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Possible solution: *Given India's lack of adequate sewage collection and treatment systems, bioremediation could be highly beneficial.*

AFFORDABLE TECHNOLOGY

How microbes can clean polluted water, from drains to rivers

Bioremediation uses naturally occurring bacteria, fungi or plants to degrade substances that are hazardous to human health or the environment

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NEW DELHI

Can the problem of water pollution be checked by letting loose sewage-eating microbes?

The answer is yes and the technology that offers this hope—bioremediation—doesn't cost the earth.

Indeed, authorities in India are batting for this technology, both to clean drains and to check pollution in the river Ganga, Prime Minister Narendra Modi's dream project.

The technology has been successfully demonstrated in pilot projects by the Central Pollution Control Board. And the National Mission for Clean Ganga is now in the process of using bioremediation for cleaning up some parts of the river.

Internationally, the technology has been used in several countries.

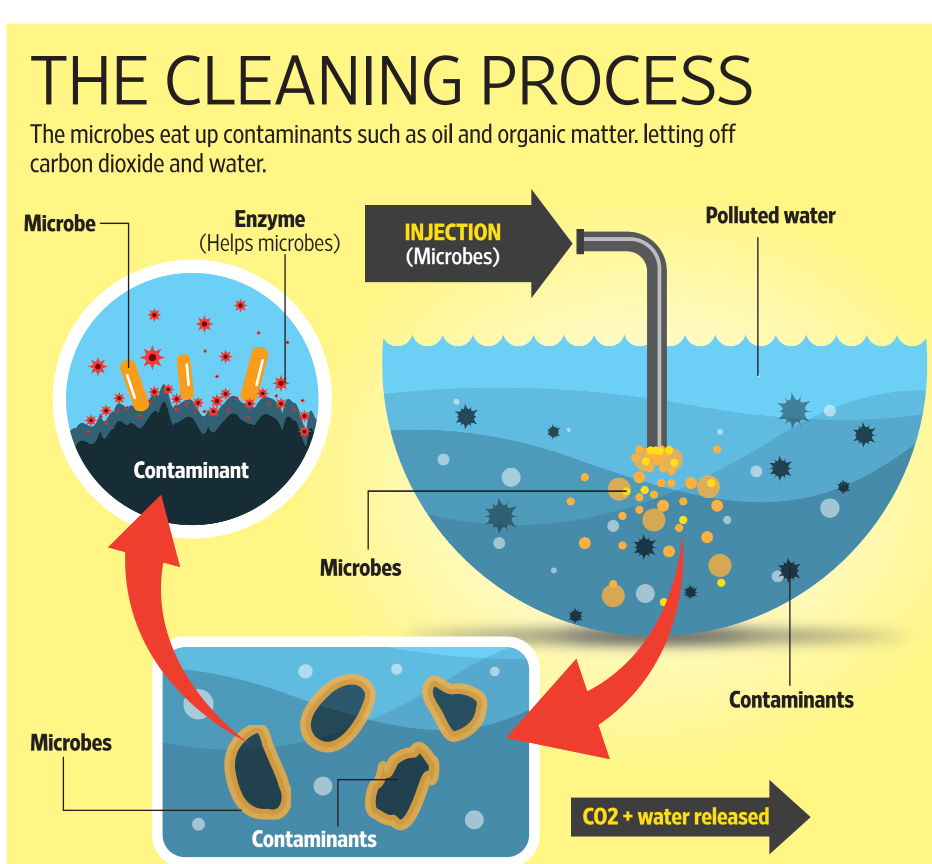
In simple terms, bioremediation is a system of sewage treatment where microbes are used to degrade flowing sewage into carbon dioxide and water. The process also reduces the stench from raw sewage.

The microbes simply eat up contaminants such as oil and organic matter (e.g., waste food), convert them and then let off carbon dioxide and water. The process uses naturally occurring bacteria, fungi or plants to degrade substances that are hazardous to human health or the environment.

Bioremediation technology includes phytoremediation (plants) and rhizoremediation (plant and microbe interaction). At present, the process is used to check contamination in soil, groundwater and surface water. The system does not require construction or any major modification of drains or diversion of flow. It takes place in open drains without displacement of sewage. The process also does not require any additional land or power, making it a simple and easy system.

It is cheaper than conventional treatment methods, easy to handle and, importantly, does not require skilled manpower.

Under the process, bacteria are cultured in bulk and applied to the flowing sewage. Then, the microbes are activated and they multiply—with or without oxygen and food available in the form of organic matter present in sewage. Sometimes, enzymes are also added to activate the microbes.



Source: Mint research
YATISH ASTHANA/MINT

However, bioremediation can be effective only in places where environmental conditions permit microbial growth and activity. Where the conditions are not favourable for their growth, manipulation of environmental parameters is carried out to allow microbial growth and allow degradation at a faster rate.

These microbes consume the organic mass of the waste water and utilize the nutrients from sewage for their growth, ultimately enhancing the cleaning action of waste water. The treatment can restore water quality and increases the self-cleansing capacity of the water body. The process also helps reduce biochemical oxygen demand (BOD) in sewage and reduces odour.

Waste water often contains organic materials that are decomposed by microorganisms, which use oxygen in the process, and BOD is the amount of oxygen that is used by such organisms in breaking down the waste matter.

The microorganisms that are used already exist in nature and this prevents any harm to the environment. Sometimes, they are indigenous to a contaminated area, otherwise, they need to be brought in to the targeted site.

It has been found that as a result of this process, heavy metals and toxic chemicals are also reduced. It also leads to the suppression and elimination of harmful pathogenic bacteria such as *E. coli* from the treated water.

For a country such as India, where there is a huge lack of adequate sewage collection and treatment systems, this process could be highly beneficial. Many Indian cities have either very poor or non-existent sewage treatment facilities; conditions in rural areas are no better.

The government claims that 25 patents have been granted by the Indian Patent Office in the field of bioremediation from 1971 to 2008.

One of the biggest advantages of bioremediation is that it can be carried out at the site that is polluted rather than by having to transport huge quantities of waste from the site. Bioremediation technology can also be used to clean oil spills.

However, the success of bioremediation depends on having the right microbes at the right place with the right environmental factors to support it. Also, for greater amounts of waste, enzymes may be needed as a catalyst to speed up the microbes' action. This means every project has to be custom-designed, operated and maintained.

EXPERT VIEW

MANOJ MISRA
Respond to this column at **feedback@livemint.com**

PROMISING BUT NO PANACEA

In nature, the waste product of one organism is the food of another. That's the reason why in the wild or in the non-humanized world, we find little abandoned or accumulated waste. Human organic waste, too, is largely degradable in nature.

Problems arise when heavy metals like lead, mercury, arsenic, chromium, etc., as rejects from our industrial activities, are let loose into the environment (soil, water and air) in the form of industrial effluents or there is an overburden of unutilized chemical pesticides, insecticides and fertilizers running off during rains from our farms to enter and pollute water bodies (ponds, lakes, rivers and oceans).

Petroleum products from oil spills in seas or land add a toxic burden to our natural environment. Leachates from landfills holding contaminants are another source of pollution.

On their own or in combination, these are serious health hazards and the cause of many cancers. Toxic chemicals are now increasingly originating even from our residences in the form of polluted wash water, including detergent run-off, cosmetics, plastics, paints, electronic waste and poisons from pest control measures, etc.

Frequent mixing of sewage and industrial effluents in common drains (many of which were originally stormwater drains) frustrate municipal and industrial cleaning systems like sewage treatment plants (STPs) and effluent treatment plants (ETPs), turning them ineffective as their respective technologies are not equipped for the toxic cocktail that they often receive.

But in the past few years, a technology popularly known as bioremediation has come to the rescue.

Bioremediation is to create enabling conditions in which the naturally occurring microorganism or their enzymes (bio-molecules) are encouraged to tackle toxic elements present in our environment by either consuming the latter as food or by isolating them for easy separation from the polluted soil, air or water. In the words of M. Vidali, a well-known expert, "Bioremediation is an option that offers the possibility of destroying or rendering harmless various contaminants using natural biological activity."

The 20th century saw not only an overwhelming pollution of the planet's natural environment through runaway industrialization and an introduction all over of intensive farming practices, but also engendered way back in 1900 the first human efforts at bioremediation to treat organics derived from human or animal waste.

The later half of the century saw investigations into bioremediation of synthetic chemicals present in waste water and with rising instances of oil spills in the seas, spurred its application to hydrocarbon contamination and cleaning of petroleum in ground water. Since then, bioremediation has been tried with varying degrees of success in different parts of the world.

In India, bioremediation offers a viable option in waste water treatment, sanitization of existing landfills and cleaning of ground water.

India has traditionally used plants like grass, sedge, hemp and canna to clean waste water. Even water hyacinth, otherwise an invasive species in any lake system, is found useful in the removal of arsenic from waste water. This in modern terminology is called phytoremediation, where some plants (estimates suggest a list in excess of 300) have the natural ability to degrade and eliminate from waste water common pollutants like metals and pesticides.

COLUMN

While bioremediation is catching on and additional research is adding value to its effectiveness, it would be premature to assume that mankind has found the proverbial silver bullet to end its increasing problem of environmental pollution. It is because experts cite both advantages and disadvantages.

Being a natural process is its greatest asset. Clean-up costs in comparison with other methods are much less. Residues from the process are usually products like gases (mainly carbon dioxide), water and cell biomass. It can also tackle a wide variety of contaminants and destroy them completely. It could be carried out in situ (on the site) thereby discounting costs and hassles associated with land purchase or acquisition and in preventing transportation costs and risks.

But everything has its disadvantages and bioremediation is no different. Although natural, it still remains an introduction by man of a microorganism that could prove disruptive or harmful to other organisms present in the same environment and hence, while solving one problem could result in the creation of one or more with impacts which might be long-term and could sometimes prove far more damaging than the pollution it started with.

The process being highly specific is also not universally applicable and is labour-intensive and time consuming. Lab-to-field transfers of research technologies and findings have also presented challenges and the upscaling of pilot projects have not always worked as planned. Often toxic cocktails (encountered in Indian conditions) of contaminants found together and even in varied forms (solid, liquid and gas) could prove frustrating.

Thus, clearly while there is an interesting and exciting pollution abatement option now in hand with the authorities, they would be well advised to not rush headlong into their adoption without mustering all due caution. There might also be issues of a legal nature, where an existing law might be inhibiting or a new one required.

Man, by trying to ape nature, does not become god. Let us not forget that it is nature alone that knows best its own complexities and processes.

Hence, the longer we desist from compromising natural processes like flowing rivers (with a huge capacity to self-rejuvenate), we can hope to have a healthy natural environment for us and our future generations at little or no cost to us.

Manoj Misra is convenor of Yamuna Jiye Abhiyaan, a civil society campaign for a rejuvenated Yamuna. He is also a forestry and wildlife expert who formerly served with the Indian Forest Service for 22 years.