NATIONAL SOLID WASTE ASSOCIATION OF INDIA

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NSWAI ENVIS

URBAN MUNICIPAL SOLID WASTE MANAGEMENT

Newsletter

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वहाँ है खुशहाली ।।

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FROM THE PRESIDENT'S DESK

Through our news letter we have been bringing out various aspects of solid waste management with the view to disseminate environmental awareness. We have also been presenting salient features of various rules relevant to solid wastes as notified by the Ministry of Environment and Forests (MoEF), New Delhi under the Environment Protection Act 1986. Our last news letter dealt with decadal growth and per capita generation of waste in 40 Class I cities of Maharashtra and the financial aspects of collection and transportation of municipal solid waste explained on the basis of six different models.

In the present issue we are bringing out the topics of ***"Waste to Energy and its importance in solid waste management in India"*** *and* ***"Climate change"****, which are the most discussed topics of present era.*

Generation of waste is inevitable in human activities. In nature, a balance is maintained as the waste generated by animals and human beings serve as nourishment for the plant life. So long as this natural cycle is maintained, the question of pollution due to waste does not arise. However, with increasing industrialization, urbanization and changes in the pattern of life, which are unavoidable in any process of economic growth, waste causes damage to environment unless it is very carefully managed. The waste to energy topic focuses on the projects related to the generation of energy from waste and comments from the experts on the same are also given.

During the last century, the Earth's average surface temperature rose by around 0.6°C. Evidence is getting stronger that most of the global warming that has occurred over the last 50 years is attributable to human activities and the green house gases that are emitted such as carbon dioxide, methane etc. These cause climate change which is one of the greatest environmental, social and economic threats facing the planet. This topic on climate change in the newsletter focuses on methane emission with respect to approximate methane emission all over India.

— Dr. Amiya Kumar Sahu

Waste to Energy and its importance in Solid Waste Management in India

A common sight in cities and towns of India is that of the piles of garbage. This is one of the consequences of the process of rapid urbanization coupled with increased industrialization that our country is witnessing. Unplanned and unscientific methods for disposal of waste materials of diverse nature generated from human and manufacturing activities, have led to increasing pollution and environmental degradation, posing a considerable hazard to public health and local as well as global environment. India's population as per 2001 census is 1027 million, of which 285.3 million people reside in 5161 urban areas. The problem of urban waste management is noteworthy not only because of large quantities of waste but also due to its spatial spread across 5161 Urban-Local-Bodies and a variety of problems faced in setting up for systems for collection, transportation and disposal of waste. According to a recent estimate, Indian urban-population generates about 42 Million Tonnes of the solid waste every year. This translates into a potential for generation of over 1700 MW of power from urban waste in the country.

Available options for Waste to Energy

There are various options available to convert solid waste into energy

1. **Sanitary Landfilling —** Sanitary landfill is the scientific dumping of MSW (Municipal Solid Waste) using an engineering facility that requires detailed planning and specifications, careful construction and efficient operation due to which maturity of waste is achieved faster and hence gas collection starts even during the process of landfilling.

2. **Incineration —** Incineration technology is controlled combustion of waste with recovery of heat to produce steam, which in turn produces power through steam turbines.

   MSW after a pretreatment is fed to a boiler of suitable choice wherein high-pressure steam is used to produce power through a steam turbine. Proper air pollution measures are taken and ash from the boiler is dumped in the nearby landfill.

   Depending on the pretreatment methodology there are mainly two types of MSW combustion technology.

   i. Unprocessed solid waste combustion technology (Mass burning)

      MSW is burnt without significant fuel preparation. The MSW undergoes only limited processing to remove non-combustible and oversized items. Mass burn technologies include water wall furnace, refractory furnace, rotary kiln furnace, water-cooled rotary combustion furnace and controlled air furnace.

   ii. Processed solid waste combustion technology (RDF burning)

      RDF (Refuse Derived Fuel) system is used to separate MSW into Combustible & non-combustible fractions. The combustible material is called RDF and can be used in boilers. Due to reduction of fuel particle size & reduction in non-combustible material, RDF fuels are more homogeneous and easier to burn than MSW feedstock. The RDF burning technologies include spreader stroker fire boiler, suspension fired boilers, fluidized bed units and cyclone furnace units.

3. **Gasification —** A gasification technology involves pyrolysis of RDF under limited air in the first stage followed by higher temperature reactions of pyrolysis product to generate low molecular weight gases such as CO, CH_4, H, N, etc. The gases known as producer gas has the calorific value of 1000-1200 kcal/Nm^3, which could be used in IC (Internal Combustion Engine) for direct power generation or in boilers for steam generation to produce power.

4. **Anaerobic digestion —** This technology is also called as Biomethanation. The putrescible factor of the waste is digested anaerobically (in absence of air) in specially designed digester. Under this bacterial activity, the digested pulp produces combustible gas CH_4 (methane) & inert gas CO_2 (carbon dioxide). The remaining digestate is a good quality soil conditioner. The core of the whole technology is the anaerobic digestion. There are many technologies for effective digestion which differ from each other depending upon their digestion parameter such as; Dry batch, Dry continuous, Wet multistage and Sequencing batch.

Waste to Energy Projects in India

MNES (Ministry of Non-conventional Energy Sources) is implementing a programme on "Energy Recovery from Urban Wastes" under which three projects for energy recovery from MSW with an aggregate capacity of 17.6 MW have been set up at Hyderabad, Vijayawada & Lucknow. Another 0.5 MW plant for vegetable market & slaughterhouse at Vijayawada and 300-kW project based on vegetable market waste is under commissioning at Chennai. Since the project at Lucknow is presently not in operation, details of other projects are given below.

MSW based power project at Hyderabad, Andhra Pradesh

A waste to energy plant has been set up by M/s SIL (Selco International Limited) for production of RDF (refuse derived fuels) pellets that can be used as an alternative to coal for energy production. The total cost of the project is about Rs 43.50 crore. The plant was commissioned in November 2003 and has been operational since then with maintenance shutdown for 1-3 days per month.

This plant is located next to the Gandhamaguda Municipal waste dump, which receives 1300 MT of garbage everyday from Hyderabad city. The installed capacity of plant is 1000 tonnes per day and it has capacity to produce 200-250 tonnes per day of fuel pellets. The calorific value of fuel pellets produced in the first phase was of the order of 3000 kcal/kg. The technology for production of RDF fuel pellets was obtained from TIFAC (Technology Information Forecasting and assessment council), DST (Department of Science and Technology). SIL is processing about 500MT of MSW for production of about 150 TPD of RDF fluff.

The salient features of the project are as follows :

Feeding mechanism

The fuel is spread from the side of the boiler. The rotary spreaders and its blades are designed to suit the RDF spreading. The drag chain conveyor is also especially designed for conveying the RDF. Second conveyor with half an hour stage storage and three screw feeders with variable frequency drives has also been installed as a standby fuel-feeding system.

Design of the boiler

The boiler tubes are protected with special alloy coating. This alloy has a high thermal conductivity and protects the boiler tubes from corrosion and erosion. This was also filed for an Indian patent. Secondary air is pre-heated and sent into the boiler at various points for proper burning of RDF. Air-cooled condenser has been employed in place of conventional water-cooled condenser, which is an emerging technology in the country, thus saving about 30,000 liters of water per hour. The initial ash fusion starts at a temperature of 860^0C hence low furnace temperature has to be maintained, and the boiler is designed accordingly to prevent clinker formation.

6 MW Municipal Solid Waste-based power project at Vijayawada, Andhra Pradesh

This project has been installed by M/s SESL (Shriram Energy Systems Ltd), Hyderabad, and is based on combustion of RDF in the form of fluff produced from MSW. A total of 500 tonnes of MSW available from Vijayawada and Guntur cities is being collected and processed for preparation of fluff in respective cities, and used at the plant site at Vijayawada. The cost of the project is about Rs. 45 crore.

The technology adopted for generation of Energy from MSW can be divided into two major stages:

RDF processing and Energy generation. In the first stage the MSW is converted into RDF, whereas in the second stage the converted RDF is combusted for generation of energy. The intrinsic parameters such as ash fusion temperature, presence of sodium salts, chlorine and PVC plastics also play a role in the sizing, specification, and configuration of the steam generator.

Biomethanation of mixed urban wastes at Vijayawada, Andhra Pradesh

A demonstration project for Biomethanation of 20 tonnes mixed wastes per day for generation of 150 kWh of electricity and rich bio-manure was installed by Vijayawada Municipal Corporation. The daily feed to the plant consists of 16 tonnes of vegetable market and 4 tonnes of slaughterhouse waste.

The sewage sludge for the adjoining STP (Sewage Treatment Plant) is used for making the slurry to be fed into the digesters. The total cost of the project is Rs 283 Lakh. This is a hybrid design of a two-stage digestion process for treatment of slurry containing high-suspended solids. The sizes of the reactors for the first and second stages are decided on the basis of suspended organic content in the slurry to be treated. The first stage is the hydrolysis stage, and the second stage is the methanization. The first stage is designed to give maximum solid retention time for hydrolysis and the second stage is a UASB (Up-flow Anaerobic Sludge Blanket) digester.

The entire process consists of the following five sections

Waste handling and processing section — Main components of waste processing are the loading dock with ramp, belt conveyor, chaff cutter, pulverizer and the waste storage tank.

Anaerobic digestion — The anaerobic digestion section has a primary and a secondary digester. Both the digesters are based on UASB (Up-flow Anaerobic Sludge Blanket) for treatment of slurry containing high quantity of suspended solids. Digesters are made of RCC (Reinforced Cement Concrete) and containing proprietary internal modules made from FRP (Fiber Glass Reinforced Plastic). Top cover of both the digesters are made of mild steel with FRP lining. A stirrer cum scum breaking mechanism is also installed in each digester. Suitable provision has also been made for removal of sludge from the bottom of digester, which is then pumped into the manure pits. The digested slurry from the secondary digester is partly recycled back into the primary digester and the rest is sent to effluent buffer tank.

Biogas storage — Biogas from both digesters is stored in a membrane-type gas-storage system having a capacity of about 4000 m^3. An automatic flare is installed to flare the biogas when gas is not in use.

Manure Processing section — The overflow of the secondary digester stored in an effluent buffer tank is passed through a thickener and then pumped into a centrifuge. The solid cake from the centrifuge is stored in the manure storage yard and the effluent is taken out for further treatment before it is used for irrigation.

Power generation — A biogas engine of 150 kW capacity is used for generation of power from the biogas after reducing its H_2S content. Part of the electricity is used for captive consumption and the rest is exported to the grid.

Biomethanation plant for vegetable market waste at Koyambedu, Chennai

The Koyambedu wholesale vegetable market generates about 80 tonnes of waste per day, and at present its waste is collected by the private agency and transferred to transfer station within the market complex. A project based on high rate biomethanation technology has been installed for generation of electricity and treatment of waste. Total cost of the project is about Rs 5.25 crore.

The various component of the plant are:

Waste receiving area — The waste collected from the vegetable market is taken to the existing transfer station through the trailers/tippers and then to the receiving area at the project.

Waste handling — On the receiving platform, to handle the waste, a mechanical handling system namely 'Grab' with a travelling electric hoist is provided. Waste is transferred by the 'Grab' to the feeding hopper of the conveyor and transferred through the conveyor to the shredder for size reduction.

Waste segregation — The waste carried through the conveyor is sorted by the persons standing on the supporting platforms parallel to the conveyor. The inerts such as plastic, clothes, wood and stones, which are not biodegradable in anaerobic digester, are removed.

Ferrous separation — Magnetic separator is provided parallel to the conveyor so that the ferrous materials can be separated

Size reduction — The waste is delivered into the shredder to reduce the waste to a uniform size of around 15-20mm.

Feed preparation — The segregated and shredded waste is blended in a collection tank to provide a feed of uniform characteristics with a solid concentration below 10%.

Anaerobic digestion — The plant involves the emerging concept of anaerobic digestion, where stabilization takes place with the production of biogas.

Biological H_2S removal system — A biological desulphurization system has been installed in the digester. A group of facultative bacteria, which adhere to the walls of digester, is utilized for biological desulphurization.

Biogas storage — The biogas is stored in a dry-type gasholder made of synthetic membrane.

Power generation — The produced biogas is used as fuel to produce electricity. The gas is withdrawn from the gasholder by the gas blowers and is blown into gas engine. An alternator is connected to the engine to produce electricity. The net power generated after captive consumption is exported to the power grid.

Dewatering of digested slurry — The digested slurry is collected in the effluent buffer tank for dewatering. Dewatering is done in a screw press. The liquor from the screw press is used as a liquid fertilizer in CMDA (Chennai Metropolitan Development Authority) campus or it is pumped to the nearby STP for further treatment. The dewatered cakes are disposed of by CDMA as manure.

Comments from the experts

Though MNES has developed an accelerated programme for promotion of the projects for energy recovery from urban waste to this; the Energy Program Coordinator Mark Radka for the UN Environment Program says that "Municipal solid waste is not considered to be a renewable energy source since it tends to be a mixture of fuels that can be traced back to renewable and non-renewable sources," Energy generated from waste by burning it is highly polluting. Attempts are underway by vested interests to promote non-renewable energy sources as renewable energy sources.

The way Ministry of Science & Technology's agency Technology Information, Forecasting and Assessment Council (TIFAC) is promoting SELCO International Limited's RDF based waste to energy plant perverts waste management because it encourages waste maximization, which is contrary to the basic tenet of waste management – that is reduce, reuse and recycle. Villagers from the Gandamguda, Perencheru Panchayat of Ranga Reddy district, Andhra Pradesh and Elikatta village, Shadnagar where SELCO's installation is located are complaining of pollution and

unbearable stink from it. Similar plants have been installed in Vijayawada and several others are proposed in the state.

The electricity generation involves burning of RDF pellets; this releases heavy metals and persistent organic pollutants like dioxins. These toxins are building up in the environment especially the aquatic ecosystem of the villages such as Osman Sagar and Himayatsagar drinking water bodies in its vicinity. The emission of the notorious pollutants in Gandhamaguda is linked to cancer, immune and reproductive system disorders, birth defects, and other health threats.

Besides environmental groups, the villagers have sought removal of the dumpsite and the plant. Residents of Gandhamaguda and nearby villages and colonies are showing evidence corroborated by the findings of Andhra Pradesh Pollution Control Board, which indicate that the chemicals leaching out of dumpsites and the air pollution because of open burning is entering the food chain.

In India the campaign against such technologies has been purposeful in so far as Indian Commerce and Industry Ministry has categorically termed incinerators as a polluting technology, which is being thrust upon developing countries. Apparently it has fine-tuned itself with the obsolete nature of these outdated technologies. Waste burning and combustion technologies violate Kyoto Protocol, Stockholm Convention on Persistent Organic Pollutants (POPs) and recommendations of Global Mercury Assessment Report. The rationale for trade in goods, which violate environmental international treaties and attempt to promote them as environmental goods and services, is questionable.

The advocates of the project claim that no segregation of the plastics from the garbage is required. This not only violates letter and spirit of the Municipal Solid Wastes (Management & Handling) Rules 2000, which stipulates segregation, and promotes recycling of "recoverable resources" but also pre-empts segregation and recycling efforts being made by municipalities and communities around the country.

Therefore, environmental groups welcomed the views of Indian Economic Advisor to Ministry of Commerce and Industry, S Nigam who said, solid waste incinerators, which are considered environmental goods by some, are considered as polluters by others. Such goods also should not be included in the list, he added.

Even as the debate about the definition of environmental good and services continues, Organization for Economic Co-operation and Development (OECD), an intergovernmental organization of industrialized countries, based in Paris, the Asia Pacific Economic Cooperation (APEC), a 21 nation group and Japan have come up with their own list. Waste Incinerators are being promoted for supposed pollution protection and dubious renewable energy in these lists. Burn technologies like incinerators and gasifiers cannot be included in the list of environmental goods and services.

At a time when our Ministry of Commerce and Industry is taking a progressive stance it is alarming to note that our Ministry of Science and Technology is promoting use of incinerators. Indian Ministry of Non- conventional Energy Sources (MNES) is subsidizing hazardous technologies like combustion and gasification in total disregard of its Timarpur waste to energy blunder in Delhi during 1989/90. The MNES and Ministry of science and technology is zealously providing technological solutions to management problems.

The MNES has issued an executive order to all the state chief secretaries and the administrators of Union Territories asking them to promote such WTE projects. As a consequence, agreements for many such toxic projects have been signed and are being signed around the country Surprisingly, these projects have undergone no environment impact assessment and public hearing process. The approval from the Technical Appraisal Committee has not even been sought.

Almitra H Patel, member, Supreme Court Committee for Solid Waste Management says, "All burn technologies for energy from mixed municipal wastes are dangerous because of the uncontrolled presence of chlorinated hydrocarbons like PVC in our wastes which yield dioxins and heavy metals like mercury."

Ravi Aggarwal from Toxic Links, an NGO fighting environmental degradation, seconds her views. "Incineration in all form is burning waste. Segregation is the key here and the kind of segregation needed to ensure no pollution is virtually impossible," he says.

The charges are obviously denied by those associated with the plants. For instance, IL&FS, the company operating of the claimed successful pelletisation plant in near Hyderabad, insists that proper segregation is done at its plant but fails to detail how. The company also claims that proper trap mechanism is in place to ensure that pollutants are not released in air and the emission norms are strictly maintained.

But experts refute the claim. "Testing facilities for the dioxins and furans emitted from the waste-to-energy facilities are not available in India. These tests cost $1,000 to $50,000 for complete profiling of dioxins and furans. In fact very few developed countries have dioxin measuring facilities," says Patel, adding, "Therefore it will also not be possible for pollution control boards to certify with confidence." Municipal

and medical waste incineration have been listed as the primary sources of dioxin production worldwide.

"The inert and ash from the plant still have to be dumped which again are environmental hazards," says Shyamala from the Centre from Science and Environment.

The Energy and Resources Institute too agrees that power from municipal waste remain a threat to environment, however it still supports the programme. "Experiments have to continue only then can we come across a successful model, says Kusum Lata, research associate, Teri.

Power from municipal waste has not been a very successful experiment even abroad. The few successful ones are cost exorbitant and unthinkable for a country like India.

"Since burn technologies are being phased out in the West, and are banned in many countries, they are being transported to India," says Aggarwal's colleague Gopal Krishna. "The only reason the concept makes its way into the Indian market is because of the lax emission norms and the absence of testing facilities for some of the deadlier pollutants like dioxins," he adds.

Barring a couple, all experiments at electric generation from municipal waste in India has failed. Yet, new projects using the same technology keep coming up. In fact, considering the spate of failures, recently the Supreme Court too has questioned the viability of such projects and has set up a committee to review the performances of some of the projects. It has also stated that under the present circumstances, the government should not sanction any further subsidies.

"The projects are energy intensive. In fact, there have been a few cases in which more energy was consumed in running the plant than what was produced," S. S Khanna, former advisor, planning commission and a senior consultant.

Thus the net result is hardly beneficial. Electricity generations from such projects are also not cost effective. The cost of generating electricity from a waste-to-energy plant is at least twice that of a thermal power plant.

The Ministry of Non-Conventional Energy Sources (MNES) has had success with biomethanation options for homogeneous finely divided wastes like slaughter-house waste, sewage sludge and industrial wastes like those from starch factories, distilleries, and paper, leather and pharmaceutical industries. The ministry is promoting energy from municipal wastes by offering subsidies and other facilities, merely on principle, expecting similar successes, without understanding the special problems of non-homogeneous wastes described above.

"The subsidy offered by the government for such projects is the big lure. But subsidizing burn technologies is an invitation to both failure and disaster," says Patel.

MNES, on its part absolves itself of all responsibility. "Our concern is exploring other sources of energy and hence we offer subsidy for such projects. There are other agencies, which are responsible for, environmental clearances," says an official from the ministry.

The mixed nature of India's urban wastes is a major obstacle to any sensible waste processing and disposal. There is no separation of wet biodegradable wastes (e.g. cooked and uncooked foods and flowers) and dry recyclables (mostly combustible), which are much sought after and removed on the street or at open dumps by waste-collectors. There is a universal tendency of cities to collect such mixed domestic wastes along with inerts like dust and ash from street sweepings, silt removed from open drains, and scattered piles of debris or road diggings.

Despite legislation to improve matters, cities prefer not to spend anything on processing and disposal, budgeting only for waste collection and transport to beyond city limits. Some cities now go for waste to energy option despite its miserable track record. This, in fact, also encourages people to produce more waste.

Conclusion

None of the above project furnishes the detail about prevention of pollution caused by the plant itself. Although Waste to energy technologies lead to reduction of waste i.e. reduction of one pollution parameter but at the same time it is contributing to water and air pollution which is questionable. Today the whole world is concentrating on "Sustainable Development" which these plants fail to achieve.

It is appalling to note that instead of eliminating hazardous technologies in keeping with our international commitments, our ministries are advocating waste management processes contrary to sustainable practices world-wide.

Indian municipal solid waste has low calorific value, high moisture content, high proportion of organic matter, and considerable inerts like earth, sand and grit. "Burn techniques are technically inappropriate for Indian garbage which has a calorific value of about 800 cal/kg. Burning the waste would require at least 1,500 cal/kg, else auxiliary fuel is needed,"

Experts insist that waste minimization is the only way out from the problem. Recycling can eliminate a large chunk of the problem. Further, they point out that wet biodegradable wastes (e.g. cooked and uncooked foods and flowers) make excellent for composting.

Though this technology sounds environment-friendly by reducing the waste, the viability compared to other plants producing energy in India with respect to economical terms is still unanswerable.

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Climate Change

Methane Emission in India

The climate of the Earth is ever changing. In the past it altered as a result of natural causes. However, over recent years, the term climate change refers to the changes in our climate, mainly as a result of human activities and behavior rather than due to natural changes in the atmosphere. The greenhouse effect is one such effect of anthropogenic activities which is very important in climate change.

Many chemical compounds found in the Earth's atmosphere act as "greenhouse gases." These are CO_2, CH_4, NO_2, Hydroflurocarbons (HFCs), perflurocarbons (PFCs) etc. These gases allow sunlight to enter the atmosphere freely. When sunlight strikes the Earth's surface, some of it is reflected back towards space as infrared radiation (heat). Greenhouse gases absorb this infrared radiation and trap the heat in the atmosphere. Over the time, the amount of energy sent from the sun to the earth's surface should be about the same as the amount of energy radiated back into space, leaving the temperature of the Earth's surface roughly constant. The Earth's positive imbalance between emissions and absorption results because of the continuing growth of greenhouse gases (GHG) in the atmosphere.

The environmental and health impacts of improperly managed waste are key concerns for our society. The disposal and treatment of waste results in the emissions of several greenhouse gases which contribute to global climate change. The most significant GHG gas produced from waste is methane (CH_4).

Emissions from waste arise through both its incineration (burning) and landfill (burial). Burning waste releases carbon dioxide to the atmosphere. Municipal landfill gas composition is controlled primarily by products of microbial reactions depending on the environmental variables such as pH, temperature, moisture content and nutrients in the landfill. Solid waste initially decomposes aerobically; the primary gas product is carbon dioxide. As the oxygen is used up, anaerobic micro-organisms predominate. These bacteria continue to produce carbon dioxide, but the process proceeds into second-stage anaerobic decomposition, where both methane and carbon dioxide are produced at approximately a 50-50 ratio. Methane is a much more potent greenhouse gas than carbon dioxide, trapping more infra-red radiation. Global emissions of methane from landfilled waste have been estimated at approximately 40 Million Tonnes per year.

Methane (CH_4) remains in the atmosphere for approximately 9-15 years. Methane is over 21 times more effective in trapping heat in the atmosphere than carbon dioxide (CO_2) over a 100-year period and is emitted from a variety of natural and human-influenced sources. Natural sources include wetlands, gas hydrates, oceans, fresh water bodies etc. Human-influenced sources include landfills, natural gas and petroleum systems, agricultural activities, coal mining, stationary and mobile combustion, wastewater treatment, and certain industrial processes.

Methane is also a primary constituent of natural gas and an important energy source. As a result, efforts to prevent or utilize methane emissions can provide significant energy, resulting in economic and environmental benefits.

Methane currently accounts for over 15 percent of expected future warming from climate change. Its global atmospheric concentration, which continues to rise, has more than doubled over the last two centuries after remaining fairly constant for the preceding 2,000 years. Its strong ability to absorb infrared radiation, combined with its relatively short atmospheric lifetime, makes its control an important issue for mitigation of climate change.

Given below is the approximate inventory of methane emission all over India as per 2001 census. The methane emission is calculated according to IPCC default (1996) method. The data is compiled by National Solid Waste Association of India (NSWAI).

Methane Emission:

A. Class I Cities in India

(Population of each city - 1 Lakh and above)

State/ Union Territory	No. of Urban Cities	Urban Population (2001)*	MSW generated (MT/day)	Methane Emission (Gg/yr)
Andhra Pradesh	46	14591534	3650	44.20
Assam	7	1572482	472	5.72
Bihar	19	4982173	1444	17.50
Chhattisgarh	9	2768318	830	10.00
Goa	4	510458	153	1.85
Gujarat	31	14733838	4419	53.46
Haryana	19	4960856	1737	21.00
Himachal Pradesh	1	142555	50	0.60
Jammu & Kashmir	3	1617553	566	6.84
Jharkhand	14	4526834	1132	13.69
Karnataka	27	7626177	1986	24.03
Kerala	20	6756646	1688	20.42
Madhya Pradesh	33	11618221	3486	42.18
##Maharashtra	40	31970350	16389.28	198.30
Meghalaya	3	678277	203	2.45
Mizoram	1	233314	70	0.80
Orissa	8	2339720	585	7.07
Punjab	20	6071843	2126	25.72
Rajasthan	24	8064947	2422	29.30
Tamilnadu	66	22018617	5510	66.67
Tripura	4	1255215	377	4.56
Uttaranchal	7	2501493	625	7.56
Uttar Pradesh	77	27440099	9609	116.20
West Bengal	7	10060697	2515	16.60
Andaman & Nicobar	2	225609	56	0.67
Chandigarh	1	808515	283	3.42
Delhi	22	11313874	3963	47.95
	515	**196817348**	**65203.28**	**788.95**

B. Class II Towns in India

(Population of each town ranges from 50000 to 99999)

State/ Union Territory	No. of Urban Towns	Urban Population (2001)*	MSW generated (MT/day)	Methane Emission (Gg/yr)
Andhra Pradesh	44	2945270	743	8.99
Assam	10	674569	203	2.46
Bihar	18	1319843	332	4.02
Chhattisgarh	9	648311	196	2.37
Gujarat	30	2058510	619	7.49
Haryana	7	447992	158	1.91
Jammu & Kashmir	5	342888	120	1.45
Jharkhand	10	665508	167	2.02
Karnataka	32	2092661	523	6.33
Kerala	20	6756646	1688	20.43
Madhya Pradesh	29	2066513	619	7.49
Maharashtra	50	3458134	1035	12.52
Meghalaya	2	117956	36	0.44
Mizoram	1	47137	14	0.17
Orissa	16	1091821	272	3.29
Punjab	18	1287506	454	5.49
Rajasthan	31	261486	677	8.19
Sikkim	1	52852	13	0.16
Tamilnadu	41	2918617	735	8.89
Tripura	2	116816	35	0.42
Uttaranchal	3	233382	82	0.99
Uttar Pradesh	61	4227556	1477	17.87
West Bengal	15	1107642	277	3.35
Delhi	2	134126	47	0.57
Dadra & Nagar Haveli	1	50463	13	0.16
Grand Total	**458**	**35124205**	**10535**	**127.47**

Major Metropolitan Cities in India

State/ Union Territory	City	Urban Population (2001)*	MSW generated (MT/day)	Methane Emission (Gg/yr)
Andhra Pradesh	Hyderabad	3829753	957	11.58
Andhra Pradesh	Vishakhapatnam	982904	246	2.98
Bihar	Patna	1961532	588	7.11
Delhi	New Delhi	350000	272	3.29
Delhi	Delhi	13363471	6000	72.60
Gujarat	Ahmedabad	4215497	1265	15.31
Gujarat	Surat City	2433835	730	8.83
Gujarat	Vadodara	1491045	447	5.41
Karnataka	Bangalore	1304008	326	3.95
Kerala	Kochi	275225	69	0.83
##Maharashtra	Mumbai	11914398	7500	90.75
##Maharashtra	Nagpur	2040175	700	8.47
##Maharashtra	Pune	2540000	1000	12.10
Madhya Pradesh	Bhopal	1482718	445	5.39
Madhya Pradesh	Indore	1550880	465	5.63
Punjab	Ludhiana	1429709	500	6.05
Rajasthan	Jaipur	1870771	561	6.79
Tamil Nadu	Chennai	4343645	1086	13.14
Tamil Nadu	Coimbatore	1501373	375	4.54
Tamil Nadu	Madurai	1233083	308	3.73
Uttar Pradesh	Kanpur	2725207	954	11.54
Uttar Pradesh	Lucknow	2262369	792	9.58
Uttar Pradesh	Varanasi	1250039	438	5.30
West Bengal	Kolkata	4572876	1143	13.83
Grand Total	**.....**	**70924513**	**27167**	**328.72**

A. Total population of India
= 1,027,015,247 (according to 2001 census)

B. Population of Class I + Class II + Metropolitans
= 302,866,066

Population of rest of India (A – B)
= 724,149,181

Assumptions:

Solid waste generated (gms/capita/day)

North	East	Central	West	South
350	250	300	300	250

• Methane emission in Class I cities in India
= 2161.50 MT/day

• Methane Emission in Class II towns in India
= 349.23 MT/day

• Methane Emission in Major Metropolitan cities in India
= 900.60 MT/day

Solid waste (invisible waste) generated (excluding Class I + Class II + Metropolitan)
= [724,149,181 x 50 gms/capita/day (Assumption)]/10^6

= 36207.45 MT / day

• Methane emission
= 1201.36 MT/ day.

Methane emission in India (approx.) as a whole
= 4612.69 MT/day

Formula :

Solid waste generated (MT/day)
= (Population x ..... gms/capita/day) / 10^6

Methane Emission (Gg/yr)
= (MSW_T x MSW_F x MCF x DOC x DOC_F x 1.33–R) x (1-OX)

Where:

MSW_T = total MSW generated (Gg/yr)
MSW_F = fraction of MSW disposed to solid waste disposal sites
MCF = methane correction factor (fraction)
DOC = degradable organic carbon (fraction)
DOC_F = fraction of DOC similated
F = fraction of CH_4 in landfill gas
R = recovered CH_4 (Gg/yr)
OX = oxidation factor

Conclusion:

The Total quantity of solid waste generated in India as a whole is approximately 303 million metric tonnes per day and based on that it emits approximately 4612.69 MT/ day of methane.

Climate has and will always vary for natural reasons. However, human activities are increasing significantly; consequently the concentration of some gases in the atmosphere, called greenhouse gases which tend to warm the earth surface also increases. One of the impacts of urbanization with a global dimension is the emission of methane. Concentration of methane in the atmosphere is increasing rapidly. Methane being one of the potent green house gases, with its global warming potential being 21 times more than that of carbon dioxide, appropriate actions should be taken to reduce its the emission thereby reducing the risk to the environment.

Sources:

* Data for population: International Institute for Population Sciences, Deonar, Mumbai

Data for the state of Maharashtra:
Solid Waste Management in Class I Cities in Maharashtra, All India Institute of Local Self-Government, Andheri, Mumbai

Methane Emission Formula: IPCC default method.

The entire data has been compiled by NSWAI.

Upcoming Events

11th Annual Landfill Symposium
& Solid Waste Managers:
Trends & Challenges Conference
5-10 June 2006
Sheraton Nashville - Downtown
Nashville, TN USA
Website: http://www.swanastore.com

CIWM 2006
"Changing the face of Waste Management"
13-16 June 2006
Paignton, United Kingdom
Website: http://www.ciwm.co.uk/414

ISWA working group on Hazardous Wastes meeting
19-20 June 2006
United Kingdom
E mail: bbh@iswa.dk

Beacon Conference on Transfer stations 2006
"The changing role of transfer stations"
09-11 August 2006
Nowotel Twin Wasters, Sunshine Coast QLD, Australia
E Mail: veronica@wmaa.asn.au

WASTECON 2006
17-21 September 2006
Charlotte Convention Center, Charlotte, NC USA
URL: http://www.wastecon.org

The ninth International IN SITU and
ON-SITE Bioremediation Symposium
7-10 May 2007
Marriott Waterfront Hotel, Baltimore, Maryland
Website: www.battelle.org/biosymp

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