INNOVATIVE TECHNOLOGIES FOR WASTEWATER TREATMENT, REUSE AND RESOURCE RECOVERY

- ANDICOS

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September 27-28, 2023 | INDIA

PAVITRA GANGA

WORKSHOP

Innovative technologies for wastewater treatment, reuse and resource recovery

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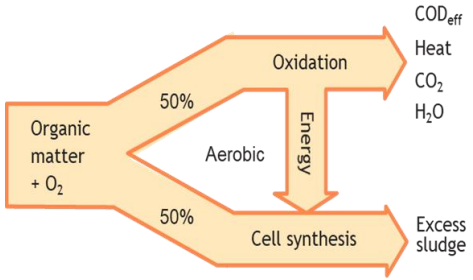
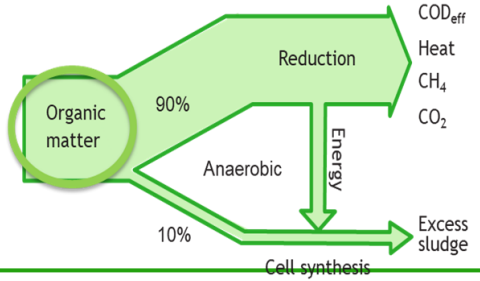
WHAT IS THE ANDICOS APPROACH?

Move away from aerobic treatment processes to anaerobic treatment





Andicos™

Anaerobic Digestion by Combining Organic Waste and Sewage

From energy consumption to energy production plus reduction in GHG emissions & wastewater reuse

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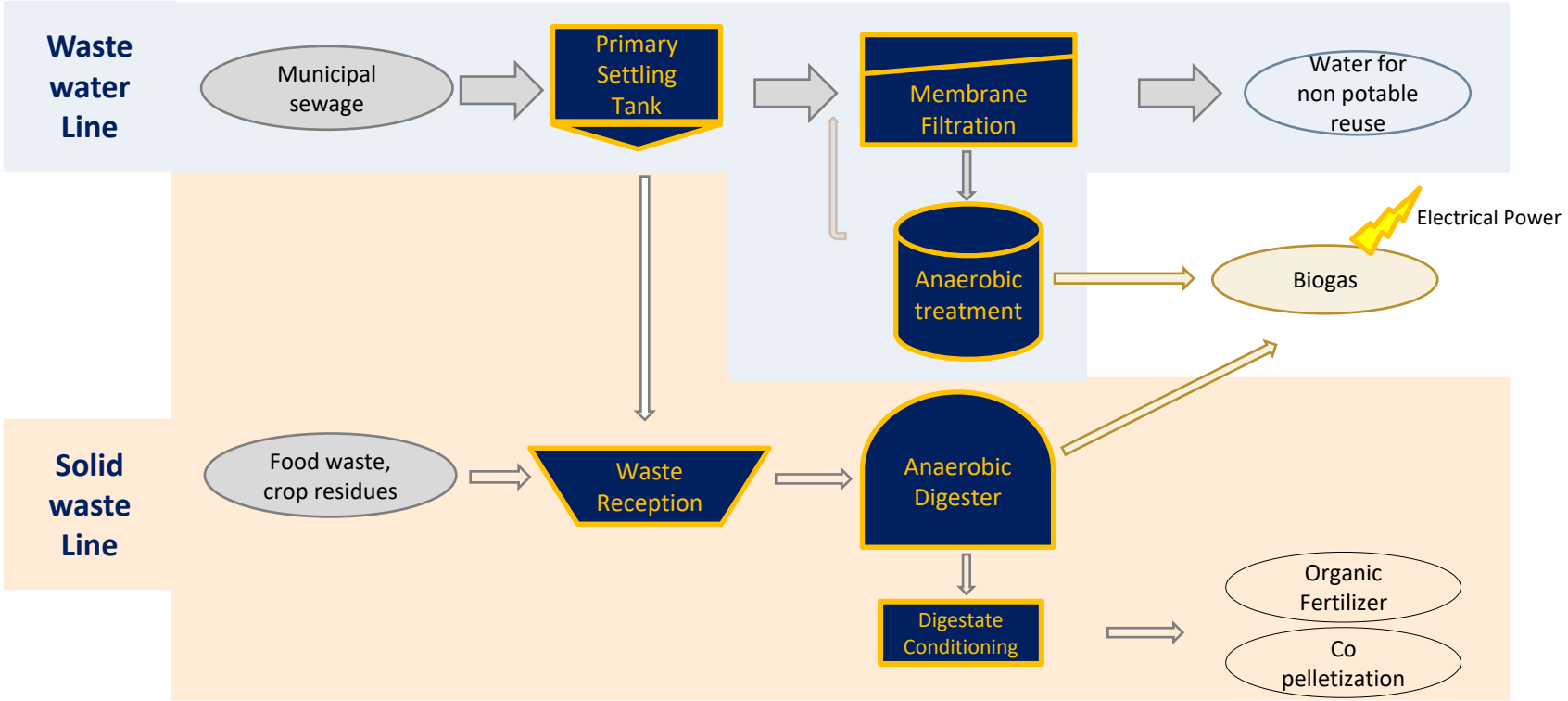
ANDICOS - PROCESS FLOW DIAGRAM



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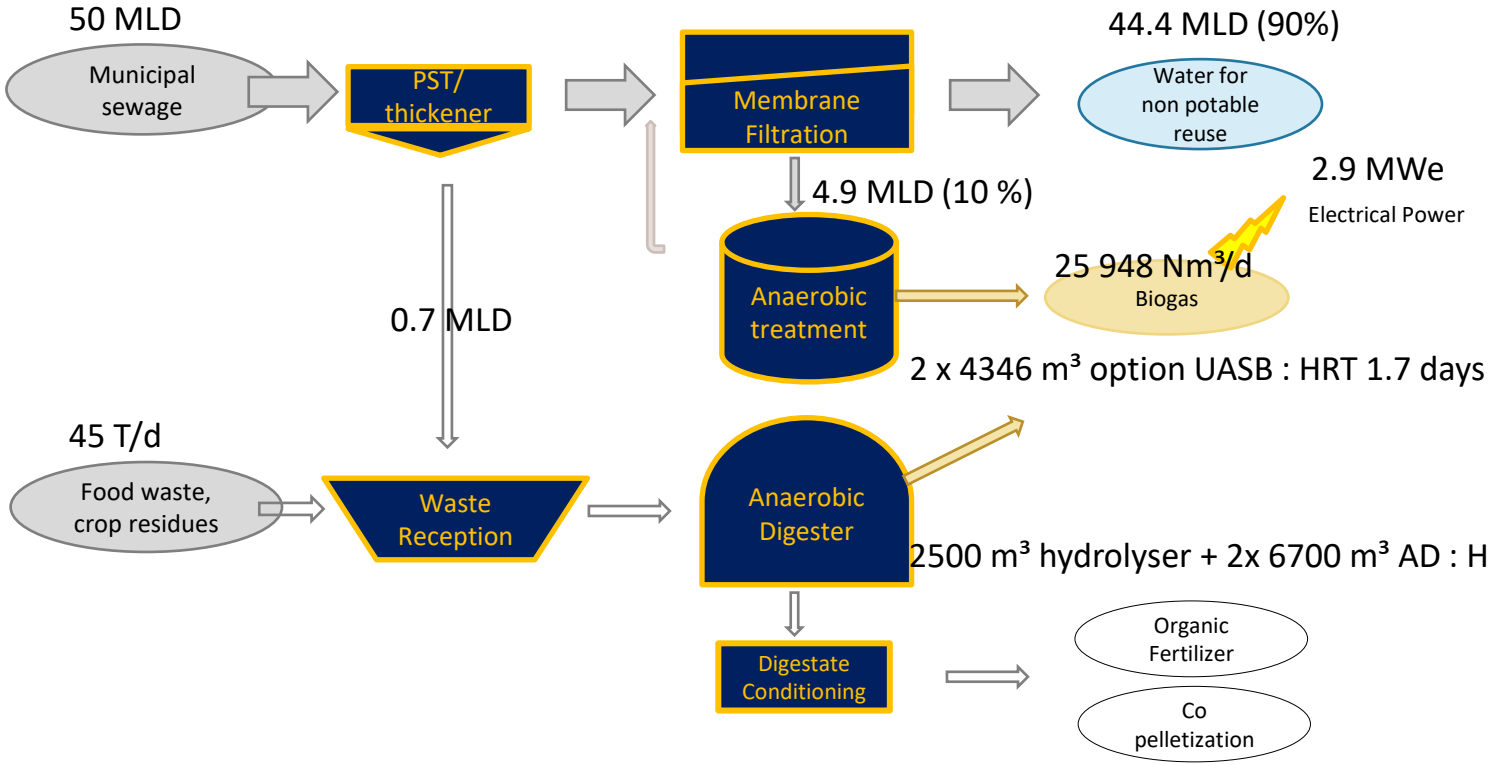
Conceptual model assuming 50 MLD sewage treatment plant



50 MLD sewage + 45 T/d Food Waste = 44.4 MLD Wastewater reuse + 2.9 MWe power + Digestate

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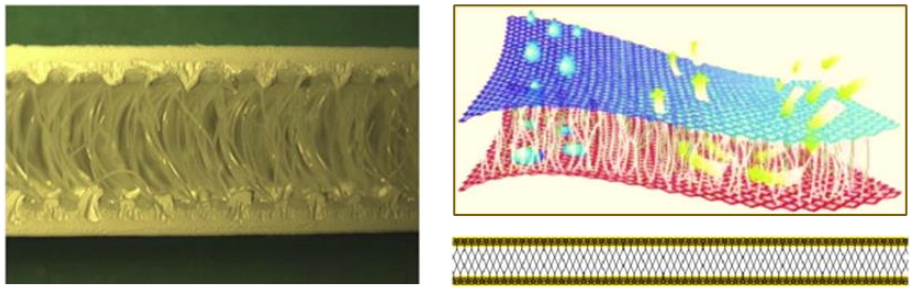
IPC MEMBRANES

Integrated Permeate Channel (IPC) Ultrafiltration membranes

Flat-sheet membranes **Pore size:** 40 nm **Total surface area:** 0.11 m^2



Cross-sectional view and schematic representation of spacer fabric of IPC membrane (Doyen et al., 2008)

	Flux	Duration
Filtration	15 L/h-m^2	
Backwash	22.5 L/h-m^2	
Relaxation	0	
Net/Total	**12 L/h-m^2**	**10 min**

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WATER QUALITY

- **Period 2020**

  - Influent COD : 1000 - 1200 mg/L
  - TSS : 1000 mg/L
  - Chromium > 6 ppm

Influent:
High COD, TSS &
Total Cr

Effluent is good quality
Low COD, TSS & Total Cr
(ammonia not removed)

  - Stable membrane process at filtration flux 20 lmh
  - Low cleaning frequency (14-21 days)
  - Volumetric concentration up to factor 10-20 (permeate volume 90-95%)
  - COD loss : 33%

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WATER QUALITY

- **Period 2021 – 2022**
  - Influent COD decreased to average 300 mg/L
  - Increased cleaning frequency
  - COD loss : using air > 50%, using N_2 < 50%
  - 100 % removal of Coliforms

Major reduction in influent: COD only 300 mg/l

Concentration of sewage more difficult due to excessive biodegradation

Total Coliform removal

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LAB-SCALE MEMBRANE EXPERIMENTS - RESULTS

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Physical cleaning

Removing the foulant layer using a sponge while the membrane is submerged under tap water.

Chemical cleaning

Cleaning chemical: NaOCl **pH:** 8 **Temperature:** 40°C

Duration: Total 50 mins

Removal Efficiency of IPC Membranes:

- COD > 85%
- TSS - 100%
- Coliform - 100%
- NH_3 > 90%

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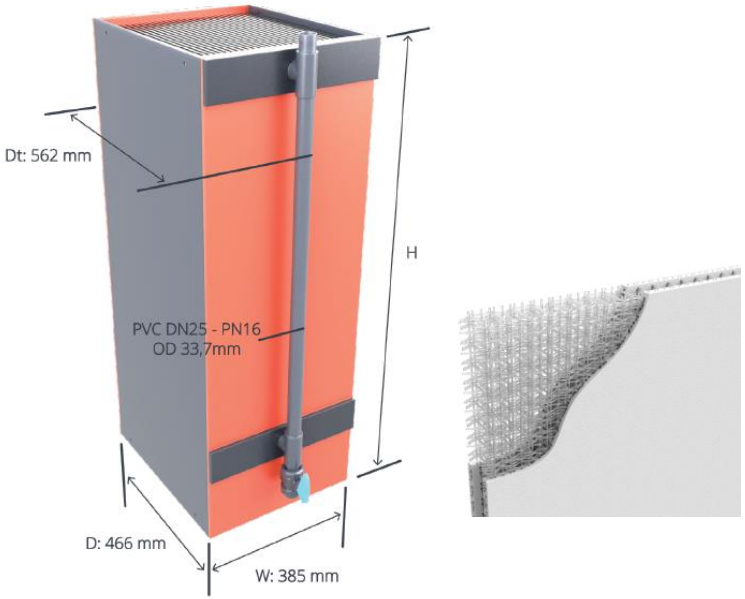
ANDICOS MEMBRANE PILOT



Pilot setup of ANDICOS technology.

Total membrane area: 25 m^2, Working Volume of Membrane tank: 5000 L, Treated water storage: 2000 L, Anaerobic Digestor: 5000 L

Membrane material
PVDF, proprietary blend

Membrane layer thickness
> 600 µm

Total membrane thickness
> 3.5 mm

Membranes backwashable upto 2 bar pressure

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PILOT - OPERATION AND MAINTENANCE

	Filtration	Backwash	Relaxation	Net / Total
Flux	15 L/h-m^2	30 L/h-m^2	0	11.5 L/h-m^2
Duration				10 min

Average operational duration = 22 hours

Total wastewater treated in a day ~ 6000 L

Total concentrate removed per day = 100 L

Air flow rate = 20 Nm^3/h

Membrane Cleaning

- When TMP ~ 200 mmHg and additional backwash is not effective.
- Sodium Hypochlorite: 300 ppm active chlorine.
- Process: Chemically Enhanced Backwashing (CEB).
- Duration: 2 hours (1 hour soaking + 2-3 cycles of backwash + aeration)

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ANDICOS MEMBRANE PILOT - RESULTS

Influent
(Wastewater
after PST)
COD : 200 mg/L

IPC Permeate
COD : 16 mg/L

Concentrate
COD : 1500 mg/L

50 days of continuous operation

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ANDICOS – ANAEROBIC DIGESTION LAB TESTS

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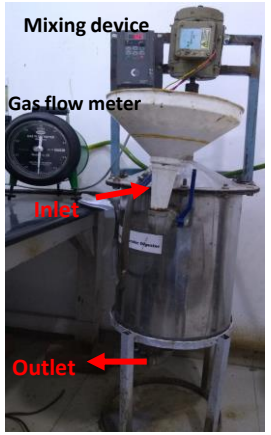
- Reactor volume : 40 L
- Influent : primary sludge Jajmau STP Kanpur
- Semi-Continuous operation at 40 days HRT
- Digester pH : 7.3 – 7.6.



No tests using mix of primary sludge and food waste: reluctance to mix fecal and non fecal waste streams:

- fecal based fertilisers can contaminate soils
- logistical demands to bring food waste to sewage treatment plant

Feed characteristics

COD_{Total} : 34 - 35 g/L
$COD_{Soluble}$: 0.12 - 0.14 g/L
TS : 84 - 90 g/L
VS : 24 - 28 g/L
VS/TS : 0.28 - 0.32
Sulphate: 23 - 25 mg/L

Effluent characteristics

COD_{Total} : 27 - 28 g/L
$COD_{Soluble}$: 0.4 - 0.5 g/L
TS: 90 - 92 g/L
VS: 24 - 25 g/L
VS/TS: 0.26 - 0.27
Sulphate: 23 - 25 mg/L

Biogas production is stable at 4 litres per day

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ANAEROBIC DIGESTION PILOT HYDERABAD

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- **Design Basis for anaerobic digester pilot plant**
  - Organic solid waste from community Kitchen : 1000 kg/day
  - STP sludge : 2000 - 6000 kg/day (2 - 6 m3/day of 1% consistency)
- **Biogas & Fertilizer generated from pilot plant**
  - Biogas production (65 % methane): ± 10 Nm^3/h
  - Gross electrical output: ± 20 kW/hr
  - Digested sludge –Fertilizer (with 4-5% solids) : ± 493 T/year

ION EXCHANGE
Refreshing the Planet

vito

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CHALLENGES AND TROUBLESHOOTING

- Pilot in corrosive environment – damage in PLC circuits, iron parts, etc.

- Changes of sewage characteristics has impact on composition of concentrate stream
  - Loss of organics due to biodegradation results in lower biogas production

- Reluctance to mix fecal and non-fecal wastes reduces biogas production potential

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CONCLUSIONS

Why is ANDICOS still potentially relevant for India?

- Converting organics from sewage + solid waste into biogas produces Green Energy + reduces GHG emissions
- Permeate from IPC Filtration can be reused for irrigation or non potable reuse and first treatment step to produce process water for industry
- Approach helps to deal with sewage, primary sludge and organic waste simultaneously – but would require new waste management approaches
- Co-pelletization is an alternative to producing fertilisers / soil improvers for agriculture

PUBLICATIONS AND CONFERENCES

- Sharma A., Bose P., Van Ermen S. (2022). Investigating performance of Integrated Permeate Channel membranes for sewage treatment and establishing chemical cleaning protocols. IMSTEC 2022, International Membrane Science and Technology Conference, **Melbourne (Australia)**, 4 - 8 Dec. 2022.

- Van Ermen S., Campling P., Diels L., Sharma A., Shakya A., Bose P., Shah S. (2023). ANDICOS™ a wastewater treatment approach that promotes water re-use and energy recovery. 13th IWA International Conference on Water Reclamation and Reuse, **Chennai (India)**, 15 - 19 Jan. 2023,

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ACKNOWLEDGEMENTS / COLLABORATORS

IIT Kanpur:
Prof. Purnendu Bose, Prof. Vinod Tare, Dr. Arvind Shakya.

VITO, Belgium:
Dr. Paul Campling.

Ion Exchange India:
Mr. Sachin Shah, Mr. Nitin More, Mr. Sankararaman.

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THANK YOU FOR YOUR KIND ATTENTION

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