EXPERIMENTAL STUDY ON POST TREATMENT OF DAIRY WASTEWATER USING HYBRID REED BED TECHNOLOGY

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ABSTRACT

Water is a crucial and one of the precious natural resources of this planet and it is a prime need for human survival and industrial development. Pollution caused by industry is a serious concern in throughout the world. Compared to other industrials sectors, the food industry uses a much greater amount of water and is one of the biggest producers of effluent. Dairy is an industry where milk is processed and various milk products are manufactured. The consumption of large volumes of water and the generation of organic compounds as liquid effluents are major environmental problems in milk processing industry. Poorly treated wastewater with high level of pollutants caused by poor design, operation or treatment systems creates major environmental problems when discharged to the surface land or water. The discharge of untreated wastewater is a major contributor to deteriorating health conditions and pollution of nearby water bodies. The conventional treatment has limitations like high cost of operation and maintenance and requirement of technically skilled labours. Hence there is need for developing low cost technique for dairy wastewater treatment. Reed bed is one of such techniques which use plants, micro-organisms to remove harmless pollutants from contaminated water.

Keyword : - *Reed bed , Constructed Wetland, Phragmites Australis, Biochemical oxygen demand, Chemical oxygen demand*

1. INTRODUCTION

Environmental Engineering and Pollution control are the main concerns of these days. Due to increase in population the economical, industrial and technological revolution and change in life style has direct to various types of environmental problems like water pollution, land pollution, air pollution, sound pollution.
As Industrialization is backbone for development of India. Of all industrial activities, the food division is one of the highest utilizations of water.

Dairy industry is considered as largest source of food processing wastewater in many countries. In Dairy industries the manufacturing of various types of milk products such as fluid milk, butter, cheese, yogurt, condensed milk, flavored milk, milk powder, ice cream, buttermilk, whey etc. are done. A chain of operations involve receiving and storing of raw materials, processing of raw materials into finished products, packaging and storing of finished products. The huge amount of water is used during processing of milk, so this result in generation of high volume of effluent. Due to rapid growth of industries it has not only improved the productivity but also resulted in the production and release of toxic substances into the environment and creating health hazards. The dairy effluent is characterized with high chemical oxygen demand, biological oxygen demand, nutrients, organic and inorganic contents.

Thus proper treatment of dairy wastewater is necessary before disposal. Dairy wastewater is readily biodegradable and can be treated easily with conventional treatment techniques like activated sludge process,

trickling filter, waste stabilization pond, etc. But conventional treatment has limitations like high cost of operation and maintenance, requirement of technically skilled labors. So there is need for developing low cost technique for dairy wastewater treatment.

2. NEED OF THE STUDY

The trend over the past years in the construction of water pollution control facilities is in the direction of "machinery" alternatives. With the introduction of higher energy prices and higher labor costs, these systems have become major cost items. So the processes that use relatively more land and are lower in energy use and labor costs are becoming attractive alternatives for these facilities. The reed bed system is cost effective and environmentally sound ways to control water pollution.

The importance in the use of reed bed for the treatment of food processing industry wastewaters including dairy wastewater is growing. The reason is the intention to create clean technologies that can substitute the currently used "environmentally unfriendly" conventional facilities.

3. REED BED SYSTEM

Reed bed is also defined as an "Engineered systems, designed and constructed to utilize the natural functions of wetland vegetation, soils and their microbial population to treat contaminants in surface water, ground water or waste streams". The red bed treatment is also known as the constructed wetland or root zone treatment system. Reed bed uses common reed plants to dewater solids in a limited area. The beds can be any shape to accommodate existing land conditions and areas.

3.1 CLASSIFICATION OF REED BED SYSTEM

The reed bed system is classified in Surface flow reed bed and Sub-surface flow reed bed.

3.1.1 SURFACE FLOW REED BED

In the Surface flow reed bed systems water flows primarily above ground and exposed to the atmosphere. Below the free water body, the bed contains a soil layer which serves as a rooting media for the emergent vegetation.

3.1.2 SUB SURFACE FLOW REED BED

The Subsurface flow reed bed uses a bed of soil or gravel as a substrate for the growth of rooted emergent plants. Mechanically pre-treated wastewater flows by gravity, horizontally or vertically, through the bed substrate, where it comes in contact with a mixture of microorganism living in the substrate and plant roots.

The subsurface flow system is classified in two types of flow directions. That is horizontal flow and vertical flow.

3.1.2.1 HORIZONTAL FLOW REED BED

It is called Horizontal flow treatment because the wastewater is fed in at the inlet and flow slowly through the porous substrate under the surface of the bed in a horizontal path until it reaches the outlet zone. During this passage the wastewater will come into contact with an aerobic and anaerobic zone. The aerobic zones will be around the roots and rhizomes of the wetland vegetation that leak oxygen into the substrate. During the passage of wastewater through the rhizosphere, the wastewater is cleaned by microbiological degradation.

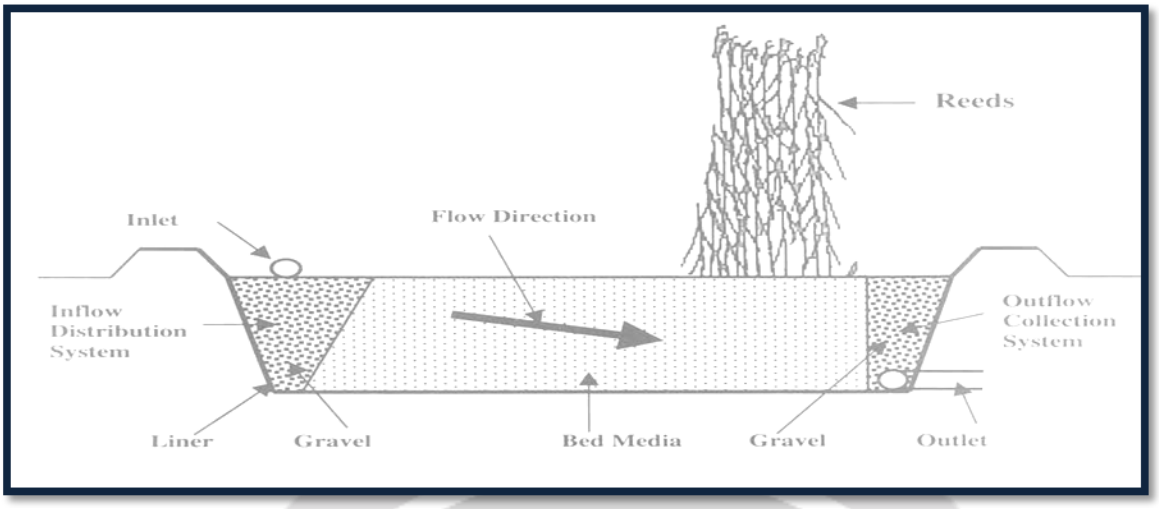

Figure 1: Horizontal flow reed bed

3.1.2.2 VERTICAL FLOW REED BED

Vertical Flow treatment comprises of layers of various sized gravels planted with reeds. Wastewater is fed from the top and then gradually percolates down through the bed and is collected by a drainage network at the base. The advantage of vertical flow systems is an improved oxygen transfer into the soil layer.

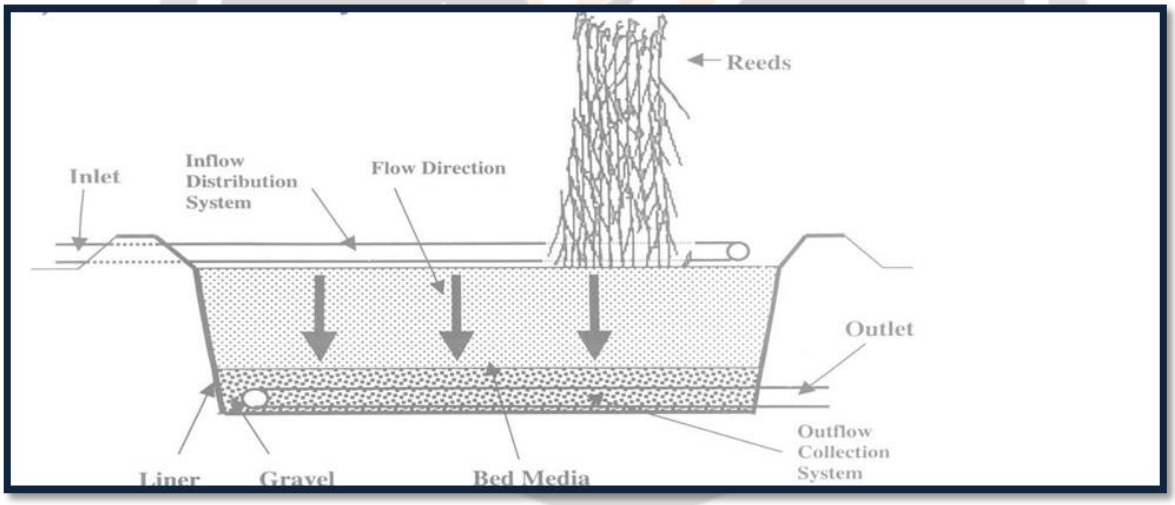

Figure 2: Vertical flow reed bed

3.1.2.3 HYBRID REED BED

Horizontal Flow treatment is used to remove biochemical oxygen demand and total suspended solids for secondary wastewater treatment. In Vertical Flow treatment there are some limitation like less efficient in solids removal and can become clogged if the media selection is not correct. Due to these reasons, the hybrid wetlands are used. In these systems, the advantages and disadvantages of the Horizontal Flow and Vertical Flow can be combined to complement each other.

Depending on the purpose, hybrid wetlands could be either Horizontal Flow wetland followed by Vertical Flow wetland or Vertical Flow wetland followed by Horizontal Flow wetland.

4. WORKING OF REED BED SYSTEM

The reed bed has the ability to transfer oxygen from its leaves, down through its stem, porous speta and rhizomes and out via its root system into the rhizosphere (root system). Due to this action a very high populations of micro-organisms are in the rhizosphere, with zones of aerobic and anaerobic conditions. Therefore with the wastewater moving very slowly and carefully through the mass of reed roots, the wastewater is successful treated.

5. MATERIALS AND METHODOLOGY

The materials used in substrate are soil, sand and aggregate. The soil and sand was collected from the farm. Aggregate was collected from the construction site. Before placing the soil, sand and aggregate in the bed, it was cleaned properly and was ensured free from impurities.

5.1 EXPERIMENTAL SET UP OF HYBRID REED BED

The hybrid reed bed system is constructed on lab scale basis in open atmosphere. The horizontal and vertical reed beds are planted with Phragmites australis. The horizontal flow reed bed is made in rectangle shape having size 45×25×25 cm. The vertical flow reed bed is made in cylindrical shape having diameter 30 cm and height 40 cm. The dairy wastewater will percolate through the bed assembly from horizontal bed to vertical bed and by passing from vertical substrate it will come out from the tap attached at the bottom.

5.2 PREPARATION OF THE BED

In horizontal flow reed bed both the sides were filled with aggregate having size of 16 mm and 31.5 mm. The aggregate are placed in 15 cm from edge of both sides. The large size aggregate are placed below the small size aggregate. In the middle area the sand and soil are placed. The sand is placed below the soil. The mean particle size of sand is 2.36 mm. Before placing the soil and sand in the bed, it was be cleaned and was ensured to free from the impurity. The soil media have the depth of 10 cm.

The vertical flow system has the height of 40 cm. The top layer is made with soil used as substrate. Before placing the soil in the bed, it was be cleaned and was ensured to free from the impurity. The soil media have the depth of 10 cm. below the soil layer the sand is placed and the depth of sand layer is 8 cm. The mean particle size of sand is 2.36 mm. The bottom of reed bed is filled with aggregate of size 16 mm & 31.5 mm respectively. The 16 mm aggregate have the depth of 8 cm and the 31.5 mm aggregate have the depth 10 cm.

5.3 STARTING OF EXPERIMENT

After the preparation of the bed for the hybrid reed bed system the actual performance was started. The raw wastewater from the dairy industry is collected and placed in the influent container. The raw wastewater characteristics like pH, BOD, COD, TSS, and TDS were determined using procedure mentioned in standard methods. Dairy wastewater was applied in to the top of the horizontal flow reed bed unit for the treatment. The dairy wastewater will flow from horizontal flow reed bed to vertical flow reed bed. The treated wastewater from vertical flow reed bed is collected from the bottom of the unit by opening tap provided at bottom of the unit at varying hydraulic retention time as 12, 24 and 36 hours. The purified wastewater characteristics were also studied by using standard methods.

Figure 3: Horizontal Flow reed bed

Figure 4: Vertical flow reed bed

Figure 5: Hybrid reed bed system

6. RESULTS

The characteristics of dairy wastewater taken from up flow anaerobic sludge blanket are described in the table. The various tests were conducted on the wastewater as per procedure laid down in standard methods.

Table 1: Characteristics of dairy waste water

No.	Parameter	Concentration, mg/L
1	pH	6.62
2	Total Dissolved Solids (mg/L)	1058
3	Total Suspended Solids (mg/L)	230
4	COD (mg/L)	1311
5	BOD (mg/L)	445
6	Ammonical nitrogen (mg/L)	20.5

6.1 PERFORMANCE OF HYBRID REED BED SYSTEM ON REMOVAL OF BIOCHEMICAL OXYGEN DEMAND AT DIFFERENT DETENTION TIME

Table 2: Performance of hybrid reed bed system on removal of BOD at different detention time

Parameter	Detention time	Initial	Final
BOD	12 Hours	458	276
	24 Hours	458	124
	36 Hours	458	14

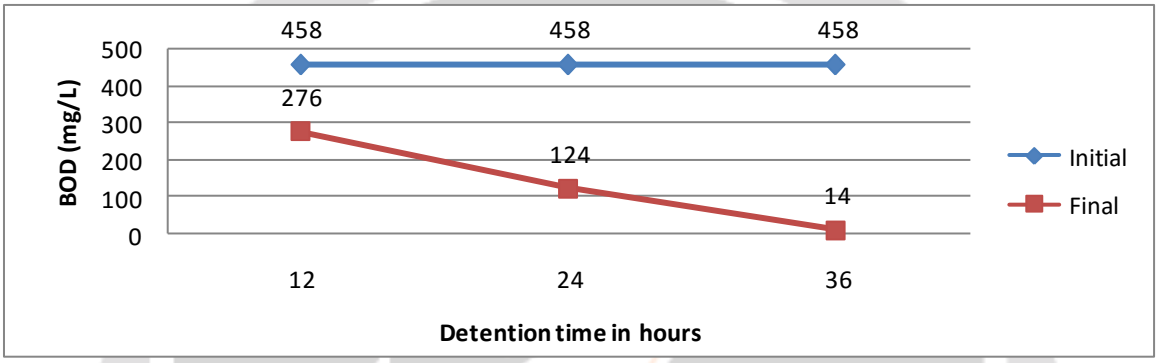

Chart 1: Performance of hybrid reed bed system on removal of BOD at different detention time

6.2 PERFORMANCE OF HYBRID REED BED SYSTEM ON REMOVAL OF CHEMICAL OXYGEN DEMAND AT DIFFERENT DETENTION TIME

Table 3: Performance of hybrid reed bed system on removal of COD at different detention time

Parameter	Detention time	Initial	Final
COD	12 Hours	1325	864
	24 Hours	1325	372
	36 Hours	1325	110

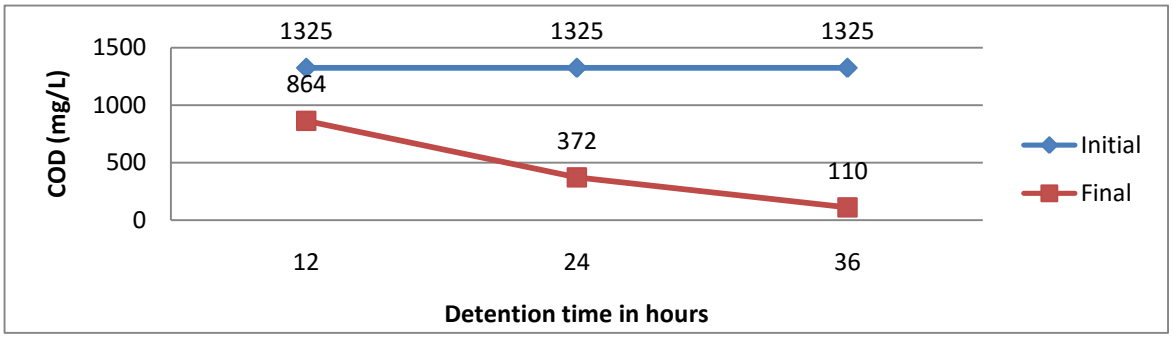

Chart 2: Performance of hybrid reed bed system on removal of COD at different detention time

6.3 PERFORMANCE OF HYBRID REED BED SYSTEM ON REMOVAL OF TOTAL DISSOLVED SOLIDS AT DIFFERENT DETENTION TIME

Table 4: Performance of hybrid reed bed system on removal of TDS at different detention time

Parameter	Detention time	Initial	Final
TDS	12 Hours	1094	1018
	24 Hours	1094	932
	36 Hours	1094	874

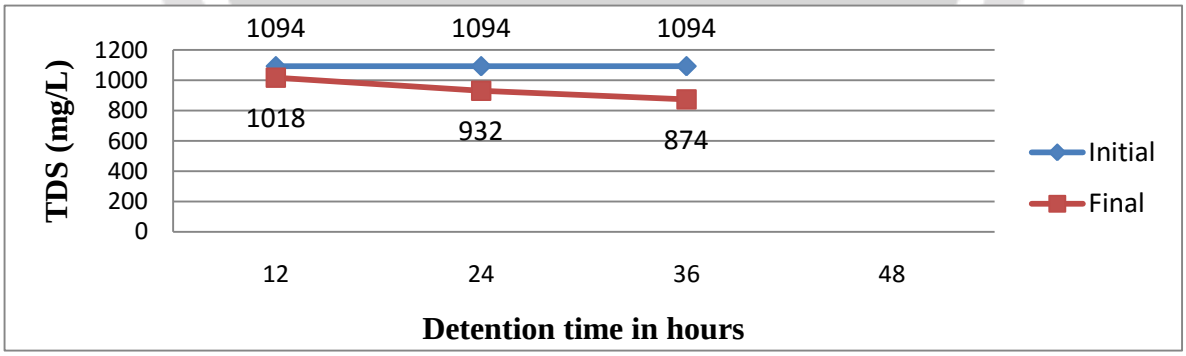

Chart 3: Performance of hybrid reed bed system on removal of TDS at different detention time

6.4 PERFORMANCE OF HYBRID REED BED SYSTEM ON REMOVAL OF TOTAL SUSPENDED SOLIDS AT DIFFERENT DETENTION TIME

Table 5: Performance of hybrid reed bed system on removal of TSS at different detention time

Parameter	Detention time	Initial	Final
TSS	12 Hours	225	204
	24 Hours	225	171
	36 Hours	225	148

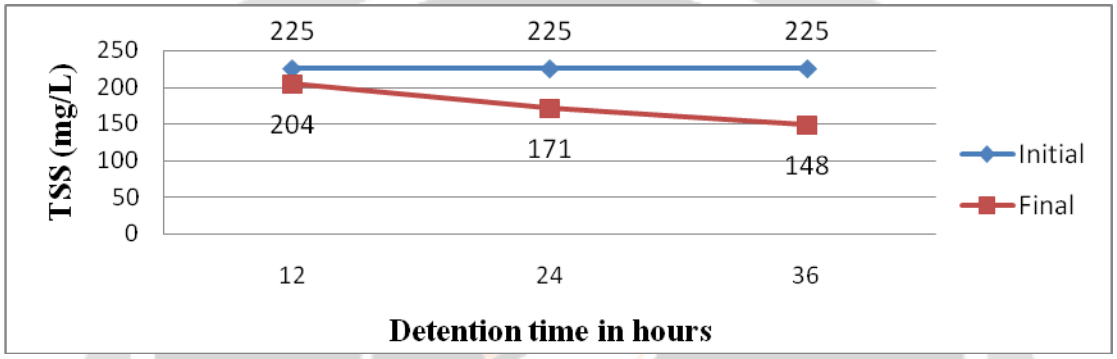

Chart 4: Performance of hybrid reed bed system on removal of TSS at different detention time

6.5 PERFORMANCE OF HYBRID REED BED SYSTEM ON REMOVAL OF pH AT DIFFERENT DETENTION TIME

Table 6: Performance of hybrid reed bed system on removal of pH at different detention time

Parameter	Detention time	Initial	Final
pH	12 Hours	6.4	6.9
	24 Hours	6.4	7.2
	36 Hours	6.4	7.1

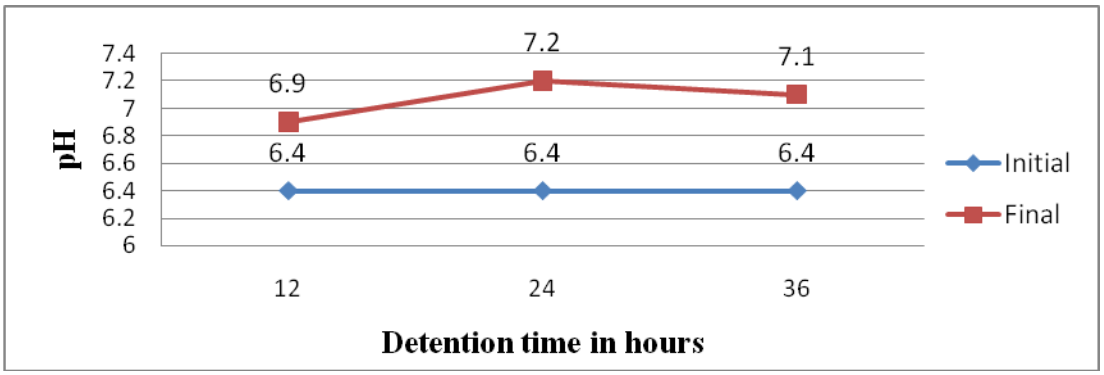

Chart 5: Performance of hybrid reed bed system on removal of pH at different detention time

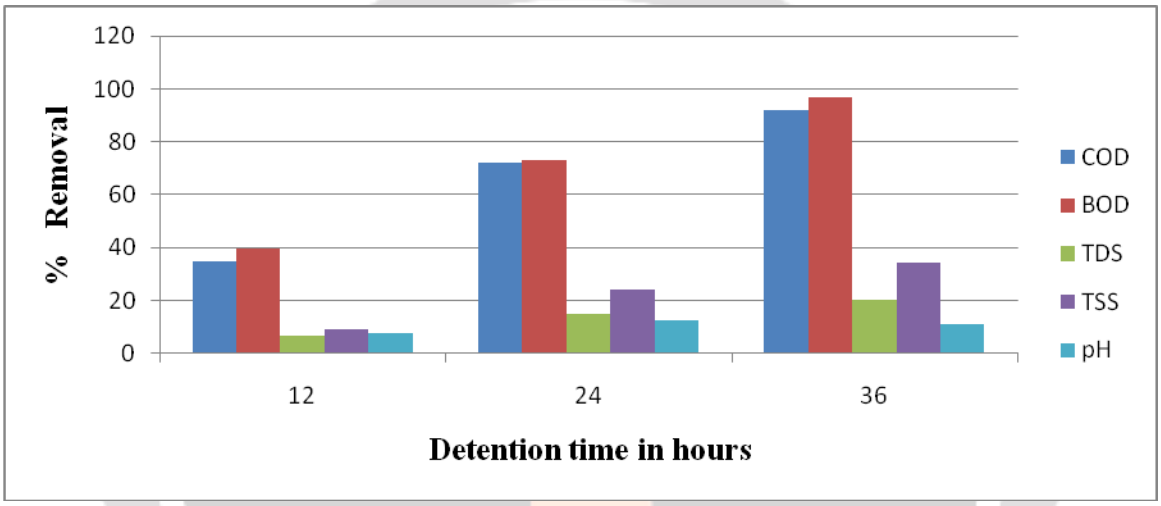

Chart 6: Comparison of percentage removal of parameters at different detention time

7. CONCLUSIONS

This study confirmed that the Hybrid reed bed system was highly effective on removing BOD up to 14 mg/L and COD at up to 110 mg /L at 36 hours detention time with a removal efficiency of BOD is 97%, and COD is 92% for dairy wastewater. Reductions in TDS and TSS were not significant. Initially the pH of Dairy waste sample was more alkaline but due to the techniques implemented the pH was brought up much near to the neutral axis. Organic matter removal was generally higher in systems, suggesting that plants may play an important role in removing organic matter from hybrid reed bed system. So the treated waste can be effectively used for irrigation and local purpose. Hence, the Hybrid reed bed treatment process may prove to be a handy solution for the organic effluents from food based industries.

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