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Ultrasound Disintegration as a Potential Method for the Pre-Treatment of Virginia Fanpetals (Sida hermaphrodita) Biomass before Methane Fermentation Process

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Abstract : As methane fermentation is a complex series of successive biochemical transformations, its subsequent stages are determined, to a various extent, by physical and chemical factors. A specific state of equilibrium is being settled in the functioning fermentation system between environmental conditions and the rate of biochemical reactions and products of successive transformations. In the case of physical factors that influence the effectiveness of methane fermentation transformations, the key significance is ascribed to temperature and intensity of biomass agitation. Among the chemical factors, significant are pH value, type, and availability of the culture medium (to put it simply: the C/N ratio) as well as the presence of toxic substances. One of the important elements which influence the effectiveness of methane fermentation is the pre-treatment of organic substrates and the mode in which the organic matter is made available to anaerobes. Out of all known and described methods for organic substrate pre-treatment before methane fermentation process, the ultrasound disintegration is one of the most interesting technologies. Investigations undertaken on the ultrasound field and the use of installations operating on the existing systems result principally from very wide and universal technological possibilities offered by the sonication process. This physical factor may induce deep physicochemical changes in ultrasonicated substrates that are highly beneficial from the viewpoint of methane fermentation processes. In this case, special role is ascribed to disintegration of biomass that is further subjected to methane fermentation. Once cell walls are damaged, cytoplasm and cellular enzymes are released. The released substances – either in dissolved or colloidal form – are immediately available to anaerobic bacteria for biodegradation. To ensure the maximal release of organic matter from dead biomass cells, disintegration processes are aimed to achieve particle size below 50 μm. It has been demonstrated in many research works and in systems operating in the technical scale that immediately after substrate supersonication the content of organic matter (characterized by COD, BOD5 and TOC indices) was increasing in the dissolved phase of sedimentation water. This phenomenon points to the immediate sonolysis of solid substances contained in the biomass and to the release of cell material, and consequently to the intensification of the hydrolytic phase of fermentation. It results in a significant reduction of fermentation time and increased effectiveness of production of gaseous metabolites of anaerobic bacteria. Because disintegration of Virginia fanpetals biomass via ultrasounds applied in order to intensify its conversion is a novel technique, it is often underestimated by exploiters of agri-biogas works. It has, however, many advantages that have a direct impact on its technological and economical superiority over thus far applied methods of biomass conversion. As for now, ultrasound disintegrators for biomass conversion are not produced on the mass-scale, but by specialized groups in scientific or R&D centers. Therefore, their quality and effectiveness are to a large extent determined by their manufacturers' knowledge and skills in the fields of acoustics and electronic engineering.

Keywords : ultrasound disintegration, biomass, methane fermentation, biogas, Virginia fanpetals
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