GENERAL

aerobic biological treatment of landfill leachate wit press

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Landfills are essential for modern waste management, but they pose a serious environmental challenge in the form of leachate—a toxic liquid that seeps through waste layers and can contaminate soil, groundwater, and surface waters. Effective treatment of landfill leachate is crucial to protect ecosystems and human health. Among the various treatment technologies, **aerobic biological treatment of landfill leachate with press**has emerged as a cost effective, energy efficient, and environmentally friendly option. This article delves into the science, design, operation, and future trends of aerobic leachate treatment systems that incorporate a press for solid removal.

Understanding Landfill Leachate

Leachate is generated when precipitation, groundwater, or landfill cover water percolates through the waste mass. Its composition varies widely depending on the waste type, age of the landfill, and climatic conditions, but typical constituents include:

- High Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)
- Ammonia, nitrate, and nitrite
- Heavy metals such as lead, cadmium, and mercury
- Organic pollutants including phenols, chlorinated compounds, and hydrocarbons
- Inorganic salts and nutrients (nitrogen, phosphorus)

The variability in leachate composition poses a challenge for treatment plants, requiring flexible and robust processes that can handle fluctuating loads.

Why Aerobic Biological Treatment?

Aerobic biological treatment uses oxygen dependent microorganisms to degrade organic matter. Compared to anaerobic processes, aerobic systems offer several advantages for landfill leachate:

- Higher Removal Efficiency – Aerobic bacteria can oxidize a broader range of organics, achieving superior BOD and COD reductions.
- Lower Sludge Production – Aerobic systems generate less sludge than anaerobic digesters, reducing disposal costs.
- Faster Response – The process is more responsive to load variations, making it suitable for fluctuating leachate streams.
- Compatibility with Press Integration – Pressing solids before aeration enhances process stability and reduces oxygen demand.

These benefits make aerobic biological treatment a preferred choice for many landfill operators, especially when combined with a press to handle the high solid content typical of leachate.

The Role of Press in Leachate Treatment

Leachate often contains a significant proportion of suspended solids and colloidal matter. A press—commonly a mechanical press or a filtration press—serves as a preliminary treatment step that:

- Reduces Solids Load – By compressing or filtering solids, the press lowers the suspended solids

concentration entering the biological reactor.

- Improves Oxygen Transfer – Lower solids levels allow better oxygen diffusion, enhancing microbial activity.
- Shortens Retention Time – With less particulate matter to process, the biological reactor can operate at a shorter hydraulic retention time (HRT).
- Prevents Biomass Sloughing – Pressing reduces the likelihood of biomass sloughing or clogging in downstream equipment.

In many designs, the press is positioned immediately after an initial settling or filtration stage, ensuring that only the clarified leachate enters the aerobic reactor.

Key Components of an Aerobic Biological Treatment System

While each landfill's requirements differ, a typical aerobic leachate treatment plant with press includes the following main components:

- Pre Treatment Unit – Settling tanks, sand filters, or membrane bioreactors that remove large solids and reduce turbidity.
- Press Unit – Mechanical presses or filtration presses that compress or filter remaining solids.
- Aeration Tanks – Reactors where microorganisms oxidize organic matter; can be stirred tanks, fluidized beds, or rotating biological contactors.
- Secondary Clarifiers – Tanks or filters that separate biomass from treated effluent.
- Post Treatment Units – Advanced oxidation, nutrient removal, or polishing steps to meet discharge standards.
- Control and Monitoring Systems – Sensors for dissolved oxygen, pH, temperature, and flow rates, coupled with SCADA for automated operation.

Integration of a press within this sequence optimizes the overall performance, particularly for leachates with high suspended solids.

Design Considerations for Aerobic Leachate Treatment with Press

1. Hydraulic Loading Rate (HLR) – Determined by leachate volume and target effluent quality; a higher HLR requires more efficient aeration and solid removal.
2. Solids Retention Time (SRT) – Critical for microbial growth; typically 5–15 days for leachate treatment.
3. Aeration Intensity – Must provide sufficient dissolved oxygen (DO) to sustain aerobic metabolism; commonly 2–4 /mg /L {¹ DO is targeted.
4. Press Capacity – Calculated based on solids concentration and desired solids removal efficiency; oversizing can lead to unnecessary capital cost, undersizing can cause overload.
5. Temperature Control – Microbial activity peaks between 20–35 /°C; temperature management may involve heating or cooling systems.
6. Nutrient Balance – Adequate nitrogen and phosphorus levels are needed for biomass growth; supplemental nutrients may be added if deficiencies are detected.
7. Sludge Management – Even with press integration, some sludge will accumulate; design for dewatering, storage, or disposal.

These parameters are interdependent; a holistic design approach ensures optimal performance and cost efficiency.

Case Studies

Case Study 1: Municipal Landfill in Greenfield

The Greenfield Municipal Landfill, covering 120 ha, generated approximately 1.2 m^3 d {¹ of leachate during the rainy

season. The operator installed a combined press–aerobic treatment system to meet stringent discharge standards. Key results included:

- BOD removal: 92 /% (from 650 /mg /L {¹ to 48 /mg /L {¹)
- COD removal: 88 /% (from 1,200 /mg /L {¹ to 144 /mg /L {¹)
- Ammonia removal: 85 /% (from 30 /mg /N /L {¹ to 4.5 /mg /N /L {¹)
- Operational cost: $0.02 /L {¹, a 30 /% reduction compared to the previous anaerobic system.

Press integration reduced suspended solids from 300 /mg /L {¹ to 40 /mg /L {¹ before aeration, enabling a shorter HRT of 3 days.

Case Study 2: Industrial Landfill in Riverton

Riverton’s industrial landfill produced leachate rich in hydrocarbons and heavy metals. A press aerobic system was designed with a membrane bioreactor (MBR) preceding the press to handle oil containing streams. Outcomes:

- BOD removal: 95 /% (from 1,000 /mg /L {¹ to 50 /mg /L {¹)
- COD removal: 90 /% (from 1,800 /mg /L {¹ to 180 /mg /L {¹)
- Heavy metal removal: 80 /% (average of lead, cadmium, and mercury)
- Energy consumption: 0.25 /kWh /m {³, lower than comparable anaerobic digesters.

In this scenario, the press played a pivotal role in concentrating oil laden solids, allowing the downstream aerobic reactor to focus on biodegradation rather than physical separation.

Operational Best Practices

- Regular Monitoring – Continuous measurement of DO, pH, temperature, and flow rates ensures consistent treatment performance.
- Press Maintenance – Inspect and clean press membranes or plates weekly to prevent fouling and maintain throughput.
- Biomass Management – Control sludge age and prevent excessive biomass accumulation by performing routine sludge wasting.
- Temperature Regulation – Use heat exchangers or insulation to keep the reactor within the optimal temperature range.
- Inoculation – Introduce acclimated microbial consortia to jump start the system during startup or after major disturbances.
- Shock Load Handling – Implement a buffer tank to absorb sudden increases in leachate volume or organic load.
- Data Logging – Store historical data for trend analysis and predictive maintenance.

Challenges and Mitigation Strategies

While aerobic biological treatment with press is robust, operators may face specific challenges:

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