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Evaluation of denitration of nitrocellulose by microbiological treatment for industrial waste effluents using calorimetry analysis

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Abstract

The problem of utilization of the compounds present in the effluents of the production of cellulose nitrates (NC) is very important and complicated, and its decision is inextricably related to the environment. The process of heat release in the samples of nitrocellulose subjected to biological processing of different types was studied. Biological processing was conducted by incubation with sulfate-reducing bacteria *Desulfovibrio desulfuricans* BKMB-1388, microscopic fungi *Fusarium solani* BKM F-819, and their mixed culture. The studies were carried out on the native NC (13.38% nitrogen) and the NC processed (NC_{proc}) using ultraviolet radiation and ozone (UV + ozone). It has been shown that the pretreatment of the NC by UV + ozone significantly increases the degree of decomposition of the NC during its subsequent biodegradation assisted by symbiotic microorganisms of *D. desulfuricans* and *F. solani*. A substantial result was achieved on the fifth day of NC_{proc} incubation, which is promising from the viewpoint of practical applications.

Keywords Nitrocellulose · Biological degradation · *Fusarium solani* · *Desulfovibrio desulfuricans* · Calorimetry

Introduction

High-energy capacity materials such as aromatic compounds, nitroesters, and nitroamines are components of polymeric composite materials. Large amounts of effluents with wastes containing environmentally hazardous substances are formed in the process of industrial production of such polymers. The problem of their utilization is important and complicated, and its decision is inextricably related to health of the present and future generations of people. The development of methods and techniques aimed at accelerating the decomposition of the compounds present in the effluents of the production of cellulose nitrates (NC) will allow one to solve environmental problems associated with the accumulation of large quantities of flammable, explosive, and poorly degradable materials in the sediment ponds and to reduce the negative impact on the environment.

The volumes of NC production in the world are very considerable. It is known [1] that Germany produced 26,050 tons of gunpowder within the period from January to March 1945. The scientific base of special chemistry in the USA is concentrated in the state enterprises, such as Livermore, Argonne, and Los Alamos National laboratories and the research center at the China Lake. Twenty-six plants producing gun powders, solid propellants, and explosives were placed in the 1980s in these cities [2].

Investigations in this area are aimed at searching for the possibility of prolonged and safe storage of NC [3] and eliminating the main drawbacks of NC. These are low density, high fragility, and low combustion temperature. The modification of the NC precursor was used in [4]. Microcrystalline cellulose nitrate was successfully prepared from Alfa grass (a cheap and easily renewable source) and showed a high potential for the use as a component of propellants. It is also proposed [5] to prepare a nanometallic fuel based on NC modified by nanoborane. The introduction of nanoborane by electrospinning into nitrocellulose fibers induces a faster and intensive combustion.

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