Study on engineering process and equipment operation of total treatment project of leachate and concentrated solution

Changzhong Chen, Qiang Jia*
Jinan Domestic Waste Treatment Center, Jinan China, 250000
*E-mail:cjbccz@sina.com

Abstract: The accumulation of a large amount of leachate and concentrated liquid caused by MSW is a serious potential safety hazard and environmental hazard. A full treatment project of leachate and concentrate were performed, with treatment capacity of leachate 1100 t/d and concentrate 550 t/d. The leachate treatment process adopts "pretreatment + second-stage A/O biochemistry + ultrafiltration + chemical softening + second-stage DTRO+HPRO+RO+ ion exchange". The main processing equipment is jet aerator, submersible mixer, centrifugal pump, ultrafiltration membrane assembly, softening membrane assembly, DT membrane column, RO system, ion exchange tank, sludge mixer, sludge dehydrator, etc. The concentrated liquid treatment process adopts "pretreatment +MVR forced circulation evaporation + triple-effect evaporation +RO+ ion exchange". The main processing equipment is filter press, feed pump, compressor, MVR heater, circulating pump, discharge pump, original liquid pump, triple-effect evaporator, RO system, ion exchange tank, etc. The treatment results show that each indicator of external drainage meets the standard requirements of GB16889-2008 and DB37/3416.4-2018. The engineering process and equipment of the project run stably, with high recovery rate, and can properly solve the problem of concentrated liquid. So, engineering process and equipment operation of total treatment project of leachate and concentrated solution were studied, which has important reference significance for the full treatment of leachate from the national waste treatment plant.

1. Introduction

A large amount of leachate and concentrated liquid was accumulated in solid waste landfill due to long-term overload operation, and there was a serious potential safety and environment hazard.

The accumulated leachate has the following characteristics[1-3]:
(1) Imbalance of carbon and nitrogen ratio and poor biochemical properties. The concentration of COD and BOD in the accumulated leachate can reach 7 000 mg/L and 1 500 mg/L, respectively. NH3-N content is up to 3000 mg/L;
(2) The composition is complex and difficult to degrade. Organic pollutants including volatile fatty acids (VFA), alkenes, carboxylic acids and lipids;
(3) High salt content, high electrical conductivity. It contains more than ten kinds of heavy metal ions such as Na+, Ca2+, Mg2+, Fe3+, Zn2+, Cd2+, Cr6+, Hg2+, Mn2+, Pb2+, Ni2+ and so on, and its electrical conductivity is up to 60 000 μS/ cm.

The concentrate has the following characteristics [4-6]:
(1) The carbon and nitrogen ratio is seriously unbalanced and cannot be biochemical. The concentration of COD and BOD in the concentrated solution is about 4500mg/L and 1 000 mg/L, respectively. Nh3-n content is high, up to 3 000 mg/L;
(2) High salt content, high electrical conductivity. It contains more than ten kinds of heavy metal ions such as Na\(^+\), Ca\(^{2+}\), Mg\(^{2+}\), Fe\(^{3+}\), Zn\(^{2+}\), Cd\(^{2+}\), Cr\(^{6+}\), Hg\(^{2+}\), Mn\(^{2+}\), Pb\(^{2+}\), Ni\(^{2+}\) and so on, and its electrical conductivity is up to 75,000 μS/cm.

According to the water quality characteristics of the accumulated leachate and concentrated leachate, the treatment process of leachate generally adopts "pretreatment + biochemical treatment + advanced treatment", and the treatment process of concentrated leachate adopts "pretreatment + evaporation + advanced treatment". These two processes have stable operation and high recovery, which is expected to solve the problem of concentrated liquid. The effective solution of this problem has important reference significance for the comprehensive treatment of leachate from national waste treatment plant.

2. Project Overview

The project is located in a district of Jinan city. The designed treatment scale is 1,100 t/d leachate and 550 t/d concentrated liquid. The leachate, concentrated liquid and newly generated leachate and concentrated liquid of the landfill are fully treated.

The long-term recharging of concentrated liquid in the landfill resulted in high salinity of the accumulated leachate, unbalanced C/N ratio and poor biodegradability. Therefore, the method of mixing with the fresh leachate of the MSW incineration power plant is adopted. The test results of the designed water quality of leachate and the water quality after mixing are shown in Table 1, and the water quality of the concentrated solution and the designed water quality are shown in Table 2.

| Table 1. Leachate water quality test results |
|--------------------------------------------|
| Project                                    |
|--------------------------------------------|
| COD (mg/L)                                |
| BOD (mg/L)                                |
| NH3-N (mg/L)                              |
| TN (mg/L)                                 |
| Electrical conductivity (μS/cm)           |
| SS (mg/L)                                 |
| Accumulation of leachate water quality    |
| 7000 1500 3000 3600 60000 400             |
| Water quality index after mixing          |
| 19000 9000 2800 2900 53000 6400           |
| Design inlet water quality                |
| 19000 9000 2800 2900 53000 6400           |

| Table 2. Water quality test results of concentrated solution |
|-------------------------------------------------------------|
| Project                                    |
|--------------------------------------------|
| COD (mg/L)                                |
| BOD (mg/L)                                |
| NH3-N (mg/L)                              |
| TN (mg/L)                                 |
| Electrical conductivity (μS/cm)           |
| SS (mg/L)                                 |
| Concentrate water quality                  |
| 5250 2100 7450 10100 70000 1870           |
| Design inlet water quality                 |
| 5300 2100 7500 10100 75000 1900           |

3. Engineering design

3.1 Overview of process flow

The project is mainly divided into leachate treatment system and concentrated liquid treatment system. The leachate treatment process adopts "pretreatment + second-stage A/O biochemistry + ultrafiltration + chemical softening + second-stage DTRO+HPRO+RO+ ion exchange". The concentrated liquid treatment process adopts "pretreatment +MVR forced circulation evaporation + triple-effect evaporation +RO+ ion exchange". The process flow of this project is shown in Figure 1.
Figure 1. Complete process flow chart of engineering project

Each section of the processing system includes six aspects.

(1) Leachate biochemical treatment system: homogenizing tank + second-stage A/O biochemical system + sludge treatment system; (2) Leachate membrane treatment system: ultrafiltration system + softening system + second-stage DTRO+HPRO+RO+ ion exchange system; (3) Concentrated liquid pretreatment system: dehardening system; (4) Concentrated liquid evaporation system: MVR evaporation system; (5) Effluent guarantee system for concentrated solution: RO+ ion exchange; (6) Evaporated original liquor treatment system: pretreatment + three-effect evaporation + continuous drying.
3.1.1 Biochemical system of leachate
The accumulated leachate raw liquid is pumped to the homogenizing pool, which causes the imbalance of carbon and nitrogen ratio and poor biochemical properties due to long-term accumulation. Therefore, the leachate newly generated from domestic solid waste incineration plant and landfill is used for mixing and conditioning, to supplement the carbon source of sodium carbonate, so as to improve the biodegradability of raw water. The mixed wastewater is transferred to a second-stage A/O tank for biochemical treatment.

A/O process has done on the mechanism of biological denitrification in to made up of second biological nitrification and denitrification process, sewage of nitrification in the aerobic reactor, first make nitrogen organic matter by bacteria that break down into ammonia, and then under the action of nitrosation bacteria, ammonia further into nitrite nitrogen, then through nitrification activity and into nitrate nitrogen. Nitrate nitrogen into anoxic or anaerobic reactor, after denitrification, the use or partial use of sewage original organic carbon source as electron donor, nitrate instead of molecular oxygen as electron acceptor, "anaerobic" respiration, decomposition of organic matter, while reducing nitrate nitrogen into gaseous nitrogen. A/O process can not only achieve satisfactory denitrification results, but also achieve high COD and BOD removal rates through the anoxic-aerobic cycle operation mentioned above.

The odorous gases produced by the smelly source structures such as the first class A pool, the second class A pool and the sludge concentration pool are collected by the fan and sent to the deodorization system for treatment. The deodorization system adopts the "pickling tower + alkali washing tower" treatment process, and is discharged by 20m high exhaust cylinder after reaching the standard. Sludge is treated by rotary sludge dehydrator and then sent to refuse incineration plant for incineration.

3.1.2 Leachate membrane treatment system
After the biochemical treatment of sewage into the external tube ultrafiltration membrane, interception of particles, microorganisms and suspended solids greater than 0.02 μm, sludge and sewage separation effectively. Ultrafiltration water pump is sent to chemical softening system for dehardening. After treatment, it is sent to second-stage DTRO. Design parameters of ultrafiltration system: the membrane water inflow is 55 m³/h, and the designed membrane flux is 65 L/m²·h.

First-stage DTRO: In this stage, the water quality of the inlet is adjusted. In order to improve the recovery rate of reverse osmosis and overcome membrane pollution, first-stage DTRO reverse
osmosis adopts concentrated internal circulation mode. The concentrated water of the membrane component is directly returned to the inlet of the component or section and mixed with the inlet water, so as to ensure the membrane surface filtration velocity. Main design parameters:(1) Hourly processing capacity is 58.2 m³/hr; (2) Designed water flow: 40.72 m³/hr; (3) Design concentrated water flow: 17.5 m³/hr.

First-stage DTRO reverse osmosis system returns a portion of the concentrate from the membrane column outlet to the in-line pump inlet to ensure sufficient flow and cross-flow velocity on the membrane surface to avoid membrane contamination. The high pressure and high flow water from the on-line pump directly enters the membrane column. Through this rational series and parallel synthesis design, the membrane components can play the highest production efficiency, can prolong the membrane life. Ensure high flux, stable rejection rate and pollution resistance of membrane components.

After the first-stage DTRO treatment, the liquid enters the second-stage high-pressure pump for further treatment by the second-stage DTRO, and the concentrated liquid of the first-stage is discharged into the HPRO raw water tank. HPRO design parameters: (1) Hourly processing capacity was 22.9 m³/hr (2) Designed water flow was 8 m³/hr. (3) Design concentrated water flow was 14.9 m³/hr.

The second-stage DTRO is used for the further treatment of the primary DTRO permeation liquid, so it is also called the permeation liquid level. The permeation liquid treated by the primary DTRO membrane system is directly sent into the secondary DTRO membrane system high pressure pump without adding any agent. There is no need to set buffer tank between the primary and secondary DTRO membrane system, and the flow is automatically matched when the system runs. As the concentration of contaminants in the second-stage DTRO influent has been greatly reduced, the membrane surface filtration flow rate is low, and the recovery rate is relatively high, so the second-stage reverse osmosis does not need online booster pump, and only high pressure pump can meet the requirements. The secondary reverse osmosis consists of second stages, which are connected in series. The high-pressure pump water directly enters the first-stage of membrane column, and the concentrated liquid of the first-stage of membrane column enters the second-stage. Main design parameters:(1) Hourly processing capacity is 58.2 m³/hr. (2) Designed water flow was 34.9 m³/hr. (3) Design concentrated water flow was 23.3 m³/hr.

As the water quality of the second-stage DTRO concentrate is much better than that of the leachate raw water, the second-stage DTRO concentrate is combined with the inflow of the first-stage DTRO to improve the recovery rate of the system. The second-stage DTRO concentrate is discharged into the second-stage DTRO production tank through the liquid and then discharged to the RO membrane system.

RO membrane system adopts concentrated internal circulation mode. The concentrated water of the membrane assembly directly returns to the assembly or the inlet of the section, and is mixed with the water, so as to ensure sufficient flow and cross-flow velocity on the membrane surface and avoid membrane pollution. The second-stage DTRO water is discharged after RO treatment. The concentrate is returned to the primary DTRO tank for further treatment.
3.1.3 Concentrated liquid pretreatment system
Dehardening process: the concentrate is pumped into the dehardening reaction tank for chemical reaction by adding Na2CO3. CaCO3 precipitation is produced to reduce the hardness of the water. Then the mixed liquid containing precipitation and suspended matter is coagulated and precipitated, and filtrate is obtained by filter press. After pressure filtration, the cake sludge is sent to the landfill for sub-landfill treatment. Then pump the filtrate into the carbon removal reaction tank, add concentrated hydrochloric acid, remove the carbonate in the water, and adjust the pH to the applicable range of MVR influent.

3.1.4 Concentrated liquid evaporation system
Three sets of MVR evaporation systems are constructed in the concentrated liquid treatment project. The MVR evaporation system adopts an intensive integrated design and is installed on the same chassis, with liquid inlet, clean water outlet, concentrated liquid outlet, exhaust outlet and power interface reserved. Heater: the heating area is 1000 square meters, and the quantity of heat exchange tubes is 1106. MVR is short for mechanical Vapor recompression technology. It uses the secondary steam and its energy generated by the evaporation system itself to improve the enthalpy of the secondary steam through the compression work done by the steam compressor, and leads into the cooling tower. The cooling water of the cooling tower circulates to preheat materials. An
energy-saving technology that thus circulates heat to an evaporation system, thereby reducing the need for external energy.

After pretreatment, the waste liquid is filtered through a filter, and the filtrate is heat exchanged with the high-temperature distilled water and high-temperature concentrated liquid generated by evaporation through a heat exchanger. After entering the evaporation body through the exhaust heat exchanger, the liquid entering the evaporation body is mixed with the original circulating liquid in the body. The circulating liquid is re-distributed on the surface of each heat exchange tube to form a thin film for evaporation, and the unevaporated liquid is gathered in the hot well at the bottom of the main body for the next cycle. At the same time, part of the circulating liquid is transported to the drying system through the concentrated liquid discharge pipeline, and the crystallized salt is precipitated after drying. With the increase of the concentration ratio, a small amount of evaporated original liquid can no longer be evaporated, and the evaporated original liquid is sent to the evaporated original liquid treatment system for treatment.

The evaporated water is separated by the defoamer, and the air is washed by the compressor and pumped away from the washing unit. After being compressed and heated by the compressor, it is returned to the MVR evaporation system as a heat source.

After the steam returns to the main evaporation heat exchange tube, the high temperature steam inside the tube and the low temperature material outside the tube carry on the heat exchange. The low temperature material is heated to evaporate and replenished into the washing unit. After heat exchange, the high-temperature steam in the tube releases latent heat into distilled water and is discharged from the system to enter the next stage of in-depth treatment.

3.1.5 Water outlet guarantee system for concentrated liquid
RO system, the reverse osmosis pressure is defined as 20bar-70bar according to the quality of distilled water. The concentrated water returns to the MVR evaporation system and the clean water enters the ion exchange system. Design parameters of processing capacity was 38.9 m³/hr per hour.

Ion exchange system: exchange resin with strong selective adsorption of NH₄⁺ is used for ion exchange, so as to achieve the purpose of removing ammonia nitrogen and ensure that the ammonia nitrogen index meets the standard.

3.1.6 Evaporated original liquor treatment system
Pretreatment system: Because of original liquor evaporation high hardness, so as to prevent the fouling heat exchanger equipment, reduce the heat transfer efficiency, in addition to the hard processing is required before entering the evaporation, the process for by adding a special potion, cooperate with traditional PAM, PAC, the coagulant aid, etc., on the front end to the oil content in the original liquor, such as COD, SS and suspended silt separation, separation by filter press filtrate, Enter into the back-end three effect evaporation system, filter cake is collected and sent to the regional landfill. The pretreatment system consists of reaction tank, dosing metering pump, pH on-line measuring instrument, filter press and so on.

Evaporation system: mainly consists of three-effect evaporation and continuous drying system unit of evaporative concentrate, in which the three-effect system adopts forced circulation evaporator, and the concentrated evaporative liquid enriched by the three-effect system enters the continuous drying system to achieve zero discharge of the system evaporative filtrate.
3.2 List of major devices

Table 3. List of major equipment

| Order number | Processing | Device name                      | Unit  | Specification            | Number |
|--------------|------------|----------------------------------|-------|--------------------------|--------|
|              | Leachate treatment system |                        |       |                          |        |
| 1            |            | Pre-treatment feed pump          | set   | Q=55m³/h, H=30 m, N=7.5kW | 2      |
| 2            |            | Basket filter                    | set   | b=2mm, Q=50m³/h          | 1      |
| 3            |            | Slurry pump                      | set   | Q=20m³/h, H=15m, N=11kW  | 2      |
| 4            |            | Sewage pump                      | set   | Q=20m³/h, H=30m, N=3kW   | 2      |
| 5            |            | Jet pump                         | set   | Q=600m³/h, H=15m, N=30kW | 6      |
| 6            |            | Defoaming mud pump               | set   | Q=150m³/h, H=30m, N=45kW | 2      |
| 7            |            | Jet aerator                      | suit  | 12 channel aerator        | 18     |
| 8            | Second-stage A/O                   | Diving mixer                    | set   | N=5.5KW                  | 4      |
| 9            |            | Nitrifying liquid reflux pump    | set   | Q=250m³/h, H=15m, N=4.5kW| 2      |
| 10           |            | Centrifugal fan                  | set   | Q=120m³/min, H=8.0m      | 3      |
| 11           | Ultrafiltration into the pump      | Ultrafiltration into the pump    | set   | 120m³/h, 30m             | 6      |
| 12           | Ultrafiltration system             | Circulating pump                | set   | 200m³/h, 58m             | 6      |
| 13           |            | Semi-automatic filter            | set   | 100m³/h, 800μm           | 6      |
| 14           | Membrane module                     | Membrane module                 | batch | 5mm, 8 ³              | 1      |
| 15           | Softening system                     | Dosing stirrer                  | set   | 60r/min, 3.0kw           | 2      |
| 16           |            | Dosing pump                      | set   | Q=10m³/h, H=20m, 1.1kw   | 2      |
| 17           |            | Sodium hypochlorite delivery pump| set   | Q=2m³/hr; H=10M; 1.1kw   | 1      |
| 18           |            | Reaction tank feed pump          | set   | Q=55m³/h, H=10m, N=1.5kW | 2      |
| 19           |            | Reaction tank feed pump          | set   | Blade stirrer, speed 60r/min, 1.5kw | 2     |
| 20           |            | Softening film original          | set   | 2.58m², 6 inch diameter, membrane tube 12.5mm | 1     |
|   |   |   |   |   |
|---|---|---|---|---|
|21| Softening circulating pump set | Q=195m³/h, H=45m, N=22kw | 2 |
|22| Box filter press set | 160 square meters, with automatic drawing plate, liquid collection system, including pressure transmitter, water inlet, inlet pneumatic valve, undercurrent | 2 |
|23| Original water pump set | Q=32m³/h, H=35m, N=5.5kw, Material: stainless steel for flow parts | 3 |
|24| Security filter set | Q=32m³/h, Φ500mm, Matching 10μm 40 melt-blown filter element, material 316L | 3 |
|25| First-stage DTRO One stage high pressure plunger pump set | Type: 3531, CAT, Plunger pump, 316L, 80bar | 8 |
|26| First-stage high pressure plunger pump piece | Component diameter: 8", Total membrane area: 9.405m², 90bar | 440 |
|27| Second-stage DTRO Security filter piece | Q=32m³/h, Φ500mm, Matching: 10μm 40 melt-blown filter element, material 316L | 2 |
|28| Dish tube type membrane column Concentrated water delivery pump set | Component diameter:", Total membrane area: 9.405m², 120bar | 120 |
|29| RO system RO Booster pump set | Q=22m³/h, H=55m, N=5.5kw, material: Fluoroplastics for flow through parts | 3 |
|30| Reverse osmosis membrane piece | SW thin film, 37m² | 48 |
|31| Ion exchange system Ion exchange feed pump set | Q=38.5m³/h, H=33m, N=5.5kw | 2 |
|32| Ion exchange tank set | Q=10000×1950 | 4 |
|33| Mud feed screw pump set | Q=20m³/h, H=40m, N=4.0kw | 2 |
|34| Sludge treatment system Sludge mixer set | N=11KW | 1 |
|35| Rotary extrusion sludge dehydrator piece | Q=16m³/h, N=5.5kw | 2 |
|36| Floculant dispensing device set | Maximum dosage 5000L/h, Solution tank volume 5.0m³ | 1 |

Concentrated liquid treatment system

|   |   |   |   |
|---|---|---|---|
|1| Dehardeni ng system Filler press set | Filter area 80m², Enhanced polypropylene | 1 |
|2| Filter pump set | Q=40m³/h, H=70m, N=45kw | 1 |
|3| Feed pump set | Q=20m³/h, H=20m, N=5.5kw | 1 |
|4| Turn feeding pump set | Q=20m³/h, H=20m, N=5.5kw | 3 |
|5| Centrifugal compactor batch | Amount of gas 10t/h, N=630kw, Inlet temperature 85°C, Outlet temperature 105°C; Rotor material TC4, Material of the spiral case TA2 | 2 |
|6| separator set | Straight section Φ2400×5000×8mm | 2 |
|7| Defoaming machine set | Baffle plate, screen defoamer | 4 |
|8| Heater set | Heating area 1000m², 32×1.5×9000mm, Quantity of heat exchange tubes 1106, Shell diameter Φ1500mm, Monitor material TA2: Shell side material TA2 | 3 |
|9| MVR Evaporation system Feed pump set | Q=20m³/h, H= lift 30m, N=7.5kw | 2 |
|10| Drainage pump set | Q=20m³/h, H=24m, N=4kw, With the inverter | 2 |
|11| Circulating pump set | Q=1400m³/h, H=18m, N=160kw, With the inverter | 2 |
|12| Discharge pump set | Q=25m³/h, H=30m, N=11kw | 2 |
|13| Mother liquor pump set | Q=25m³/h, H=30m, N=7.5kw | 2 |

Evaporated mother liquor treatment system

|   |   |   |   |
|---|---|---|---|
|14| Tripe effect evaporator set | Heating area 1000m², 450×12000mm, Quantity of heat exchange tubes 3, Shell diameter Φ300mm, Pipe side material carbon steel | 1 |
|15| Filter press set | Filter area 40m², Enhanced polypropylene | 1 |
|16| Filter pump set | Q=20m³/h, H=30m, N=30kw | 1 |
|17| Feed pump set | Q=20m³/h, H=20m, N=5.5kw | 1 |
3.3 Main structures and parameters

Table 4. Main structures and parameters

| Order number | Main structures | Units | Specification | Material | Number |
|--------------|-----------------|-------|---------------|----------|--------|
| 1            | Homogeneous pools statue | Processing scale: Q=55m³/h, Design pool type: square pool | /       | 1       |
| 2            | First stage denitrification pond statue | Residence time of denitrification: 2.88d; Effective water depth: 8.0m; Total effective volume: 3168m³ | Reinforced concrete | 2       |
| 3            | First stage nitrification tank statue | Nitrification residence time: 6.33d; Effective water depth: 8.0m; Total volume: 6963m³ | Reinforced concrete | 2       |
| 4            | Second stage denitrification pond statue | Residence time of denitrification: 2.33d; Effective water depth: 8.0m; Total volume: 2563m³ | Reinforced concrete | 2       |
| 5            | Second stage nitrification tank statue | Nitrification residence time: 1.08d; Effective water depth: 8.0m; Total volume: 1188m³ | Reinforced concrete | 2       |
| 6            | Chemical reaction cell statue | 3.5m×3.5m×5m | Concrete | 2       |
| 7            | Settling basin statue | 6m×6m×7m | Concrete | 1       |
| 8            | Strong pool statue | Residence time: HRT nitrification =2h; Effective water depth:4.0m | Reinforced concrete | 1       |
| 9            | Sludge pit statue | Sludge moisture content 80%, The amount of sludge into the sludge storage tank 210m³/d. Design parameters: size: L×B×H =6.0×6.0×7.5m | Reinforced concrete | 1       |
| 10           | Reaction pool set | V=20m³, With mixing and other supporting facilities | Reinforced concrete | 2       |
| 11           | Raw liquid cache pool statue | V=20m³, With mixing and other supporting facilities | Reinforced concrete | 3       |
| 12           | Original liquid pool statue | V=15m³, With mixing and other supporting facilities | Reinforced concrete | 1       |
| 13           | Reaction tank statue | V=15m³, With mixing and other supporting facilities | Glass fiber reinforced plastic | 3       |

3.4 Analysis of treatment effect

According to the acceptance monitoring report, the project runs stably, and all indicators of the discharge water can meet the standard requirements of GB16889-2008 and DB37/3416.4-2018. The water quality test data of the project is shown in Table 5.

After leachate treatment system, the concentrations of COD Cr, BOD 5, NH 3-N, total nitrogen and total salt were 11.25 mg/L, 2.25 mg/L, 0.74 mg/L, 1.24 mg/L and 25.75 mg/L, respectively. The removal rates were 99.83%, 99.84%, 99.97%, 99.96% and 99.89%, respectively.

After concentrated solution treatment system, the concentrations of COD Cr, BOD 5, NH 3-N, total nitrogen and total salt were 16mg/L, 3.38mg /L, 0.19mg /L, 2.18mg/L and 458.38mg /L respectively.
The removal rates were 99.63%, 99.62%, 99.99%, 99.94% and 99.11%, respectively.

Table 5. Water quality of project inlet and outlet (mg/L)

| Project          | COD$_{2}$ | BOD$_{5}$ | NH$_{3}$-N | Total nitrogen | Soluble |
|------------------|-----------|-----------|-------------|---------------|---------|
| Leachate raw water | 6545      | 1374      | 2833        | 3223          | 23588   |
| Leachate effluent | 11.25     | 2.25      | 0.74        | 1.24          | 25.75   |
| Concentrate raw water | 4280     | 894       | 1938        | 3890          | 51325   |
| Concentrated effluent | 16       | 3.38      | 0.19        | 2.18          | 458.38  |

3.5 Potential System Running problems and solutions

(1) The water quality of the accumulated leachate changes greatly, and the foam of the biochemical system is serious, which affects the operation. Solution was that adjusting the position of the sewage pipe inlet and the project inlet to buffer water quality and minimize the impact of water quality changes on the biochemical system.

(2) The conductivity of the leachate at the bottom of the temporary sewage storage tank is high, and the nitrifying bacteria are inactivated, which affects the nitrogen removal effect. The solution is to pump 200t/d of biochemical sludge from the incinerator leachate treatment project O tank to the project for mixed treatment. At the same time, nitrifying bacteria were added to ensure the normal denitrification function of biochemical system.

(3) On-site environmental management of concentrated liquid treatment system. Improving rain and sewage diversion facilities in the plant area, conducting anti-seepage treatment for waste gas treatment facility area, pretreatmenting area and evaporation facility area, seting up cofferdams and accidenting pools to avoid environmental pollution incidents caused by waste liquid spillover due to pipe bursting, flushing and failure.

(4) MVR evaporator of concentrated liquid treatment system has serious scaling, reduced heat transfer efficiency and processing capacity, and long time and high frequency of pipe overhaul, which affects the normal operation of the project. Solution is suggested that the spare evaporator should be built simultaneously in the concentrated liquid treatment system for the treatment of the concentrated liquid during maintenance, and a special concentrated liquid temporary storage pool should be built for the temporary storage of the concentrated liquid during maintenance, and the maintenance plan and treatment plan should be made reasonably to reduce the risk of concentrated liquid accumulation.

(5) The effluent quality of concentrated solution treatment system is unstable. Solution is that setting up the effluent buffer tank. After the concentration of the effluent guarantee system to meet the standard again, mixing with the leachate system effluent discharge.

(6) In the early stage of operation, the treatment scheme of evaporated original liquor was the incinerator backinjection. Due to its conductivity as high as hundreds of thousands of μS/cm, the backinjection incinerator chamber caused the incinerator coking failure, and the preparation of lime slurry would react and bubble. After a period of treatment, it was determined that the treatment scheme was not feasible. Therefore, technical reform was carried out in the process of operation, and the technological process of technical reform measures was "pretreatment + three-effect evaporation + drying system", which solved the problem of evaporation original liquor treatment.

4. Investment estimation and economic analysis

The main construction contents of the project includes A/O biochemical tank, sludge tank, sludge dewatering room, blower room, membrane treatment workshop, concentrated liquid pretreatment area, 3 sets of MVR evaporator, three-effect evaporator, pretreatment and stirring reaction tank, etc. The total investment of the project is 152 728 800 yuan, in which the financial internal rate of return of leachate treatment system is 6.43%, and the investment payback period is 7.31 A. The concentrated
liquid treatment system has a financial internal rate of return of 6.56% and a payback period of 3.77 A.

5. Conclusion
The leachate treatment process of this project adopts "pretreatment + second-stage A/O biochemistry + ultrafiltration + chemical softening + second-stage DTRO+HPRO+RO+ ion exchange". The concentrated solution is treated by "pretreatment +MVR forced circulation evaporation + three-effect evaporation +RO+ ion exchange". After 2a years of operation, all indexes meet the standard requirements of GB16889-2008 and DB37/3416.4-2018. The process has stable operation, high recovery rate, and properly solved the problem of concentrated liquid. This process has important reference significance for the full treatment of leachate from the national waste treatment plant.

Reference
[1] Weigold J. Onsite evaporation using waste energy solves disposal challenges[J]. World Water & Environmental Engineering, 2019, 42(1):37-38.
[2] Cope C C. Characterization of chat leachate and mine discharge into tar creek, ottawa county, Oklahoma [J]. Research.
[3] Trabelsi I, Horibe H. Origin of low carbon/nitrogen ratios in leachate from old municipal solid waste landfills[J]. Waste management & research, 2000.
[4] Guo R. Review on Treatment Technology of Concentrated Landfill Leachate by Membrane Filtration[J]. Chemical Engineering Design Communications, 2019.
[5] Johnson A S, BaKer A, Bruer L. Interdependence, Garbage Dumping, and Feral Dogs: Exploring Three Lifeworld Resources of Young Children in a Rural School[J]. Early Childhood Education Journal, 2007, 34(6):371-377.
[6] Draper, C. I. Processed Garbage Meal in the Chick Ration[J]. Poultry ence, 1946, 24(5):442-445.