



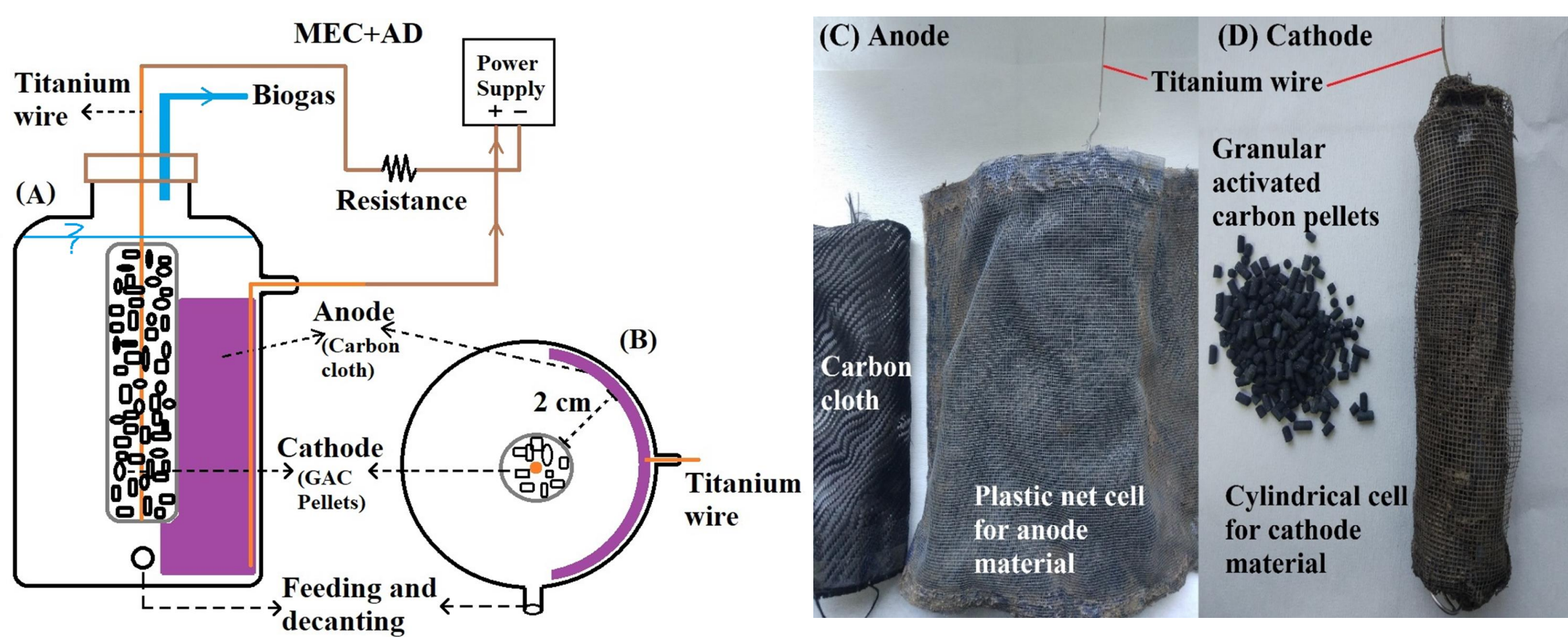
High-rate Biogas Production from an Integrated Microbial Electrolysis Cell and Anaerobic Digestion System at Short Hydraulic Retention Times

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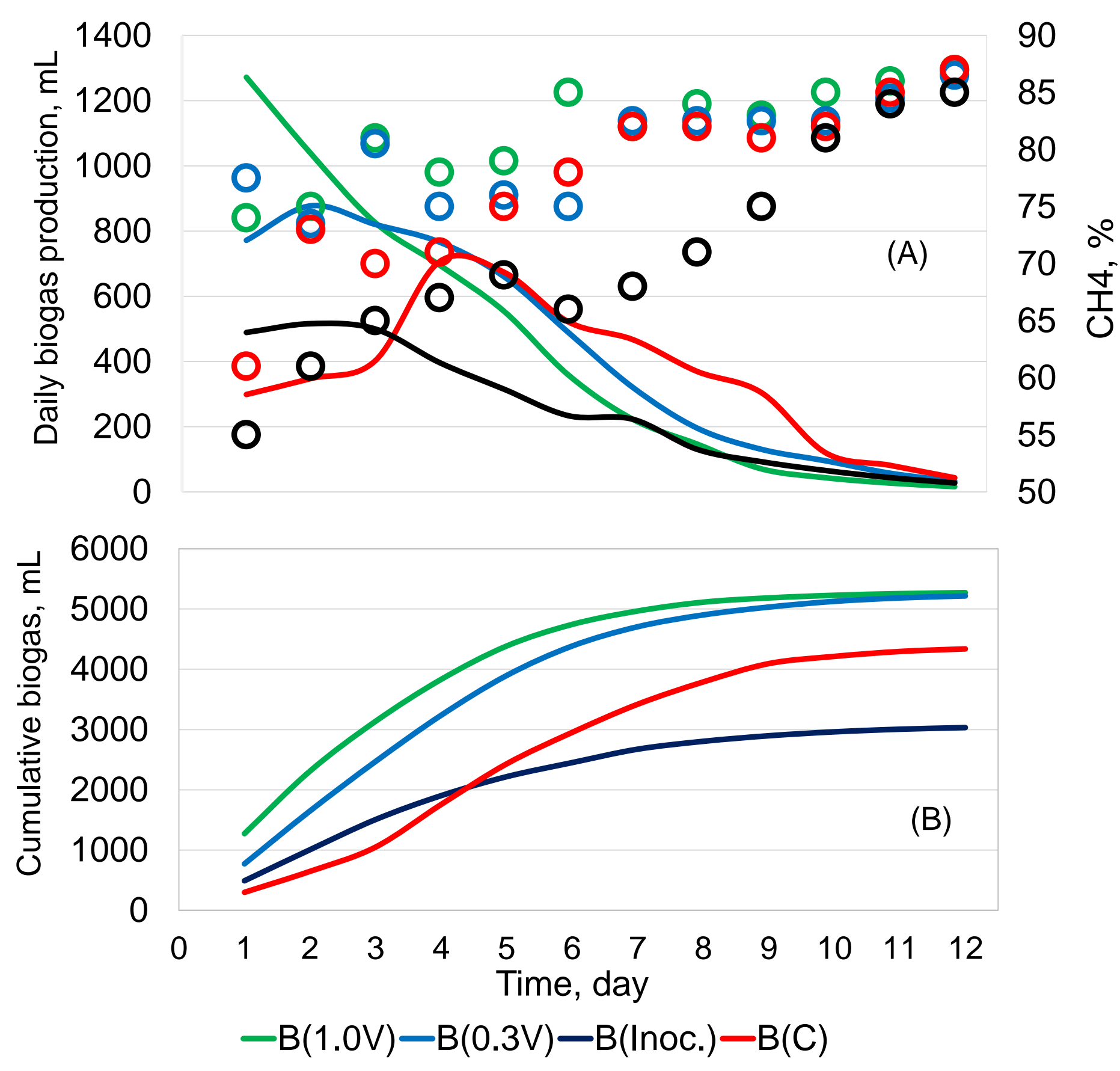
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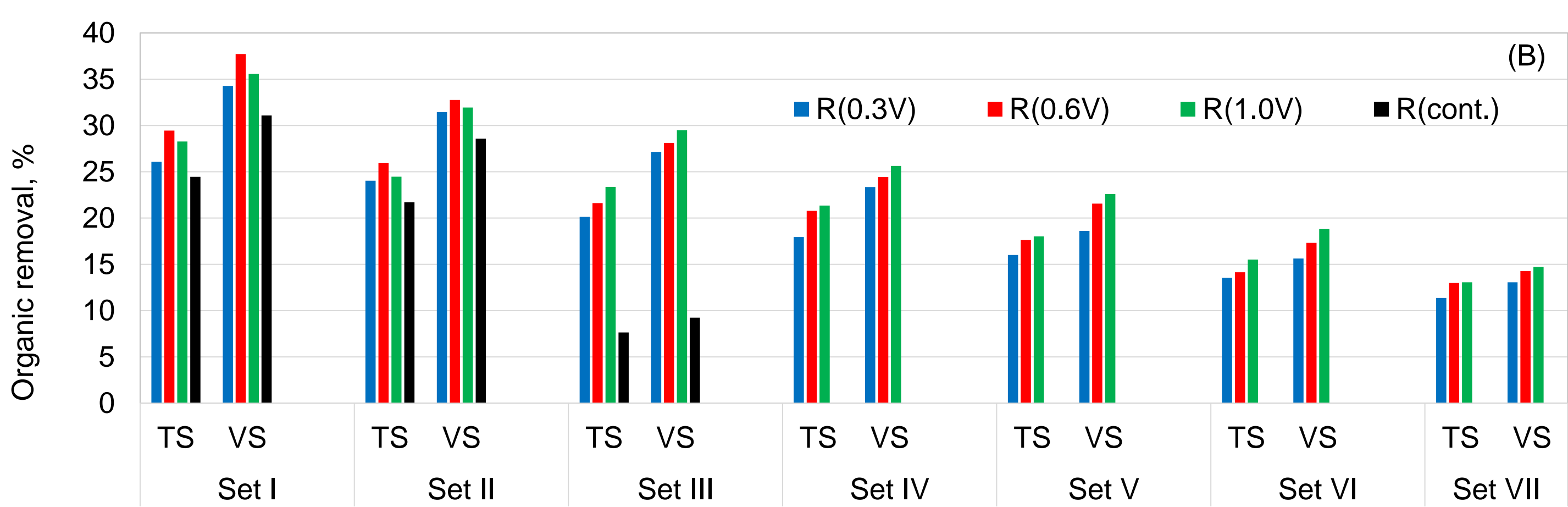
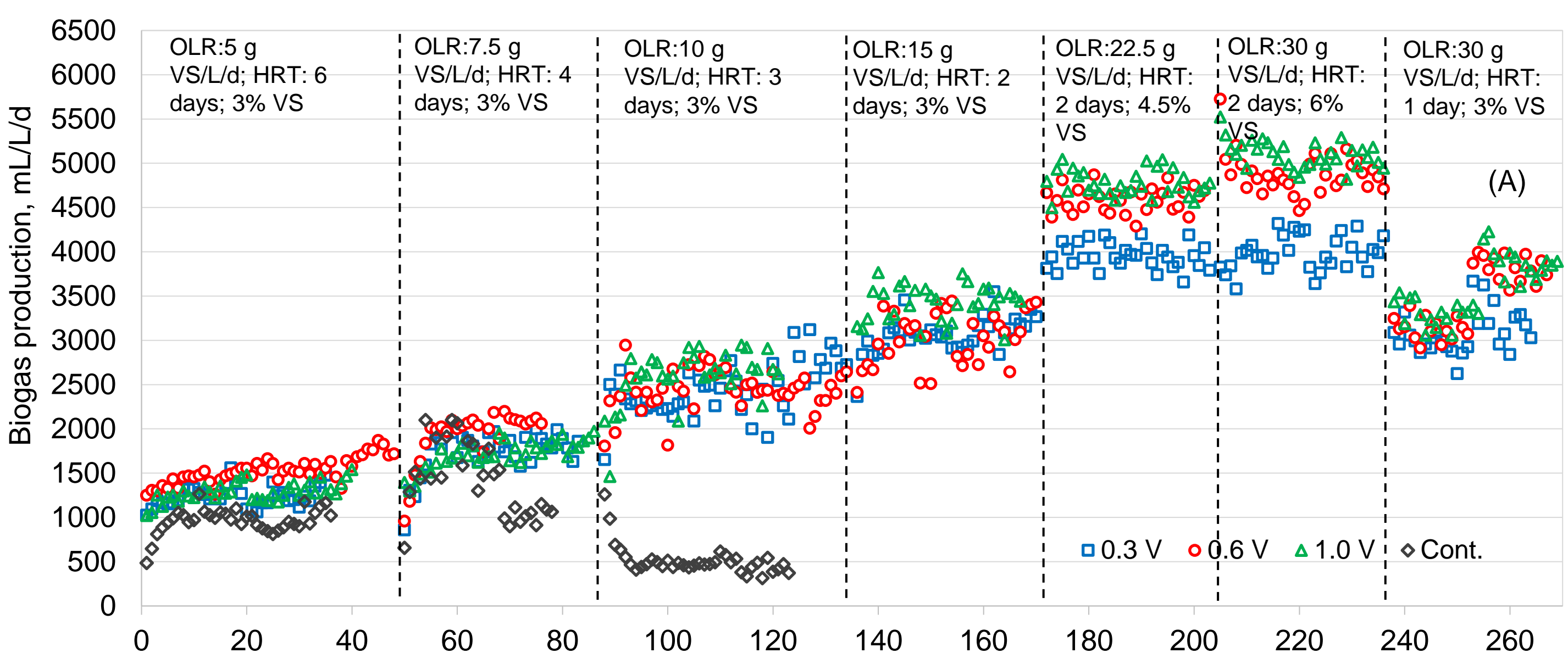
Aim: In this study microbial electrolysis cell and anaerobic digestion reactor were combined in a single reactor (MEC+AD) to enhance the biogas production from cattle manure. The MEC+AD system was operated in batch and semi-continuous mode under various operational conditions. The hydraulic retention times (HRT) ranging from 6 days to 1 day were applied to the MEC+AD. Lowering the HRT increased the organic loading rate (OLR) from 5 g VS/L/d to 30 g VS/L/d. Different voltages of 0.3, 0.6, and 1.0 V were applied to the MEC+ADs to observe the effect on the biogas production performance.



Schematic presentation and photos of electrodes of MEC+AD (a) lateral view, (b) top view, (c) anode, and (d) cathode materials



Daily biogas production and methane rate (A), cumulative biogas (B) of MEC+AD with voltage of 1.0 and 0.3 V, inoculation, and control reactors at batch process.



Biogas production (A) and organic removal rates (B) of MEC+AD and control reactors.

Results: The MEC+AD system achieved 25 to 60 % higher biogas production and 10 to 21% higher organic removal rates compared to the conventional reactor. Depending on the HRT and applied voltage, biogas productions of MEC+AD system increased from 1.24 L/L/d to 5.10 L/L/d during the study. In addition, voltage application to the MEC+ADs enhanced methane content in biogas as much as 75 to 81%. The biogas yields obtained from the MEC+AD systems fed with cattle manure consists of 6% VS decreased from 378 to 169 ml/g VS due to the OLR increment from 5 g VS/L/d to 30 g VS/L/d.

Conclusion: Combined MEC+AD shortened the hydraulic retention time as low as 1 day without a sign of inhibition. Provided that the effects of the voltage magnitude are to be compared between each other, higher biogas production (16 to 21%) was observed at higher applied voltages of 0.6 and 1.0 V, especially at high OLR conditions. It can be concluded that MEC+AD systems could be employed efficiently under challenging conditions such as short HRTs, small volume reactors, fast pretreatment, and the first stage of a multi-staged process.