Microfluidic study of biomass-growth induced changes on hydraulic properties. Investigation of growth characteristics under varying nutrient gas environments.

Apart from the bacterial instrumentalization for EOR processes, aspiration in utilizing anaerobe archaea representatives for renewable methane synthesis in geological formation exists. In a previous study, the investigation of biomass accumulation in pore-space under saturated flow conditions has shown that bacteria exert a significant change in the hydraulic properties of porous media altering both, porosity and permeability. Via time-lapse imaging different modes of bacterial accumulation as well as preferential channel formation as a result of the changing velocity field could be observed. The segmented pictures were used as input for Navier–Stokes–Brinkmann flow simulations in a digital-twin approach to estimate intrinsic biomass permeability. From history matching the experimental data, the average intra-biomass permeability was determined to be 500±200 mD, which indicates a significant contribution to the advective nutrient supply potential. In the following study, an anaerobic culture is utilized to investigate the interaction between a blended hydrogen and carbon dioxide nutrient gas phase, similar to what is considered for synthetic methane production. The metabolic characteristics of a methane-producing species M.formicicum were investigated in the presence of nutrient and inert gas at shut-in conditions.

The temporal change in biomass count was captured using a high-resolution camera to establish the link between growth rate and nutrient concentration. The presented results focus on the change in biomass concentration with respect to different gas environments under saturated conditions and investigate the timescale of diffusive nutrient transport and consumption in sub-porous biomass aggregates. These experiments are the next step towards unlocking the potential of hydrogen as an energy carrier for subsurface energy conversion technologies.