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Obtaining lactide in the presence para-toluene sulfonic acid

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Biodegradable polymers have recently been gained much more attention as the potential replacement for conventional synthetic (petroleum-based) materials [1]. Among the new biodegradable polymers, polylactides (PLA) are of particular interest [2]. Moreover, because of their excellent properties [3], they are widely used in medicine (surgical sutures, orthopaedic applications, tissue engineering). For the same reason, they are also applicable in packaging field as an environmental friendly substitute [4]

Polylactide can be synthesized in several methods: thermal polycondensation of lactic acid (LA); polycondensation of lactic acid with azeotropic distillation of water; obtain lactide and its the ring-opening polymerization in the presence of various catalysts and initiators. The latter method the most common and effective for of obtaining biodegradable polymer with high molecular weight [5].

Synthesis of lactide includes the following stages: concentration of LA solution; preparation of LA oligomers using a catalyst; preparation and purification of raw lactide. One of the stages in the preparation of lactide is oligomerization LA, which determines the yield and purity of the lactide [6].

For the synthesis of lactide oligomer LA using catalysts such as metals (such as tin, zinc), oxides of zinc, antimony, aluminum, tin salts and metal complexes, and many others. It is known that para-toluene sulfonic acid is the active catalyst, which is widely used for the production of esters based on carboxylic acids and alcohols.

Previously, it was revealed that by using as a catalyst para-toluene sulfonic acid at a concentration of 1.5% and a process time of 120–240 min for the synthesis of lactic acid oligomer in the reaction flask was observed the formation of very viscous mass, which subsequently led to a significant decrease in the yield lactide – raw.

It was therefore of interest to investigate the concentration step the LA and oligomerization process on rotary vacuum evaporator Heidolph Hei-VAP and choose optimal conditions of the reaction to increase the yield and purity of the crude lactide.

We used 80% aqueous solution of L-lactic acid from PURAC (Spain).

The oligomerization process was performed at a temperature of 150 °C, the rotation speed of the flask on a vacuum rotary evaporator, 60 rev/min, vacuum of 30–50 mbar, the vacuum being created immediately. After 30 minutes the reaction mixture was added the catalyst para-toluene sulfonic acid in an amount of 0.025–1.5% by weight of concentrated MC. The process was carried out without nitrogen blanket, for 60 minutes. [7].

Synthesis of crude lactide was performed on a standard laboratory setup for vacuum distillation using an electromagnetic stirrer IKA C-MAG HS 7 at a temperature of 200–240 °C and a vacuum of 10–20 mbar. The process of depolymerization of the oligomer takes lactide in MK 120–180 minutes. The table shows experimental data on the synthesis of lactide oligomer MC in the presence of para-toluene sulfonic acid.

From the results, it was neck of that highest yield of lactide raw obtained at concentrations of para-toluene sulfonic acid 0.2–0.05%. At the same catalyst concentrations observed the formation of a purer raw lactide. Revealed that MK time oligomer in the presence of this catalyst is reduced by 4 times in comparison with the reaction catalyzed by zinc oxide.

The structures of the lactide was confirmed by infrared spectroscopy. In the present lactide characteristic absorption bands in the 1788 ~ 1720 cm^{-1} relating to the vibrations of the carbonyl group C=O vibrations of C-O-C appear in the 1200 ~ 1040 cm^{-1}. Absorption band at 2900 ~ 2844 cm^{-1} belong to the group $C\text{-}CH_3$. These data indicate the structure lactide.

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Study of physical and mechanical ash properties of Krasnokamensk power station

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The thermal power stations operating on peat, slate or coal produce about 70 million tons of cindery waste every year. Currently, this waste hasn't been fully utilized and storage of such waste disposal areas requires more than 150 million of RUB per year. Moreover, it requires agriculturally used areas approximately 300–1500 hectares near each big thermal power plant [1].

The study purpose is a complex research of physical and mechanical properties of Krasnokamensk ash for further utilization.

The object of research is ashes of the Krasnokamensk district power station. Ahes are taken from the dump which is directly adjacent to output pipes through, where ashes are taken out by water in the form of a pulp from boiler installations of the station. The chemical composition of the studied material determined by the method of the chemical analysis is given in Table 1.

Losses, when calcinating, are caused by availability of coke and particles of coal that are not burned down. These particles of coal in the presence of moisture are known to be easily oxidized and increased, thus increasing in volume up to 15 % and even more. In addition, the high content of these particles leads to fast self-destruction of the product.

Table 1. Chemical composition of Krasnokamensk ashes (%)

Name or code name	Oxide content, %											
	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	MnO	Na_2O	K_2O	P_2O_5	SO_3	Impurities
Ash	63.1	1.17	13.22	7.99	8.67	0.88	0.09	0.54	2.47	0.37	0.6	10.7