

# A Study on the Methods Used for the Management of Residue of Water Treatment Plant

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**Abstract – Our modern lifestyle provides us the luxury of using various products to make our lives more comfortable and easy, but it comes at a price. A common byproduct of our current lifestyle includes wastewater, which can either be in the form of water running down the shower or runoff from wet roads. This wastewater is unfit for human consumption or use.**

**Fortunately, we can make the wastewater potable and usable by employing wastewater treatment technologies that filter and treat the wastewater by removing contaminants such as sewage and chemicals.**

**Four common ways to treat wastewater include physical water treatment, biological water treatment, chemical treatment, and sludge treatment.**

**Keywords – Methods, Management, Residue, Water, Treatment Plant**

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## INTRODUCTION

### Physical Water Treatment

In this stage, physical methods are used for cleaning the wastewater. Processes like screening, sedimentation and skimming are used to remove the solids. No chemicals are involved in this process.

One of the main techniques of physical wastewater treatment includes sedimentation, which is a process of suspending the insoluble/heavy particles from the wastewater. Once the insoluble material settles down at the bottom, you can separate the pure water.

Another effective physical water treatment technique includes aeration. This process consists of circulating air through the water to provide oxygen to it. Filtration, the third method, is used for filtering out all the contaminants. You can use special kind of filters to pass the wastewater and separate the contaminants and insoluble particles present in it. The sand filter is the most commonly used filter. The grease found on the surface of some wastewater can also be removed easily through this method.

### Biological Water Treatment

This uses various biological processes to break down the organic matter present in wastewater, such as soap, human waste, oils and food. Microorganisms metabolize organic matter in the wastewater in biological treatment. It can be divided into three categories:

- ◆ Aerobic processes: Bacteria decomposes the organic matter and converts it into carbon dioxide that can be used by plants. Oxygen is used in this process.
- ◆ Anaerobic processes: Here, fermentation is used for fermenting the waste at a specific temperature. Oxygen is not used in anaerobic process.
- ◆ Composting: A type of aerobic process where wastewater is treated by mixing it with sawdust or other carbon sources.

Secondary treatment removes most of the solids present in wastewater, however, some dissolved nutrients such as nitrogen and phosphorous may remain.

## Chemical Water Treatment

As the name suggests, this treatment involves the use of chemicals in water. Chlorine, an oxidizing chemical, is commonly used to kill bacteria which decomposes water by adding contaminants to it. Another oxidizing agent used for purifying the wastewater is ozone. Neutralization is a technique where an acid or base is added to bring the water to its natural pH of 7. Chemicals prevent the bacteria from reproducing in water, thus making the water pure.

## Sludge Treatment

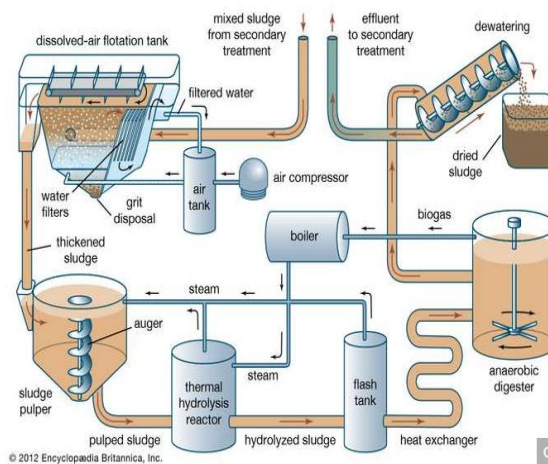
This is a solid-liquid separation process where the least possible residual moisture is required in the solid phase and the lowest possible solid particle residues are required in the separated liquid phase.

An example of this includes dewatering of sludge from industrial wastewater or sewage plant where the residual moisture in dewatered solids determines the disposal costs and the centrate quality determines the pollution load returned back to the treatment facility. You need to minimize both.

Wastewater has a lot of impact on the natural world and it is important to treat it effectively. By treating wastewater, you don't just save the creatures thriving on it, but also protect the planet as a whole.

## METHODS USED FOR THE MANAGEMENT OF RESIDUE OF WATER TREATMENT PLANT

The residue that accumulates in sewage treatment plants is called sludge (or biosolids). Sewage sludge is the solid, semisolid, or slurry residual material that is produced as a by-product of wastewater treatment processes. This residue is commonly classified as primary and secondary sludge. Primary sludge is generated from chemical precipitation, sedimentation, and other primary processes, whereas secondary sludge is the activated waste biomass resulting from biological treatments. Some sewage plants also receive septage or septic tank solids from household on-site wastewater treatment systems. Quite often the sludges are combined together for further treatment and disposal.



Treatment and disposal of sewage sludge are major factors in the design and operation of all wastewater treatment plants. Two basic goals of treating sludge before final disposal are to reduce its volume and to stabilize the organic materials. Stabilized sludge does not have an offensive odour and can be handled without causing a nuisance or health hazard. Smaller sludge volume reduces the costs of pumping and storage.

## Thickening

Thickening is usually the first step in sludge treatment because it is impractical to handle thin sludge, a slurry of solids suspended in water. Thickening is usually accomplished in a tank called a gravity thickener. A thickener can reduce the total volume of sludge to less than half the original volume. An alternative to gravity thickening is dissolved-air flotation. In this method, air bubbles carry the solids to the surface, where a layer of thickened sludge forms.

## Digestion

Sludge digestion is a biological process in which organic solids are decomposed into stable substances. Digestion reduces the total mass of solids, destroys pathogens, and makes it easier to dewater or dry the sludge. Digested sludge is inoffensive, having the appearance and characteristics of a rich potting soil.

Most large sewage treatment plants use a two-stage digestion system in which organics are metabolized by bacteria anaerobically (in the absence of oxygen). In the first stage, the sludge, thickened to a dry solids (DS) content of about 5 percent, is heated and mixed in a closed tank for several days. Acid-forming bacteria hydrolyze large molecules such as proteins and lipids, breaking them into smaller water-soluble molecules, and then ferment those smaller molecules into various fatty acids. The sludge then flows into a second tank, where the dissolved matter is converted by other bacteria into biogas, a mixture of carbon

dioxide and methane. Methane is combustible and is used as a fuel to heat the first digestion tank as well as to generate electricity for the plant.

Anaerobic digestion is very sensitive to temperature, acidity, and other factors. It requires careful monitoring and control. In some cases, the sludge is inoculated with extra hydrolytic enzymes at the beginning of the first digestion stage in order to supplement the action of the bacteria. It has been found that this enzymatic treatment can destroy more unwanted pathogens in the sludge and also can result in the generation of more biogas in the second stage of digestion.

Another enhancement of the traditional two-stage anaerobic digestion process is thermal hydrolysis, or the breaking down of the large molecules by heat. This is done in a separate step before digestion. In a typical case, the process begins with a sludge that has been dewatered to a DS content of some 15 percent. The sludge is mixed with steam in a pulper, and this hot homogenized mixture is fed to a reactor, where it is held under pressure at approximately 165 °C (about 330 °F) for about 30 minutes. At that point, with the hydrolytic reactions complete, some of the steam is bled off (to be fed to the pulper), and the sludge, still under some pressure, is released suddenly into a "flash tank," where the sudden drop in pressure bursts the cell walls of much of the solid matter. The hydrolyzed sludge is cooled, diluted slightly with water, and then sent directly to the second stage of anaerobic digestion.

Sludge digestion may also take place aerobically—that is, in the presence of oxygen. The sludge is vigorously aerated in an open tank for about 20 days. Methane gas is not formed in this process. Although aerobic systems are easier to operate than anaerobic systems, they usually cost more to operate because of the power needed for aeration. Aerobic digestion is often combined with small extended aeration or contact stabilization systems.

Aerobic and conventional anaerobic digestion convert about half of the organic sludge solids to liquids and gases. Thermal hydrolysis followed by anaerobic digestion can convert some 60 to 70 percent of the solid matter to liquids and gases. Not only is the volume of solids produced smaller than in conventional digestion, but the greater production of biogas can make some wastewater treatment plants self-sufficient in energy.

### Dewatering

Digested sewage sludge is usually dewatered before disposal. Dewatered sludge still contains a significant amount of water—often as much as 70 percent—but, even with that moisture content, sludge no longer behaves as a liquid and can be handled as a solid material. Sludge-drying beds provide the simplest method of dewatering. A digested sludge slurry is

spread on an open bed of sand and allowed to remain until dry. Drying takes place by a combination of evaporation and gravity drainage through the sand. A piping network built under the sand collects the water which is pumped back to the head of the plant. After about six weeks of drying, the sludge cake, as it is called, may have a solids content of about 40 percent. It can then be removed from the sand with a pitchfork or a front-end loader. In order to reduce drying time in wet or cold weather, a glass enclosure may be built over the sand beds. Since a good deal of land area is needed for drying beds, this method of dewatering is commonly used in rural or suburban towns rather than in densely populated cities.

Alternatives to sludge-drying beds include the rotary drum vacuum filter, the centrifuge, and the belt filter press. These mechanical systems require less space than do sludge-drying beds, and they offer a greater degree of operational control. However, they usually have to be preceded by a step called sludge conditioning, in which chemicals are added to the liquid sludge to coagulate solids and improve drainability.

### Disposal

The final destination of treated sewage sludge usually is the land. Dewatered sludge can be buried underground in a sanitary landfill. It also may be spread on agricultural land in order to make use of its value as a soil conditioner and fertilizer. Since sludge may contain toxic industrial chemicals, it is not spread on land where crops are grown for human consumption.

Where a suitable site for land disposal is not available, as in urban areas, sludge may be incinerated. Incineration completely evaporates the moisture and converts the organic solids into inert ash. The ash must be disposed of, but the reduced volume makes disposal more economical. Air pollution control is a very important consideration when sewage sludge is incinerated. Appropriate air-cleaning devices such as scrubbers and filters must be used.

Dumping sludge in the ocean, once an economical disposal method for many coastal communities, is no longer considered a viable option. It is now prohibited in the United States and many other coastal countries.

### Emerging Technologies

Experts in the wastewater treatment sector have been working to implement established technologies and to improve environmental rules and regulations to meet water quality goals and human health protection. At the same time, the industry has also been transitioning to prepare

for future challenges, such as climate change, changing populations, and aging infrastructure.

### Improved treatment methods

Many older wastewater treatment facilities require upgrading because of increasingly strict water quality standards, but this is often difficult because of limited space for expansion. In order to allow improvement of treatment efficiencies without requiring more land area, new treatment methods have been developed. These include the membrane bioreactor process, the ballasted floc reactor, and the integrated fixed-film activated sludge (IFAS) process.

In the membrane bioreactor process, hollow-fibre microfiltration membrane modules are submerged in a single tank in which aeration, secondary clarification, and filtration can occur, thereby providing both secondary and tertiary treatment in a small land area.

In a ballasted floc reactor, the settling rate of suspended solids is increased by using sand and a polymer to help coagulate the suspended solids and form larger masses called flocs. The sand is separated from the sludge in a hydroclone, a relatively simple apparatus into which the water is introduced near the top of a cylinder at a tangent so that heavy materials such as sand are “spun” by centrifugal force toward the outside wall. The sand collects by gravity at the bottom of the hydroclone and is recycled back to the reactor.

Biological aerated filters use a basin with submerged media that serves as both a contact surface for biological treatment and a filter to separate solids from the wastewater. Fine-bubble aeration is applied to facilitate the process, and routine backwashing is used to clean the media. The land area required for a biological aerated filter is only about 15 percent of the area required for a conventional activated sludge system.

### Automation

Advanced wastewater purification processes involve biological treatments that are sensitive to processing parameters and to the environment. To ensure stable and reliable operations of physical, chemical, and biological processes, treatment plants quite often need to implement sophisticated technologies involving complex instrumentation and process control systems. Use of online analytical instruments, programmable logic controllers (PLC), supervisory control and data acquisition (SCADA) systems, human machine interface (HMI), and various process control software allow for the automation and computerization of treatment processes with the provision for remote operations. Such innovations improve system operations significantly, thus minimizing supervision needs.

### Environmental considerations

Natural treatments, energy conservation, and carbon footprint reduction are some of the key considerations for communities facing energy and electricity challenges. Green technologies and the use of renewable energy sources, including solar and wind power, for wastewater treatment are evolving and will help minimize the environmental impacts of human activities. Ecological and economical natural wastewater treatment and disposal systems have already gained importance in many places, especially in smaller communities. These include constructed wetlands, lagoons, stabilization ponds, soil filters, drip irrigation, groundwater recharge, and other similar systems. The simplicity, cost-effectiveness, efficiency and reliability of these systems have provided potential applications for such environmentally friendly technologies.

### CONCLUSION

Given that wastewater is rich in nutrients and other chemicals, sewage treatment facilities have gained recognition as resource recovery facilities, overcoming their former reputation as mere pollution mitigation entities. Newer technologies and approaches have continued to improve the efficiency by which energy, nutrients, and other chemicals are recovered from treatment plants, helping create a sustainable market and becoming a revenue generation source for wastewater processing facilities.

Concepts such as nutrient trading have also emerged. The intention of such initiatives is to control and meet overall pollution load targets for a given watershed by trading nutrient reduction credits between point and non-point source dischargers. Such programs can help to minimize nutrient pollution effects as well as reduce financial burdens on societies for costly treatment plant upgrades.

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