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The prospects of the microbial sulfate reduction for polymetallic wastewater treatment

The operation of large mining and beneficiation plants inevitably leads to the formation of a large amount of wastewater containing extremely high concentrations of heavy metals [1]. Microbial dissimilatory sulfate reduction is a promising methabolic pathway to solve the problem of polymetallic wastewater treatment. The process is based on the application of sulfates by microorganisms as the terminal electron acceptor [2]. As a result, sulfates are reduced to sulfides, which precipitate a wide range of divalent cations Co^{2+}, Ni^{2+}, Pb^{2+}, Fe^{2+}, etc in the form of insoluble metal sulfides ($CoS\downarrow$, $NiS\downarrow$, $PbS\downarrow$, $NiS\downarrow$, etc.).

The aim of our work was to investigate the patterns of heavy metals precipitation of on the base of sulfate reduction on the example of Co^{2+} and Ni^{2+} via anaerobic fermentation of ecologically hazardous model waste (potatoes).

For this purpose, highly soluble Na_2SO_4 and slightly soluble gypsum $CaSO_4$ (LLC LOGICLABGROUP) were studied as electron acceptors. Starch (potato) was used as electron donors. Potatoes were pre-cleaned and cut into 5 mm cubes. As the source of microbiome, the sludge from methane tanks (Bortnytsia aeration station in Kyiv, Ukraine) was used. The study of the bivalent cations precipitation via sulfate reduction was tested by adding the solution of Co^{2+} and Ni^{2+} to a final concentration 100 mg/L of cations to culture medium. Cultivation was carried out in hermetic flasks with a volume of 250 mL at 32°C. The colorimetric method with 4-(2-pyridylazo)resorcinol (PAR) (0.1 %) was used to determine the metals concentration.

As a result of the study, the process of sulfate reduction was determined to be quite active regardless of the source of sulfates. It took 21 days for the complete precipitation of Co^{2+} and Ni^{2+} in the medium with potatoes using Na2SO4. Using $CaSO_4$, the precipitation occurred on the 19th day of cultivation. At the same time, hydrogen was released during cultivation, the share of which was 25–40 % in the gas phase. This indicates the possibility to obtain green energy carrier in the process of the degradation of environmentally hazardous waste.

Thus, the effectiveness of the sulfate reduction process using low-soluble gypsum for the precipitation of divalent metals, in particular Co^{2+} and Ni^{2+}, has been experimentally confirmed. This approach can be used as a basis for the development of new biotechnologies for the treatment of wastewater contaminated with heavy metals with the simultaneous treatment of ecologically hazardous compounds and the production of green energy carrier.

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