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- Pilot SFD MBR TARON® at Jajmau WWTP, Kanpur (India)
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THE SFD MBR: PRINCIPLES AND TESTING

What is it?

- Evolution of UF-based MBR, aimed at **limiting the cost of installation** (membranes, pumping systems) **and operation** (cleaning requirements);
- Self-formed membrane layers supported by **low-cost filtration mesh/nets** (nylon, PET, stainless steel);
- **Lower pressure gradient** w/respect to conventional MBR, suitable to gravity-driven operation;
- **Very low turbidity effluent** suitable for direct UV disinfection.

What have we done?

- Developed and crafted net filtration modules and built bench-scale experimental plants;
- Tested different operating conditions for process optimization and effluent quality evaluation, in terms of biological parameters and air scouring and other approaches for cake maintenance;
- Performed long term tests (months) to achieve biological steady state conditions;
- Supported the procurement of a pilot scale plant, now installed at Kanpur Jajmau WWTP, and we are providing advice for its operation. IITK is monitoring pilot plant operation through sampling and analyses.

What do we plan to do?

- Keep working on process optimization by testing different tools for minimization of mesh cleaning needs;
- Assist in transferring bench scale results to pilot plant and evaluating process performance towards optimization.

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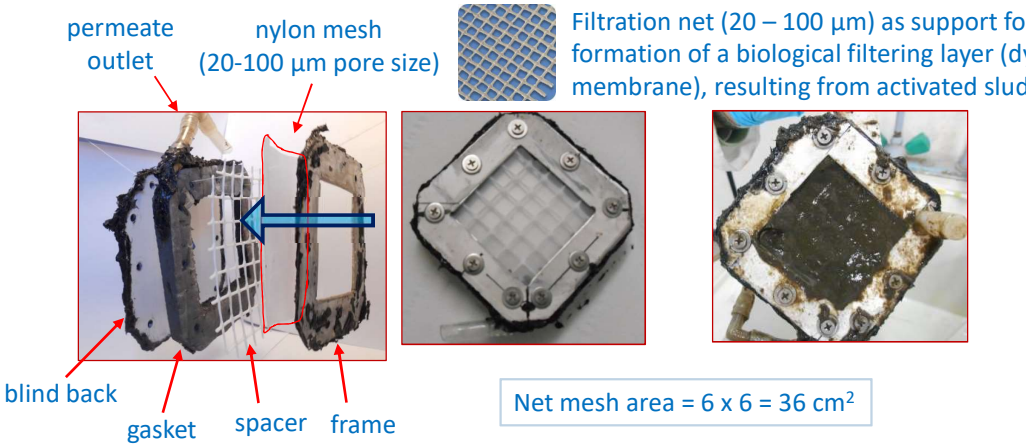
BENCH SCALE SFD MBR: THE FILTRATION MODULE



Filtration net (20 – 100 µm) as support for the formation of a biological filtering layer (dynamic membrane), resulting from activated sludge filtration

Net mesh area = 6 x 6 = 36 cm^2

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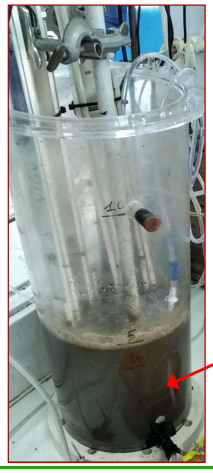
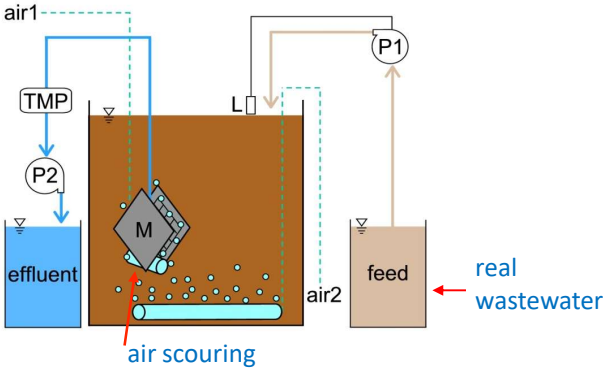
BENCH SCALE SFD MBR: BIOREACTOR SET-UP

Bioreactor



Submerged modules (2 x 36 cm^2)



Effluent

Feed

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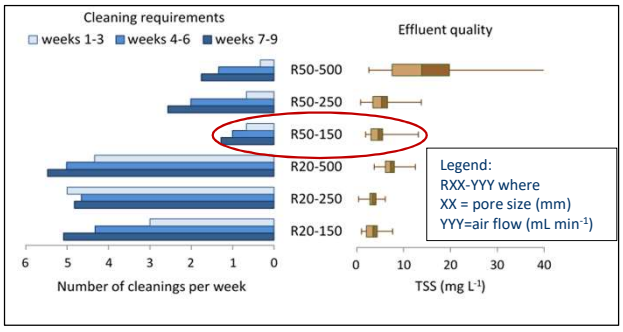
BENCH SCALE SFD MBR: RESULTS 1/4

Optimization of mesh pore size and air scouring

Operating conditions:

T = 20°C; VLR (volumetric loading rate) = 1.25 Kg_{COD} m^{-3} d^{-1}; SRT (sludge retention time) = 16 d;

Flowrate = 16.4 L d^{-1}; Flux = 95 L m^2 h^{-1}; HRT (hydraulic retention time) = 6.7 h



Net cleaning needs and corresponding effluent quality under different mesh size and aeration intensity tested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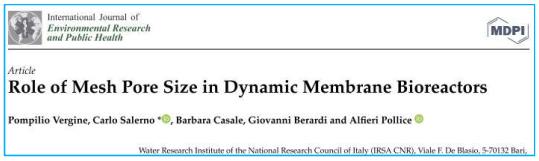
journal homepage: www.elsevier.com/locate/biortech

Short Communication

Influence of air scouring on the performance of a Self Forming Dynamic Membrane BioReactor (SFD MBR) for municipal wastewater treatment

Carlo Salerno, Pompilio Vergine *, Giovanni Berardi, Alfieri Pollice

IRSA CNR, Viale F. De Blasio, 5, 70132 Bari, Italy


International Journal of Environmental Research and Public Health

MDPI

Article

Role of Mesh Pore Size in Dynamic Membrane Bioreactors

Pompilio Vergine, Carlo Salerno *, Barbara Casale, Giovanni Berardi and Alfieri Pollice

Water Research Institute of the National Research Council of Italy (IRSA CNR), Viale F. De Blasio, 5-70132 Bari,

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 821051.
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BENCH SCALE SFD MBR: RESULTS 2/4

PAVITRA GANGA

Optimization of sludge retention time (SRT)

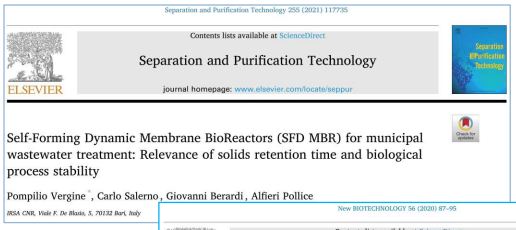
Operating conditions:

T = 20°C; VLR (volumetric loading rate) = 0.9-1.1 Kg_{COD} m^{-3} d^{-1}; SRT (sludge retention time) = 15 d; 30 d; 50 d;
Flowrate = 10.5-11.5 L d^{-1}; Flux = 61-68 L m^2 h^{-1}; HRT (hydraulic retention time) = 8.5-9.5 h

	R15	R30	R50
MLSS (g L^{-1})	2.0±0.7	7.2±1.1	7.7±0.7
F/M (gCOD^{-1} gVSS^{-1} d^{-1})	0.53±0.19	0.21±0.08	0.17±0.03
COD removal (%)	90.3±2.4	93.5±0.8	93.9±1.6
Nitrification (%)	100(*)	100(*)	100(*)
Effluent turbidity (NTU)	4.1±3.5	1.2±0.5	1.2±0.8
Cleaning frequency (week^{-1})	3.5±1.2	0.8±0.4	1.6±1.0

(*) Ammonia in the effluent was below the detection limit (1 mgN-NH_4^+ L^{-1}).

Range of TMP values	Percentage of testing time		
	R15	R30	R50
0 mbar	72.9 %	79.5 %	74.8 %
Between 0 and -100 mbar	12.8 %	16.9 %	18.6 %
Below -100 mbar	14.3 %	3.6 %	6.6 %



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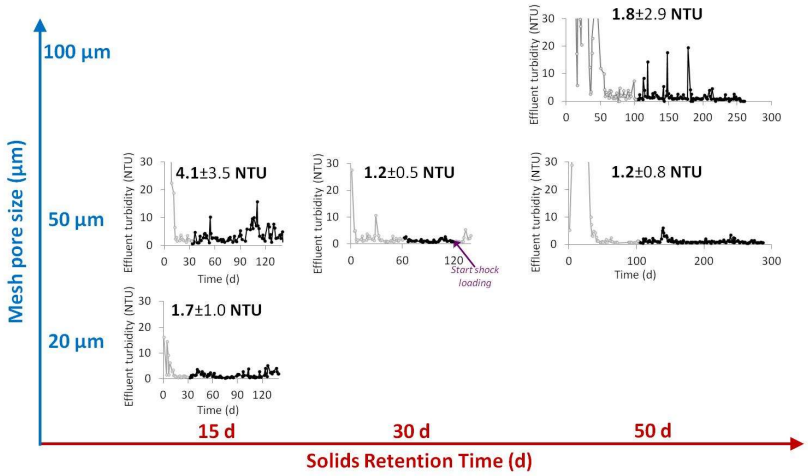
BENCH SCALE SFD MBR: RESULTS 3/4

PAVITRA GANGA

Effluent quality under different conditions

- Mesh pore size = 20, 50, and 100 µm
- SRT = 15, 30, and 50 d
- Continuous air scouring (150 mL min^{-1})
- Only steady state values



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BENCH SCALE SFD MBR: RESULTS 4/4

PAVITRA GANGA

Optimization of maintenance cleaning (in progress)

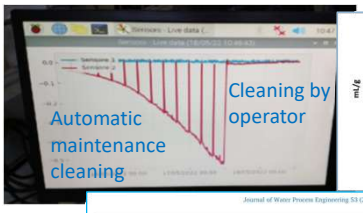
Operating conditions:

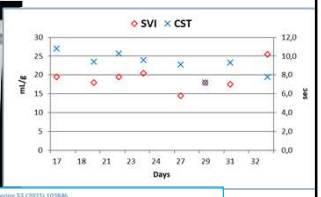
T = 20°C; VLR (volumetric loading rate) = 0.8 Kg_{COD} m^{-3} d^{-1}; SRT (sludge retention time) = 15 d;

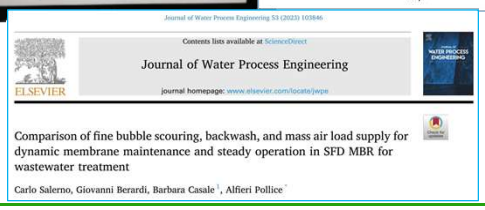
Flowrate = 11-12 L d^{-1} (about 0.5 L h^{-1}); Flux = 65-75 L m^2 h^{-1}; HRT (hydraulic retention time) = 14.5 h

Maintenance approach	Cleaning frequency $weeks^{-1}$	Effluent turbidity NTU
air scouring + relax	1.39	1.9 ± 1.7
backwash + air scouring	1.42	23.5 ± 20.4
backwash only	1.36	3.0 ± 3.7
air mass flow (bubbles)	0.17	6.1 ± 6.0

Legenda:
- air scouring: 229 min every 240 min; air flowrate: 0.15 L min^{-1}
- relax: 11 min every 240 min
- backwash: 5 min every 240 min; permeate flowrate: 0.24 L min^{-1}
- air mass flow: 5 min every 240 min; air flowrate: 45 L min^{-1}






Journal of Water Process Engineering

Comparison of fine bubble scouring, backwash, and mass air load supply for dynamic membrane maintenance and steady operation in SFD MBR for wastewater treatment

Carlo Salerno, Giovanni Berardi, Barbara Casale, Alfieri Pollice

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BENCH SCALE SFD MBR: CONCLUSIONS AND NEXT STEPS

PAVITRA GANGA

SFD MBR bench scale testing (IRSA CNR, Italy)

- Very good performance under all tested conditions in terms of high effluent quality;
- Processes optimized for different SRT and mesh size;
- Different approaches for membrane maintenance were compared;
- Steady long term operation obtained under different conditions.

Next steps

- Keep testing at higher SRT;
- Optimize large bubble periodic scouring for filtration maintenance;
- Characterization of dynamic membranes (morphology, microbiology, etc.)

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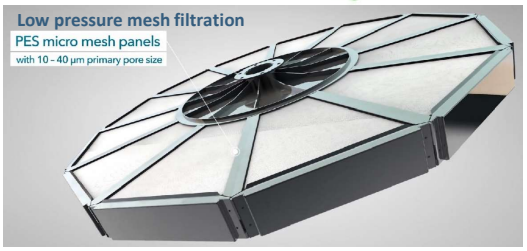
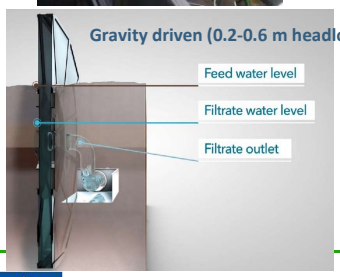
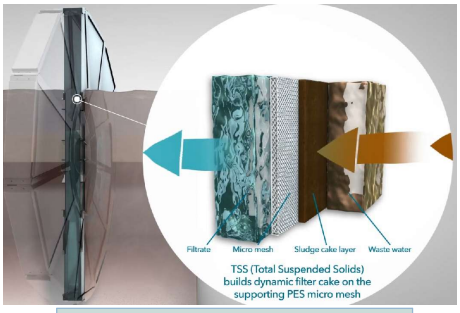
THE SFD MBR TARON® BY XYLEM







all pics from Sanitaire, a Xylem brand

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PILOT SFD MBR TARON® AT JAJMAU WWTP, KANPUR

SFD Taron Biological Treatment System – Design Basis

Parameter	Unit	Estimated in Influent	Expected Effluent
pH	[-]	7 to 9	7 to 9
TDS	mg/l	800-1600	≤1600
TSS	mg/l	100 - 600	≤5
BOD5 at 20 C	mg/l	100 - 400	≤5
COD	mg/l	250 - 800	≤70
NH4-N	mg/l	5 - 30	≤5
TN	mg/l	10 - 50	≤10
TP	mg/l	1 - 5	≤2

SFD Taron Biological Treatment System – Salient Design Parameters

Parameters	Unit	Value
Design Treatment Capacity	m^3/d	80
Bio-Tank Volume	m^3	35
Footprint	m^2	~30
Taron 2202 active filter surface	m^2	6.46
UV disinfection (@UVT 65%)	m^3/h	4
Sludge generation	kg/d (m^3/d)	32 (2.7)
Power Consumption per day	kwh/d	137

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PILOT SFD MBR TARON® AT JAJMAU WWTP, KANPUR

PAVITRA GANGA

State of play

Pilot plant installed in April 2022.

Until end of 2022, intermittent operation due to:
- unsteady wastewater supply,
- electric power interruptions,
- early malfunctioning of PLC,
- need to contract for plant operation.

From February to June 2023, almost continuous operation:
- Xylem India contracted for O&M,
- first period of manually controlled filtration,
- new PLC installed in March 2023,
- regular sampling and analyses by IITK from January 2023.

From June to August 2023 interruption of operation:
- filtration backwash pump broken,
- pump fixed and operation resumed mid August 2023
- manual mode due to PLC malfunctioning (no data logging?)

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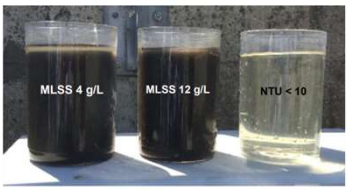
PILOT SFD MBR TARON®: CONCLUSIONS AND NEXT STEPS

PAVITRA GANGA

TARON® pilot scale testing (IITK and Xylem, India)
- Very good performance in terms of high effluent quality despite discontinuous operation;
- Effluent productivity (flux) close to 1000 LMH, i.e. more than one order of magnitude higher than the bench scale plant;
- Very low SRT and MLSS due to large sludge wastage (2-3 mc/d);
- Steady continuous operation obtained for about 3 months.

Next steps
- Higher loading rates (i.e. increase filtration flux);
- Higher SRT up to 30 days and above (i.e. higher MLSS, smaller sludge purging volumes);
- Reduced backwash intensity (e.g. intermittent disk rotation, lower backwash flux).



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- Salerno C., Berardi G., Casale B., Pollice A. (2023) Comparison of fine bubble scouring, backwash, and mass air load supply for dynamic membrane maintenance and steady operation in SFD MBR for wastewater treatment. ***Journal of Water Process Engineering***, 53, article n. 103846.
- Vergine P., Salerno C., Casale B., Berardi G., Pollice A. (2021) – Role of mesh pore size in Dynamic Membrane bioreactors. ***International Journal of Environmental Research and Public Health***, 18, article n. 1472.
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- Vergine P., Salerno C., Berardi G., Pappagallo G., Pollice A. (2020) - The Self Forming Dynamic Membrane BioReactor (SFD MBR) as a suitable technology for agro-industrial wastewater treatment. ***New Biotechnology***, 56, 87-95.

- Castrogiovanni F., Salerno C., Berardi G., Tumolo M., Pollice A. (2023) An easy numerical evaluation of the DM growth in Self-Forming Dynamic Membrane Bioreactors (SFD MBR) for Wastewater Treatment. CEST 2023, Intern. Conf. on Environmental Science and Technology, **Athens (Greece)** 30 Aug-2 Sept 2023.
- Vergine P., Casale B., Salerno C., Berardi G., Pollice A. (2023) - Bench scale optimization of the Self Forming Dynamic MBR for wastewater treatment and effluent reuse. The 13th IWA International Conference on Water Reclamation and Reuse, January 15-19, 2023 – **Chennai, India**
- Vergine P., Salerno C., Berardi G., Pollice A. (2021) Optimizing the operation of Self Forming Dynamic MBR for wastewater treatment: 5 years of bench scale tests. ECO STP, Intern. IWA Conf. on Ecotechnologies for Wastewater Treatment. **Milano (Italy)** 21-25 June 2021.

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Dr. Barbara Casale, Dr. Marina Tumolo, Dr. Fabiano Castrogiovanni

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Dr. Dirk Herold, Dr. Bhishma Patel

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PAVITRA GANGA

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alfieri.pollice@cnr.it shaditya@iitk.ac.in

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