# A Comparative Study on Using Different Types Of Membrane Combination To Treat Sewage Wastewater

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**Abstract** In global scenario it lies in the fact that fresh water availability is very less thus the only option left for the maintaining the sustainable development is the reuse and recycling of the used water with a proper treatment. This project toward the sustainable development contributes the recycling of sewage water by using Membrane filtration process. The Membrane filtration process refers the technology based on the combination of membranes in series for the treatment of wastewater and its reuse. By using the different combinations of membrane the efficiency of water treatment can be optimized both in terms of effluent efficiencies and in terms of cost. In the process of membrane filtration the solid particulates are rejected by the membrane. Thus different types of membranes based upon their pore sizes and characteristics were used in a combination and the most efficient membrane combination has been proposed in this project. The Membrane filtration is basically a suspended growth activated sludge process that utilizes micro porous membranes for solid/liquid separation rather than secondary clarifiers. It represents a decisive breakthrough regarding effluent quality by delivering a hygienically pure effluent and by exhibiting an awfully high operational responsibility. Water supply and treatment demands are foreseen to face tremendous challenges over the coming decades to meet the alarming demand of water in the country. Various treatment processes have been predicted and membrane separation process has been identified as one of the possible solutions to meet future demands. Application and implementation of membrane filtration technique is expected well in treatment of wastewater. Membrane filtration technology is probably the membrane process which has its wide applicability and has the best prospects for the future in wastewater treatment. Recent researches have indicated that this technology is becoming accepted and is rapidly becoming the best available technology for many wastewater treatment applications. Thus, in this project various membranes have been identified and output quality parameters of each of the membrane is computed by performing the tests over the five main parameter of the water and have been used in different combinations for the analysis of best output parameter with the optimized cost.

**Introduction**

When $H_2O$ is employed by folks for domestic, industrial use, then Wastewater is emerges. This project mainly focuses on effluents produced by domestic use for a range of domestic purposes like laundry, bathing, flushing bathrooms; water is used for all these things. Generally in laundry water is used for washing of utensils employed in cookery, vegetables and alternatives food peels, bathing etc. The water emerges by these purposes contains matter like oils in cookery, oil in hair, detergents, dirt from floors etc. This water is called as “sullage or gray Water”. Water is involved in flushing of bathrooms to remove human excretion (human waste) is termed “Black Water” or biodegradable pollution. Purification of Gray water is much easier than black water i.e. sewage. However, apply preponderantly followed in India is to mix these two wastes to discharge into biodegradable pollution treatment plant in a very residential community/building that has no access to a public sewer.

 

**Methodology**

The methodology adopted for use of different combination of membrane in Wastewater treatment plant needs a systematic approach which includes collection, study and analysis of various data is under following heads:

1. Study and analysis for the requirement of wastewater treatment.
2. Analysis of conveyance system and other treatment process already present in the premises.
3. Detailed Study of the basic processes necessary for the treatment of wastewater.
4. Collection and testing of the sewage wastewater sample.
5. Deciding the effluent standards desired after the treatment process as per its use and under the Central Public Health and Environment Engineering Organization (CPHEEO) limits.
6. Analyzing different types of membranes available.
7. Computing the effluent quality from different membranes.
8. Computing the effluents quality from the series membrane combination.
9. Performing analysis of the output parameter.
10. Compare all combinations and choose best possible economical / optimal membrane or their series combination (on the basis of cost parameters and effluent qualities).
11. Suggestion for future expansion of the project.

Result

**Test Results of Influent Water**

The Influent water quality was found by conducting several laboratory tests on the various important parameters like pH, BOD, COD, turbidity, total suspended solid etc. The test was performed over the 12 Water samples at certain interval and for different places of Jagdalpur city.

The details of the laboratory test results of are given below:

**Table 4.2: Test Results of Various Raw Sewage Sample of Jagdalpur City**

| Parameters | pH (mg/l) | BOD (mg/l) | Turbidity (NTU) | COD (mg/l) | Oil & Grease (mg/l) | TSS (mg/l) | Place |
|---|---|---|---|---|---|---|---|
| Sample-1 | 8.1 | 345 | 6.7 | 371 | 0.2 | 212 | Haatkachora (Near kendriyaVidhyalaya) |
| Sample-2 | 7.9 | 375 | 6.9 | 345 | 0.1 | 223 | Haatkachora (Near Petrol Pump) |
| Sample-3 | 8 | 341 | 6.5 | 352 | 0 | 219 | Sirhasar Area (Near Tiwari building) |
| Sample-4 | 7.8 | 350 | 6.5 | 353 | 0 | 215 | Sirhasar Area (Near Hanuman Statue) |
| Sample-5 | 8.1 | 321 | 6.9 | 356 | 0.4 | 210 | Vrindavan Colony (Near BSNL office) |
| Sample-6 | 7.7 | 370 | 7.1 | 354 | 0.1 | 212 | Vrindavan Colony (Near Ayyappa Temple) |
| Sample-7 | 7.8 | 368 | 4.2 | 351 | 0 | 208 | Lalbag Area ( Near Suncity) |
| Sample-8 | 7.6 | 351 | 4.3 | 363 | 0 | 213 | Lalbag Area ( Near Ground) |
| Sample-9 | 8.2 | 347 | 7.1 | 350 | 0.8 | 211 | Dharampura ( Near PG College) |
| Sample-10 | 7.8 | 274 | 7.4 | 348 | 0.7 | 216 | Dharampura ( Near Sai Temple) |
| Sample-11 | 7.9 | 278 | 6.8 | 364 | 0 | 208 | Circuit House Road ( Near Mona Lodge) |
| Sample-12 | 8.1 | 312 | 6.5 | 332 | 0 | 211 | Circuit House Road ( Near Kiran Optical) |
| Average | 7.9 | 336 | 6.4 | 353.3 | 0.2 | 213.3 | |

 

**Table 4.3: Characteristics of Influent Raw Sewage Water**

| Parameter | Temperature (C) | pH (mg/l) | BOD (mg/l) | TSS (mg/l) | Turbidity (NTU) |
|---|---|---|---|---|---|
| Maximum | RT | 8.2 | 375 | 223 | 7.4 |
| Minimum | RT | 7.6 | 274 | 208 | 4.2 |
| Average | RT | 7.85 | 324.5 | 215.5 | 5.8 |

**4.3.2 Effluents Test Results through Single Membrane**

After done laboratory testing of sample following results are obtained for different types of Membrane -

**Table 4.4: Characteristics of Treated Sewage Water thorough Single Membrane**

| | Parameter | Temperature (ºC) | pH (mg/l) | BOD (mg/l) | TSS (mg/l) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| Cellulose | Maximum | RT | 8 | 74 | 75 | 4.9 |
| | Minimum | RT | 7.6 | 61 | 45 | 4.8 |
| | Average | RT | 7.8 | 67.5 | 60 | 4.85 |
| | Parameter | Temperature (ºC) | pH (mg/l) | BOD (mg/l) | TSS (mg/l) | Turbidity (NTU) |
| Charged Polysulphone Polyacrylonitrile (PAN) | Maximum | RT | 8.1 | 84 | 84 | 7.3 |
| | Minimum | RT | 7.5 | 81 | 80 | 4.2 |
| | Average | RT | 7.75 | 82.5 | 82 | 5.75 |
| | Parameter | Temperature (ºC) | pH (mg/l) | BOD (mg/l) | TSS (mg/l) | Turbidity (NTU) |
| Polyvinylidene Difluoride (PVDF) | Maximum | RT | 7.9 | 74 | 89 | 7.4 |
| | Minimum | RT | 7.6 | 76 | 78 | 4.2 |
| | Average | RT | 7.65 | 75 | 83.5 | 5.8 |
| | Parameter | Temperature (ºC) | pH (mg/l) | BOD (mg/l) | TSS (mg/l) | Turbidity (NTU) |
| Polyethylene (PE) | Maximum | RT | 8.3 | 61 | 69 | 6.9 |
| | Minimum | RT | 7.9 | 62 | 64 | 4.8 |
| | Average | RT | 8.1 | 61.5 | 66.5 | 5.85 |
| | Parameter | Temperature (ºC) | pH (mg/l) | BOD (mg/l) | TSS (mg/l) | Turbidity (NTU) |
| Polypropylene (PP) | Maximum | RT | 7.8 | 71 | 56 | 6.4 |
| | Minimum | RT | 7.2 | 69.5 | 53 | 4.9 |
| | Average | RT | 7.5 | 70.25 | 54.5 | 5.65 |

**Note**: The tests were conduct0ed on a sample collection basis i.e. Random sample was collected among the group of samples and some modifications were also made in the tests for the experimental procedures.

**4.3.3 Effluent Testing Results through Series of Membrane (Average Value)**

**Table 4.5: Characteristics of Treated Sewage Water through Series of Membrane**

| Sr. No. | Temperature (ºC) | pH (mg/l) | BOD (mg/l) | TSS (mg/l) | Turbidity (NTU) | | membrane |
|---|---|---|---|---|---|---|---|
| 1 | RT | 7.4 | 28.6 | 37 | 3.4 | | *Cellulose* |
| 2 | RT | 7.4 | 34.3 | 47 | 4.3 | | *PAN* |
| 3 | RT | 7.4 | 25.1 | 46 | 5.1 | | *PVDF* |
| 4 | RT | 7.4 | 29.3 | 42 | 4.8 | | *PE* |
| 5 | RT | 7.4 | 26.4 | 36 | 4.9 | **Cellulose** | *PP* |
| 6 | RT | 7.6 | 25.9 | 36 | 3.9 | | *Cellulose* |
| 7 | RT | 7.6 | 29.4 | 32 | 3.8 | | *PAN* |
| 8 | RT | 7.6 | 34.1 | 42 | 3.8 | | *PVDF* |
| 9 | RT | 7.6 | 24.9 | 39 | 4.2 | **PAN** | *PE* |

 

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|---|---|---|---|---|---|---|---|
| 10 | RT | 7.6 | 26.3 | 37 | 4.3 | | *PP* |
| 11 | RT | 7.4 | 24.8 | 56 | 4.8 | | *Cellulose* |
| 12 | RT | 7.4 | 31.8 | 45 | 4.7 | | *PAN* |
| 13 | RT | 7.4 | 23.9 | 48 | 4.8 | | *PVDF* |
| 14 | RT | 7.4 | 25.1 | 67 | 4.7 | | *PE* |
| 15 | RT | 7.4 | 28.3 | 53 | 4.6 | **PVDF** | *PP* |
| 16 | RT | 7.5 | 34.8 | 48 | 4.1 | | *Cellulose* |
| 17 | RT | 7.5 | 29.9 | 41 | 4.3 | | *PAN* |
| 18 | RT | 7.5 | 24.9 | 42 | 4 | | *PVDF* |
| 19 | RT | 7.5 | 31.7 | 44 | 4.2 | | *PE* |
| 20 | RT | 7.5 | 35.1 | 36 | 4.6 | **PE** | *PP* |
| 21 | RT | 7.4 | 35.9 | 29 | 3.9 | | *Cellulose* |
| 22 | RT | 7.4 | 31.5 | 36 | 4.3 | | *PAN* |
| 23 | RT | 7.4 | 26.3 | 31 | 4.1 | | *PVDF* |
| 24 | RT | 7.4 | 25.7 | 34 | 4.2 | | *PE* |
| 25 | RT | 7.4 | 27.1 | 37 | 3.3 | **PP** | *PP* |

**Table 4.6: Characteristics of Influent and Effluent Sewage Sample**

| Parameters | Influent Sample | Effluent Sample From Various Membrane Combination (avg.) |
|---|---|---|
| pH (mg/l) | 7.6 – 8.2 | 7.4 - 7.6 |
| BOD (mg/l) | 274 – 375 | 23.9 – 35.9 |
| TSS (mg/l) | 208 – 223 | 29 – 67 |
| Turbidity (NTU) | 4.2 – 7.1 | 3.3 – 5.1 |

**4.3.4 Analysis of Test Results**

Thus, from the testing and analysis of various membranes and their series combinations, it can be concluded that among the various combinations of membrane following test results are obtained and that series combination of membrane are selected which gives optimized value of effluent parameters at a reasonable cost. The various water quality parameters are also found within the range as per lay by CPCB.

**4.3.4.1 Analysis of Test Result for pH**

**Table 4.7: pH removal (%)**

| Combination of membrane | CE | PAN | PVDF | PE | PP |
|---|---|---|---|---|---|
| CE | 5.7 | 5.7 | 5.7 | 5.7 | 5.7 |
| PAN | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 |
| PVDF | 5.7 | 5.7 | 5.7 | 5.7 | 5.7 |
| PE | 4.5 | 4.45 | 4.45 | 4.5 | 4.5 |
| PP | 5.7 | 5.7 | 5.7 | 5.7 | 5.7 |

**4.3.4.2 Analysis of Test Result for BOD Removal**

**Table 4.8: BOD Removal (%)**

| Combination of membrane | CE | PAN | PVDF | PE | PP |
|---|---|---|---|---|---|
| CE | 91 | 89.4 | 92.26 | 91 | 92 |
| PAN | 92 | 90.9 | 89.49 | 92 | 92 |
| PVDF | 92 | 90 | 92.63 | 92 | 91 |

 

| | | | | | |
|---|---|---|---|---|---|
| PE | 89 | 90.8 | 92.32 | 90 | 89 |
| PP | 89 | 90.3 | 91.89 | 92 | 92 |

**4.3.4.3 Analysis of Test Results for TSS Removal**

**Table 4.9: TSS Removal (%)**

| Combination of membrane | CE | PAN | PVDF | PE | PP |
|---|---|---|---|---|---|
| CE | 82.83 | 78.19 | 78.65 | 80.51 | 83.29 |
| PAN | 83.29 | 85.15 | 80.51 | 81.9 | 82.83 |
| PVDF | 74.01 | 79.12 | 77.73 | 68.91 | 75.41 |
| PE | 77.73 | 80.97 | 80.51 | 79.58 | 79.58 |
| PP | 86.54 | 83.29 | 85.61 | 84.22 | 82.83 |

**4.3.4.4 Analysis of Test Results for Turbidity Removal**

**Table 4.10: Turbidity Removal (%)**

| Combination of membrane | CE | PAN | PVDF | PE | PP |
|---|---|---|---|---|---|
| CE | 41 | 26 | 12.1 | 17 | 16 |
| PAN | 33 | 34 | 34.5 | 28 | 26 |
| PVDF | 17 | 19 | 17.2 | 19 | 21 |
| PE | 29 | 26 | 31 | 28 | 22 |
| PP | 33 | 26 | 29.3 | 28 | 43 |

## Conclusion

Municipal water treatment plants monitor drinking, waste and surface water for the presence of various water quality parameters / microorganisms by Membrane Filtration process. Presently the MF process is essential to treat domestic and other wastewater. Thus, from the analysis of results obtained from the tests it can be concluded that the combination of Polypropylene (PP) and Polyethylene (PE) would give the optimum value for various parameters of sewage sample at optimum cost and efficiency. Treated wastewater may be suggested to be used as secondary purposes like farming, industrial cooling and horticulture uses

**Table 5.1: Final Results**

| **Parameters** | **Output from the combination of PP-PE** | **Minimum output from other combinations** | **Maximum output from other combinations** | **Variation from others** |
|---|---|---|---|---|
| pH (mg/l) | 7.4 | 7.4 | 7.6 | ~3% |
| BOD (mg/l) | 25.7 | 23.9 | 35.9 | 7-20% |
| TSS (mg/l) | 34 | 29 | 67 | 14-50% |
| Turbidity (NTU) | 4.2 | 3.3 | 5.1 | 15-22% |
| Cost (avg.) (INR) | 1385 | 1360 | 2170 | 7-35% |

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