

Fig. 1. Clean and fertilizing index values for the sludges generated in sewage treatment plants in urban India

The helminth eggs were found in the range of 25-1450 Numbers/4g of TS in sludge samples. The highest number of helminth eggs of 1450 /4g of TS was found in the fecal sludge sample. The SOUR values in the sludge samples varied from 0.3-4.9, with a median value of 1.3 and RSD of 86% is way too high. It indicates that the sludge samples need further treatment to be less attractive as a food source for vectors and rodents. However, sludge samples have fertilizing potential and FI value is reported to ranges from 4.1 to 4.9 and CI value ranging from 2.5 to 5.0. It indicates that compost is best in quality and having high-fertilizer potential and low heavy-metal content which is suitable for high-value crops such as organic farming. Further sludge treatment using typical composting, aerobic or anaerobic digestion, and solar or thermal drying could bring the sludges into the class A and B category.

Table 5. Categorization of dewatered sludge for marketability and use for various purposes

Class	Fertilizing Index	Clean Index	Pathogens and Vector Presence	Remarks
	(TOC, TN, TP, K, C: N)	(Heavy Metal Index)	(Fecal Coliforms, Salmonella species, Helminthes Eggs, SOUR)	
A	> 4.0	> 4.0	Complying thresholds of US EPA Class A	**Best-Quality Compost**, Low levels of heavy metals, high potential for manure, and application to high-yield crops in organic farming
B	> 3.1	> 3.0	Complying thresholds of US EPA Class A	**Good Quality Compost,** Medium fertilizing potential and low levels of heavy metals
C	> 3.0	> 2.0	Complying thresholds of US EPA Class B or CPHEEO	**Medium Quality Compost,** Medium fertilizing potential and medium levels of heavy metals
LU-1	> 2.5	> 2.0	Complying thresholds of US EPA Class B or CPHEEO	**Limited utilization- 1,** Can be utilized as a soil conditioner, or for growing non-food crops, and in non-public contact sites
LU-2	> 2.5	> 1.0	Complying thresholds of US EPA Class B or CPHEEO	**Limited utilization- 2,** Must not be allowed to market, can be applied for non-food crop cultivation. Requires regular soil quality monitoring, if applied regularly,
LU-3	> 2.5	-	-	**Limited utilization- 3.** may only be applied once for the development of lawns and gardens, and if Clean Index is less than 1.0, then to be disposed of as per Hazardous Waste Management Rules- 2016

This study revealed that the sludge samples have higher fertilizing potential (Fertilizing index > 4.0) except for K (as K_2O) and comply with the regulatory limits set by Indian Fertilizer Control Order for TOC, TN, TP (as P_2O_5), and C: N ratio. Sludge sample from STPs receiving only sewage was able to satisfy the clean index of Class A (Clean Index > 4.0).

References:

CPHEEO (2016), Indian standard methods of Analysis of solid wastes. Central Public Health and Environmental Engineering Organisation IS-10158, 1982 (Reaffirmed 2003).

FCO (2009) Fertiliser (Control) Order 1985. The Fertiliser Association of India, Ministry of Agriculture and Rural Development, India. 10, Shaheed Jit Singh Marg, New Delhi, India.

USEPA (1982) Guide to the Disposal of Chemically Stabilized and Solidified Waste, SW-872, Washington, DC, Office Solid Waste Emergency Response.