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Review of Landfill Leachate Treatment

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Abstract: The treatment method of leachate was increasing with the progress of science and technology, the management system was more perfect. The paper gathered so far the leachate treatment technology, including physical, chemical and biological treatment technology, and found the technology to be improved, the paper expounds the advantages and disadvantages of each method, applicable scope in the future, leachate treatment technology.

Key Words: leachate; treatment technology; advantages and disadvantages

In recent years, with the rapid development of the national economy, people's quality of life has been improved, but the problems that follow are also very difficult, one of which is the problem of garbage. The output of garbage has increased at a high rate of 10% per year. It is estimated that the urban domestic refuse will exceed 400 million[1] by 2030. With the aggravation of the problem, the treatment of landfill leachate has been paid great attention at home and abroad, and various treatment methods of landfill leachate have been formed.

1. Leachate Treatment Methods

Leachate treatment can be generally divided into in-site treatment and out-of-site treatment. In-site treatment means that leachate is not transported or discharged directly outside the site, and is recycled in-situ, including recharge treatment and the establishment of landfill leachate treatment station in the site. Recharge treatment is to recharge the leachate to the waste dump area through some power facilities. The leachate is biodegraded by using the soil covered by the dump area and the degradation of microorganisms in the garbage at various "age" stages. A landfill leachate treatment station is established in the site, and a reasonable combination of treatment technologies can be used to treat the leachate in the treatment station.

Over-the-counter treatment includes the establishment of artificial wetlands and the transportation to urban sewage treatment plants[2]. Constructed wetlands have the advantages of large buffer capacity, low construction and operation costs, and good sewage treatment effect. However, it covers a large area and is restricted by biological and hydraulic complexity. The combined treatment to the sewage treatment plant is suitable for landfill sites that are close to the urban sewage treatment plant and have a moderate concentration of pollutants in leachate.

2. Traditional Leachate Treatment Technology

Traditional treatment technologies mainly include physical and chemical treatment, biological treatment, combined physical and chemical treatment, land treatment and other technologies. Physical and chemical treatment is mainly used in the pretreatment stage. The effluent quality is relatively stable without the influence of leachate quality. The operation is simple and the reaction speed is fast. It has certain treatment effect on NH_3-H, chroma, turbidity and some refractory organic matters in leachate. Especially for water with poor

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biodegradability. Because it is difficult for a single treatment process to meet the leachate discharge standard, a complete treatment process is often physicochemical pretreatment, combined with biological and advanced treatment technology to achieve the leachate discharge standard.

2.1 Physicochemical Treatment

2.1.1 Photocatalytic Oxidation Technology

Wang Sheng [3]etal. successfully developed a new type of nanocomposites with shell-hollow structure after sintering, which solved the problems of load system and suspension system. The experiment proves that the treatment effect is the best under the conditions of temperature 180°C and reaction time 5 h. Wei Hongbin et al. tested the feasibility and influencing factors of photocatalytic oxidation technology. The results showed that the technology had a good treatment effect in the advanced treatment stage. The amount of titanium dioxide was related to light intensity and water quality, and the light intensity was inversely related to the amount of photocatalytic oxidation. The reaction time was generally 1.5 h to 2.5 h, and the wavelength was 253.7nm, which had the best treatment effect.

2.1.2 Advanced oxidation technology (AOPs)

The difference between advanced oxidation technology and ordinary oxidation technology is that its action factor is hydroxyl radical, which has strong oxidation ability to degrade refractory organic matter in water. There are many advanced oxidation technologies, such as Fenton reagent oxidation, ozone oxidation, photocatalytic oxidation, wet oxidation and so on. Because of its treatment characteristics, it has broad application prospects in the field of leachate treatment.

3. Anaerobic Biological Treatment Technology

Anaerobic biotechnology and aerobic biotechnology have their own advantages and disadvantages. The main advantages of anaerobic biotechnology are low energy consumption, and can produce methane and methane as clean energy materials to generate electricity[6].

3.1 Anaerobic Digestion Tank

Anaerobic digestion tank usually uses ASBR reactor to pretreat high concentration solid organic leachate. First, it reduces the content of organic matter in leachate, and then it is treated by other biological treatment methods, such as SBR technology. This method is not only suitable for high concentration wastewater, but also resistant to high load and less excess sludge. However, the slow growth of anaerobic microorganisms and long treatment time lead to long retention time of leachate.

Geng Xiaoli et al[7]. digested leachate from incineration garbage power plant with pig manure as inoculant at 35°C, stable pH between 7.2 and 7.8, high basicity and NH_3-Nconcentration. The anaerobic digestion experiments were carried out under the cumulative load of 5% to 35% leachate, respectively. The results showed that when the leachate load was 25%, methane production reached a peak of 75.5%, and CODcr was 3373 mg after the experiment. The removal rate was 95.2%. However, NH_3-N has no removal ability.Geng Xiaoli [8] and others used straw as inoculant to do similar experiments on leachate. The results showed that the highest proportion of methane in total biogas was 70.89%, and COD_{cr} was 83.02%.

Anaerobic digestion has its own development prospects in the era of energy shortage, and needs improvement. In the field of high concentration organic wastewater and leachate, it has its own unique development space.

3.2 Upflow Anaerobic Sludge Bed Reactor (UASB)

Upflow anaerobic sludge bed reactor (UASB) is often used to treat high concentration organic leachate because of its large biomass, large leachate load and adaptability to temperature and pH changes. Upflow anaerobic sludge bed reactor is mainly composed of three parts, the main part is the reaction zone. Leachate enters from the bottom of the sludge

bed and is decomposed by a large number of microorganisms in granular sludge to produce methane and carbon dioxide.

Hu Gang et al[9]. took the leachate from a landfill as the research object. The influencing factors of the leachate from a landfill were experimented with an upflow sludge bed reactor. The results showed that the start-up time was 82 days and the maximum volume load was controlled at 5 kg COD/m^3.d. It is concluded that no extra medicines need to be added in the process of treatment, only some trace elements such as Fe, Ni and Co need to be added when appropriate, so as to ensure that the removal rate of COD can be steadily increased to 50%.

3.3 Physicochemical Treatment

The principle of treatment of leachate by anaerobic biofilter and upflow anaerobic sludge bed reactor is similar to that of [10]. There are different carriers on anaerobic microorganism. Biofilm bed is formed by microbiological carrier of anaerobic biofilter for some filling materials and microorganism. In AF, the biological concentration is high, operation is sensitive and simple, and there is no sludge problem.

Wei Juwang [11] and others made a series of experiments [12] considering the influence of seasonal factors On the treatment effect of domestic sewage and leachate by anaerobic biofilter. The COD removal rate was used as the evaluation index. The results showed that the removal rate could reach 61% [13] in summer, 47.5% in autumn and 30% in winter. It was also found that the treatment effect decreased sharply when the temperature was below 10 °C. Wang Chang et al[14][15]. Used a downflow/upflow two-stage anaerobic biofilm filter bed reactor to treat domestic wastewater. The COD content decreased significantly after two-stage anaerobic digestion. The removal rate of BOD was 58% and 68% respectively.

4. Aerobic Biological Treatment Technology

Biological treatment is the main treatment method of leachate. Organic substances and metal ions are generally treated after physical and chemical pretreatment. Biological treatment has the advantages of high treatment efficiency [16], relatively small secondary pollution, and its main technologies are aerobic treatment, anaerobic treatment and combined aerobic and anaerobic treatment.

4.1 Activated Sludge Process

Activated sludge process is an aerobic biological treatment method with simple operation, low operating cost, strong flexibility and buffer capacity. Aerobic microorganisms were oxidized and metabolized by aeration in the reactor. The metabolites were precipitated in the sedimentation tank to reduce the pollution of BOD_5,COD_{cr}, organic carbon content and NH_3-Nin leachate.

Hu Huiqing [17] et al. Found that the removal rate of COD and BOD_5 by conventional activated sludge treatment can reach 89.2% and 94.2%, while in other months, the removal rate of COD and BOD_5 is 71.1% and 84.4% respectively. [18] et al. Used magnetically loaded enhanced activated sludge to carry out experiments on leachate and put in 20 g magnetic powder every 3 days. When the dosage of magnetic powder reached 3~4 g/l, the MLVSS of aeration area increased from 2000 mg/l to 5000 mg/l, and the removal rate of COD and NH_3-N was 45%, 35% to 83% and 66%,respectively.

4.2 Biofilm Process

Biological rotary disc (RBC) treatment process has been widely used in domestic sewage and industrial sewage[19]. It also has a certain treatment effect in leachate treatment[20]. This method can achieve a better treatment effect in a short time, and the operation and disk maintenance and cleaning are convenient[21]. However, due to the characteristics of large flow rate and complex composition, the treatment effect of this method is limited, and it can be mixed with domestic sewage in a certain proportion to achieve better effluent quality. According to[22] and others, the leachate and domestic sewage were treated by 1:600. The effluent concentration of NH_3-N<5mg/L, COD<50 mg/L and TN<15 mg/L under the optimal conditions of HRT 10h and

rotating speed of 2 r/min reached the first level A standard of pollutant discharge standard of municipal sewage treatment plant.

4.3 Stabilization Pond

From the beginning of 90 s to the present, stabilization pond technology is mostly used in urban sewage treatment in developing countries. It also shows excellent removal effect on organic pollutants in landfill leachate treatment, which has been promoted by our government. It uses the natural purification ability to purify the sewage.

Wudi [23] et al. studied the treatment effect of the three-stage stabilization pond in the leachate follow-up treatment system through an example. It was found that the single-stage treatment effect of aerobic aeration pond, aquatic plant pond and natural oxidation pond was relatively stable[24]. The removal rates of NH3-N, BOD_5, COD and COD were 36%-68.7%, 31.9%-47.8% and 40.1%-56.5% respectively. The effluent water quality also reached the standard of "Domestic Waste". Emission requirements of Landfill Pollution Control Indicators.

The stabilization pond treatment process has the advantages of low capital construction and operation costs, convenient maintenance and operation, high impact resistance, beautifying the environment and realizing wastewater resource utilization. But it covers a large area and is greatly affected by climate.

5. Epilogue

The types of leachate treatment technologies mentioned above have their own advantages and need to be improved. The leachate treatment technology of oxidation ditch has the advantages of simple process and low operation cost, but the foam and concentration problems need to be improved urgently, which makes it impossible to fulfill the hard requirement of leachate treatment to meet the discharge standards. This requires us to combine two or more treatment technologies to make up for each other, support each other and complement each other.

The existing landfill leachate treatment technology has its unique advantages, and has certain effect in the removal of leachate pollution parameters, such as COD and BOD_5. However, each method needs improvement, and more new landfill leachate technology is expected to emerge, breaking the conventional train of thought and opening up a new path to achieve better effect of leachate treatment.

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