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Bioconversion of low-rank coal into humic substances by Acinetobacter sp. RKB

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Abstract: -- **Over recent years, the area of coal bioprocessing has been growing steadily due to its negative consequences for the environment, as fossil coal mainly harnessed as an energy source. The current state of the research on low-rank coal processing is aimed at improving its efficiency and environmental safety, as well as at obtaining high-demand chemical products, such as humic substances. This study was conducted that took into consideration the nature of coal low-rank coal biosolubilizaticonversion processes. The results presented herein show that the bacterial strain could be used as an effective aid for bioutilization efficiency to produce humic substances from low-rank coal.**

Keywords — **Acinetobacter, bioconversion, biosolubilization, humic substances, low-rank coal**

I. INTRODUCTION

Oxidation of various fossil coals during their weathering occurs on the huge scale and adversely affects the coal properties, as well as its composition and structure, contributing to their degradation, concentration, and dispersion [1,2]. As a result of oxidation, there is a deterioration in the quality characteristics of coal as a fuel, while in some cases it is such great that these coals do not even find energy-fuel use, due to the low heat of combustion and extreme fragmentation. Such coals are not taken into account when calculating economic profits or reserves and refer to the so-called "off-balance" or "low-rank" coals (LRC) [3].

When extracting solid fuel by an open method, a significant part of it goes to dumps in the form of waste heaps, which are generally unstable and unsuitable for use in the national economy. The reserves of oxidized brown and black coal reach billions of tons. They are scattered over large areas, which makes them difficult to selective-mining and processing [4].

However, LRC could be used for the production of chemical raw materials, including fertilizers and the recultivation of polluted and disturbed lands [5]. Weathered and metamorphosed coals contain a huge amount of humic acids, which in their properties and composition are similar to humic substances contained in agricultural backgrounds, i.e. fertile soils. This circumstance was the decisive basis for a detailed study of the possibility of obtaining humic acids for their use in the production of humus, a natural fertilizer for vegetable crops. Currently, a significant number of studies show the positive effect of humic acids on soil fertility and crop yields [6-8]. Biotechnological processes significantly contribute to receive valuable products from various types of raw materials. Recent achievements in biotechnology have begun to attract increased attention and are now broadly used in extracting and processing of coal. Biotechnological transformation of coal can be aimed at obtaining solid, liquid and gaseous types of products, as well as improving its consumer-oriented characteristics. Depending on the method of bioprocessing of coal and the strains of microorganisms used in this process two main technological methods are distinguished: aerobic and anaerobic [9]. In aerobic conditions, due to the supply of oxygen-containing gas, oxidative processes develop predominantly, contributing to the partial destruction of the structure of coal and its transfer to a suspended state; while under anaerobic conditions, the metabolic processes lead to the formation of methane and carbon dioxide with the production of solubilized coal particles.

The aim of this study is to examine the biosolubilization of LRC samples in a bioreactor under aerobic condition using a selected strain of *Acinetobacter* sp.

II. MATERIALS AND METHODS

Coal sampling

Two LRC samples were received from the coal beds of "Kiyakty" (LRC-1) and "Lengerskoe" (LRC-2), Kazakhstan. The samples were collected according to Dai

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CONTENTS

S.NO	TITLES AND AUTHORS	PAGE NO
10.	Solid Waste Management Plant at Hamirpur, Himachal Pradesh: A case study ➢ ***Swasti Sthapak***	40-43
11.	New Technology of Destruction of Waste of the 1st And 2nd Class of Danger ➢ ***Vladimir A. Grachev***	44-48
12.	Bioconversion of low-rank coal into humic substances by Acinetobacter sp. RKB ➢ ***Zhubanova A.A*** ➢ ***Akimbekov N.S*** ➢ ***Qiao X*** ➢ ***Tastambek K.T*** ➢ ***Abdieva G.Zh*** ➢ ***Ualieva P.S*** ➢ ***Kayirmanova G.K***	49-52
13.	An Assessment of Waste Management Practices by Households in Gully-Ravaged Areas in Uyo, Akwa IBOM State, South-South Nigeria ➢ ***Harrison, U. E*** ➢ ***Osu, S. R*** ➢ ***Uko, I. E***	53