ABSTRACT

Anaerobic digestion of organic substrates in wastewaters from agro-industrial sector can be efficient method to reduce the pollutant contents, and also a source of biogas. The research is focused on developing of intensified biogas technology and integrated equipment, based on a series of original approaches. New types of new phyto-catalysts of methanogenic digestion were proposed: aescinum, squalene, and betulinol, introduced in the digested biomass in micro-concentrations of 10-3-10-5%. The proposed substances promote about 1.5-2 times acceleration of methanogenic process and increase biomethane contents in biogas close to the natural gas level – up to 93-97%. As a feedstock for biochemical digestion, post-distillery vinasse in mixture with farmyard manure was used. By combining of biochemical treatment with microfiltration an advanced treatment degree was reached, reducing COD from 28530 mg O₂/L to 187 mg O₂/L. In bioreactor proposed, biomass using coefficient reaches 85-93%, as compared to 60% in the conventional biogas processes.
INTRODUCTION

The problem of natural environment pollution preventing with wastes and waste waters is nowadays in the centre of attention of many researchers and practitioners in many countries. Although the large number of biochemical treatment technologies and related equipment have been proposed for the wastewaters purification containing the organic pollutants, along with the biogas production (McCarthy, 2001; Show et al., 2010; Khalid et al., 2011; Velmurugan et al., 2014; Mao et al., 2015), the experts always seek for the more efficient, cheap and valuable solutions.

The present research is aimed to intensify the existing biochemical water treatment technology by applying the original approach – introducing the biologically active substances (phyto-catalysts) into the fermenting biomass which makes it possible to essentially improve this process. This approach, involving the application of organic compounds in biogas processes, is novel and has no analogues in the world, although the application of enzymes in biochemical digestion processes has been tested (Parawira, 2011; Sutaryo et al., 2014). Our scope was to enlarge the nomenclature of vegetable raw materials containing the biologically active compounds, which can essentially promote biogas and biomethane formation processes, to perform microbiological and technological studies of their stimulating effects on methanogenesis processes, to develop the integrated bioreactor with the auxiliary equipment to intensify the studied biochemical processes. At the same time, an important issue is to provide the higher wastewaters treatment degree resulted from the digestion of the organic feedstock, as well as to enhance the biomass using coefficient to improve the biogas yield with high caloric value, due to the increased biomethane contents in it. To ensure the treated water reuse in agricultural activity or other technological scopes, it is necessary to explore the combination of treatment methods. The higher treatment efficiency of the combined processes has been already demonstrated by different authors (Kamiya et al., 1998; Campos et al., 2002; Oller et al., 2011; Ganzenko et al., 2014). Such treatments can be applied as a consecutive steps or can be combined within one and the same apparatus.

BACKGROUND

The pollution of surface water with organic compounds from leachates of wastes generated by industries of agricultural products processing has become an issue of serious environmental concern, especially considering the lack of efficient treatment technologies and facilities, their high maintenance and operational costs and need for energy resources for the conventional aerobic digestion treatment of such waste waters (Rozich et al., 2002; Suvilampi, 2003).

This problem is common for many countries worldwide. For instance, in the Republic of Moldova two large rivers Dniester and Prut and a network of their tributaries, small rivers, serve as the main sources of drinking water for the millions of people. However, due to the discharges of untreated wastes and waste waters from the industries of agro-industrial sector, the major economy sector developed in this area, such as wineries, cattle and poultry farms, fruit and vegetable processors the waters of small rivers become highly polluted with organics and suspended solids. As a result, such waters, when inflowing the Dniester and Prut, bring a variety of pollutants, among them rather toxic and persistent substances (Opopol, 2006; Nastasuic et al., 2016). Along with the environmental problems, the natural water sources polluted with the insufficiently treated effluents can be a matter of serious health concerns (Okoh et al., 2010; Verbyla et al., 2015; Xiao et al., 2018).
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