Short Communication (T-II)

FIXED FILM BIOLOGICAL REACTOR WITH ROTATING PADDLES

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ABSTRACT

A study was carried out to check the feasibility of treatment of domestic wastewater with
attached growth system with provision of some modification in the conventional rotating
biological contactor. Effort is made to develop treatment option to treat domestic wastewater by
using fixed film biological reactor with rotating paddles. For this purpose, a laboratory scale
model was developed comprising of horizontal and vertical shaft on which rotating paddles were
fitted instead of disc. The paddles were packed with artificial media to enhance the efficiency.
The current experimental study of fixed film biological reactor with rotating paddles revealed
that, the maximum removal efficiency for BOD and COD was observed to be 85% and 80% at
an optimal rotational speed of 7 rpm and detention time of 24 hours. The present paper discusses
various options adopted for operation and treatment of wastewater using fixed film biological
reactors with rotating paddles.

Key Words: Attached growth, Paddles, Rotating biological contactor, Total solid, Wastewater

INTRODUCTION

Wastewater management in developing
countries has become an extremely important
for the improvement in the quality of life and
enhancement of productive efficiency of
people. In most of the cases wastewater is
discharged into the natural drainage system or
surface sources causing pollution in
downstream areas. Various treatment processes
such as trickling filters activated sludge
process, anaerobic filter, anaerobic lagoons are
available for the treatment of wastewater and
are broadly categorized as attached growth
system or suspended growth processes.1 RBC2
system is an attached growth bioreactor2 that
offers an alternative technology to the
conventional wastewater treatment processes
as it allows a sufficiently long biomass
retention time, compact unit, low energy cost,
easy operation, high process stability, less
footprint requirement and high specific
removal rate.34 In general the RBC, contains a number of discs

*Author for correspondence which are arranged along the shaft axis of the
contractor.5 The wastewater is fed in the
contractor at a certain flow rate. All the discs
are partially submerged into the wastewater.
When the discs are continuously rotated by a
shaft, the lower portion of the discs submerged
in the wastewater would then be turned to the
upper atmosphere phase. Thuis, the microbial
film on the disc that is initially in contact with
the nutrients of the wastewater phase and the
oxygen in the atmosphere would then perform
its metabolism.6 Hence, the organic
compounds in the wastewater would serve as
the nutrients for the microbes to digest and
grow and thus brings about the treatment of
wastewater. Considering the action of
biological growth on the discs to treat
wastewater various modification have been
developed to increase the efficiency of the
RBC. The present study aims to developed
new technique for effective domestic
wastewater treatment with the modification in
the conventional RBC. To bring about the
effective treatment a physical model was
developed comprising of shafts with paddles
attached to it, and those paddles were filled with different media to judge the performance of the model for wastewater parameters such as BOD and COD. The model was operated for different operating conditions such as different detention time and different rpm.

**AIMS AND OBJECTIVES**

To modify the conventional RBC in order to get higher level of efficiency. The basic objective of the study is to observe the performance of fixed film biological reactor with the introduction of horizontal and vertical shaft fitted with rotating paddles and the incorporation of different media in the paddles to bring about the effective treatment of wastewater.

**MATERIAL AND METHODS**

The laboratory model was fabricated with GI with appropriate inlet and outlet arrangement. The total capacity of the model was 60 liters. The model was developed as a single stage reactor. The horizontal PVC shaft was mounted at both the sides of tank with provision of ball bearings at both ends. One vertical PVC shaft was mounted at the center of the tank. The horizontal and vertical shafts were provided with paddles made up of GI net. The paddles were filled with various media to judge the performance of fixed film biological reactor at various operating condition. The inlet and outlet arrangement was provided at both ends such that the rotating paddles remains 40% immersed. The driving mechanism was mounted at influent end directly fitted to horizontal and vertical shaft with the provision of speed control unit through regulator. The surface of the rotating paddle was perforated to provide opportunity for the growth of microorganism. The reactor was operated as continuous reactor at varying detention time, varying rotational speed and change in operating conditions. The performance of the biological reactor was observed for various operating conditions for pH, BOD and COD parameters. To judge the efficiency of fixed film biological reactor the model was fed with domestic wastewater at designed inflow.

To study the performance of fixed film biological reactor the paddles attached to the horizontal and vertical shaft were filled with media such as plastic scrubber and aerocon stones. The reactor was feed with wastewater continuously through inlet provided at the side of the tank. The model was operated at varying detention time and varying rotational speed.

**RESULTS AND DISCUSSION**

The performance of fixed film biological reactor with rotating paddles was observed for all the combinations to achieve the maximum efficiency. The study was carried out for nearly 4 months. The characteristic of the influent and effluent wastewater was analyzed by adopting standard methods. The parameters such as BOD, COD and Total Solid were tested at varying detention time and rotational speed at regular intervals. (Table 1 to Table 3) The model was operated at rotational speeds ranging from 7rpm to12rpm and detention time ranging from 18 to 27 hours. Various parameters were tested with varying detention time but detention time of 24 hours was found to be optimum.

Table 1 : BOD removal efficiency at varying rotational speed and detention time of 24h

<table>
<thead>
<tr>
<th>S/N</th>
<th>Influent BOD (mg/l)</th>
<th>Effluent BOD (mg/l)</th>
<th>Percent removal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 rpm</td>
<td>10 rpm</td>
<td>12 rpm</td>
</tr>
<tr>
<td>1</td>
<td>174</td>
<td>188</td>
<td>188</td>
</tr>
<tr>
<td>2</td>
<td>207</td>
<td>192</td>
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<td>213</td>
<td>232</td>
<td>177</td>
</tr>
<tr>
<td>5</td>
<td>245</td>
<td>214</td>
<td>210</td>
</tr>
</tbody>
</table>
Table 2: COD removal efficiency at varying rotational speed and detention time of 24 h

<table>
<thead>
<tr>
<th>S/N</th>
<th>Influent COD (mg/l)</th>
<th>Effluent COD (mg/l)</th>
<th>Percent removal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 rpm</td>
<td>10 rpm</td>
<td>12 rpm</td>
</tr>
<tr>
<td>1</td>
<td>365</td>
<td>375</td>
<td>390</td>
</tr>
<tr>
<td>2</td>
<td>370</td>
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</tr>
<tr>
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<td>390</td>
</tr>
<tr>
<td>5</td>
<td>378</td>
<td>412</td>
<td>410</td>
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</table>

Table 3: Total Solids (TS) removal efficiency at varying rotational speed and detention time of 24 h

<table>
<thead>
<tr>
<th>S/N</th>
<th>Influent TS (mg/l)</th>
<th>Effluent TS (mg/l)</th>
<th>Percent removal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 rpm</td>
<td>10 rpm</td>
<td>12 rpm</td>
</tr>
<tr>
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<td>256</td>
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</tr>
<tr>
<td>5</td>
<td>319</td>
<td>400</td>
<td>280</td>
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</table>

From the above results, it was revealed that the rotational speed of 7 rpm and detention time of 24 hours was found to be optimum for various operating conditions. It was observed that the biological reactor with rotating paddles filled with plastic scrubber showed higher efficiency with BOD, COD and TS removal of 85%, 80% and 84% respectively. It was noted that with the increase in detention period of the treatment, there was remarkable increase in removal efficiency.

**CONCLUSION**

Fixed film biological reactor with rotating paddles showed higher efficiency than conventional rotating biological contactor with BOD and COD reduction to a considerable extent. The study claims that the fixed film biological reactor with rotating paddles filled with plastic media showed better performance as compared to the rotating paddles filled with aerococon stones. It was concluded that fixed film biological reactor with rotating paddles is one of the promising wastewater treatment technologies suitable for treatment of domestic wastewater generated from small community. This system can also be used for the treatment of industrial and agricultural wastewater.

**ACKNOWLEDGEMENT**

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**REFERENCES**

2. Kadu P., Badge A. and Rao Y., Treatment of municipal wastewater by using rotating


