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BROWN COAL HUMIC SUBSTANCES HYBRID MODIFIED BIODEGRADABLE COMPOSITES WEAR SIMULATION

Abstract
Researching on wares modeling from brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee waste technology are carried out in this work. New wares are pots for seedlings and vases for planting greenery that can be used for landscaping for urban territories. The products design was made, the mathematical modeling of the designed products was carried out. The process of modeling products based on brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee was carried out in the SolidWorks 2020: 3D CAD environment with subsequent receipt of g-code, which is intended for machines for the production of molds for plastic injection.

Keywords: *modeling, humic substances, brown coal, biodegradable, composite, polylactide, coffee waste, wares*

Introduction

Currently, in the area of landscaping for urban territories, a numbers of different polymeric materials and compositions are widely used, which have a number of operational and aesthetic advantages over other materials. These include properties such as high strength and durability, light weight and ample opportunities in design, color scheme and other important aesthetic characteristics.

At the same time, the last 10 years the current world's trend is the use of biodegradable polymeric materials. Such biodegradable polymeric materials implement the principle of "Zero waste" throughout the life cycle - "production-use-disposal", so this class of polymers today is widely used in the market [1, p. 2653]. Based on the possibility of using biodegradable polymeric materials in a wide areas in urban spaces landscaping, today research on the study, development and design of various parts, products from such materials are important and popular[2, p. 6310].

Polylactide is today widely used in packaging as a special product. Many branded companies use products from this particular bio-plastic to pack their goods [3, p. 535]. Highly efficient polylactide grades can be used as an alternative to polyethylene, polypropylene, polystyrene and ABS plastics.

Polylactide can be used even in fairly critical areas of engineering and instrumentation. The wide distribution of products from polylactide in Ukraine is limited by the high cost of finished products. So, a 200 ml coffee cup costs about $ 25. The cost of polylactide products can be reduced by introducing of various fillers that do not affect the physicochemical and operational properties of the finished product. using of coffee grounds waste as a filler, you can get a product that haven't negative environmental impact with low price [4, p. 1712]. That is why the development of biodegradable polymer composite materials based on polylactide and coffee grounds waste is very relevant.

One of the main approaches that ensure the fulfillment of the tasks set is the transition to computer-aided design of products from biodegradable polymer materials [5, p. 118580].

In such cases, it becomes possible to use complex models based on biodegradable polymer materials, take into account the physical, chemical characteristics, features and requirements of production processes, as well as the possible behavior of the material during the wares made from them operation.

Modeling products made from biodegradable polymer materials cannot be carried out without understanding the areas of their application and predicting the prospects for use in specific products or functional systems.

Thus, the design of products from polymeric materials is a very difficult task in terms of creating new polymeric materials, because it requires appropriate technological and design information, for the developed wares, equipment for their manufacture, as well as different technological parameters of their processing.

Thus almost always high quality and durability of polymeric products and details is caused by a complex

of material's correct choice and selection of the most effective method of their processing.

Bioplastic polymer matrices filled with coffee husk waste have also been studied in [6, p. 134841], however, these works are more research than applied industrial in nature. That's why it's very relevant to develop and study biodegradable polymer composite materials based on polylactide and coffee grounds waste in order to use them for the manufacture of dishes for catering establishments: coffee cups, glasses, plates, cutlery, etc. We have previously studied [7, p. 154] chemical, physical, mechanical and operational properties of new high-filler composite based on polylactide.

It is also noticed, that using coffee grounds as fillers for polymer materials can decrease the total volume of it at landfills faster than any other method of coffee ground reuse. Further research the level of sorption stability for developed materials to the most characteristic environments of their operation is perspective [8, p. 646].

The aim of the research was to design modeling of brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee waste wares for the improvement of urban spaces.

Raw materials and test methods

The objects of study were:

- extrusion polylactide of the Terramac TP-4000 brand;

- coffee grounds waste, gathered in 8 different coffee shops in Kharkiv and dried to moisture content 50%. Coffee grounds waste have a polyfractional composition in the particle size limit from 0.5 to 1 mm;

- humic substances, which were obtained by extraction of brown coal with alkaline solution of sodium pyrophosphate, followed by extraction with 1 % sodium hydroxide solution and precipitation with mineral acid.

Brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee were obtained by extruding pre-prepared raw materials in a single-screw laboratory extruder at a temperature of 170–200 ° C and a roll rotation speed of 30–100 rpm. The L / D ratio of the extruder is 25, and in order to increase the uniformity of dispersed waste distribution in the finish compositions, 2 mass passes were used to obtain finished samples. It was made 20 parallel experiments for each composition, statistical processing was made by characteristics such as arithmetic mean, standard deviation and variation coefficient.

The process of modeling products based on brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee was carried out in the SolidWorks 2020: 3D CAD environment with subsequent receipt of g-code, which is intended for machines for the production of molds for plastic injection.

Results and discussion

The design of ware's outward appearance for urban spaces landscaping was carried out in the form of vases for gardening and vases for planting greenery on the basis of an optimized brown coal humic substances hybrid modified biodegradable composites on polylactide and coffee waste in the SolidWorks 2020: 3D CAD environment.

Regardless of whether you will be using a CNC milling or turning machine, the typical process for creating injection molds for the production from polymer materials consists of the following steps:

- SolidWorks 2020: 3D CAD used to parts design;

- using additional tools SolidWorks 2020: 3D CAD to optimize the further use of CAD models for injection mold manufacture on a machine;

- SolidWorks 2020: 3D CAD analyzes the CAD drawing and outputs G-Code control commands to the machine controller;

-the operator of the machine, based on the commands received from the G-code-commands, activates the corresponding electrical circuits in the desired sequence and with the specified duration, which forces the machine to perform the operations specified by the program.

In fact, G-Code is the most common language understood by CNC machines.

Table 1 below shows the G-Code model for the ware design for urban spaces landscaping in the form of pots for seedlings and vases for planting from an optimized brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee waste [10, p. 168]. In fig. 1 presents 3d model outward appearance of a typical wares for urban spaces landscaping in the form of pots for planting seedlings of greenery with the indication of the main dimensions that made of optimized brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee waste.

Table 1

G-Code models of ware design for urban spaces landscaping in the form of pots for seedlings and vases for planting from an optimized brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee waste

G-Code	Responsive action
O0001 (VAL);	Program number.
N5 G00 X40 Z50;	Accelerated movement to the tool change point.
N10 T0202 (FINISHING TOOL SVJC (08));	Changing the tool, turning on the corrector on the tool.
N15 M3 S2000;	Rotation of the spindle counterclockwise with a speed of 2000 rpm
N20 G00 X22 Z0;	Accelerated movement to point 1
N25 G01 X-2 F0.12;	Moving to point 2 with a feed of 0.12 mm / rev.
N30 Z1;	Moving to point 3.
N35 G00 X19 S1600;	Accelerated movement to point 4, changing the spindle speed by 1600 rpm
N40 G01 Z-20 F0.1;	Moving to point 5 with a feed of 0.1 mm / rev.
N45 X22;	Moving to point 6.
N50 G00 Z1;	Accelerated movement to point 7.
N55 X15;	Accelerated movement to point 8.
N60 G01 X18 Z-0.5 S1700 F0.05;	Moving to point 9 with a feed of 0.05 mm / min and the spindle speed of 1700 rpm
N65 Z-9.5;	Moving to point 10.

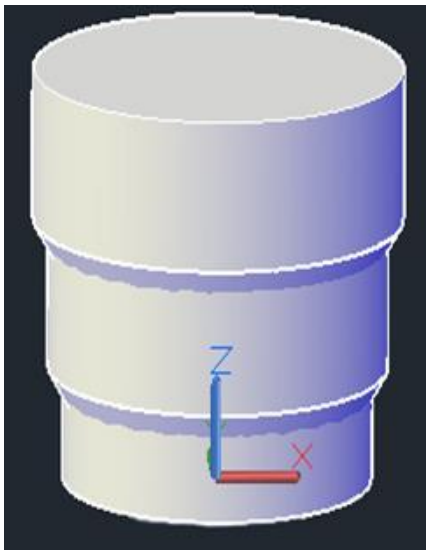

Figure 1. 3d model outward appearance of a typical wares for urban spaces landscaping in the form of pots for planting seedlings of greenery with the indication of the main dimensions that made of optimized brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee waste

SolidWorks 3d model outward appearance of a typical wares for urban spaces landscaping in the form of pots for planting seedlings of greenery with the indication of the main dimensions that made of optimized brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee waste can be used for injection molds creation within the production processes of polymeric materials processing.

Conclusion

The article conducts research on modeling of wares from the brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee waste for urban landscaping in the form of pots for seedlings and vases for planting greenery.

The design of new wares was constructed, the mathematical modeling of the designed products from brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee waste was carried out. Created in SolidWorks 3d, a model of a typical ware design for urban landscaping in the form of pots for seedlings of green plantings with the indication of the main dimensions making from optimized brown coal humic substances hybrid modified biodegradable composites based on polylactide and coffee waste can be used to create molds in the production processes of polymer materials.

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ALGORITHM FOR OPTIMIZING THE OPERATION OF THE EVAPORATOR OF ABSORPTION-REFRIGERATION INSTALLATIONS UNDER THE CONDITIONS OF THE MULTI-PARAMETER EFFECT OF EXTERNAL DISTURBANCE

Abstract.

An analysis of the operating conditions of the evaporators of absorption-refrigeration units of the secondary condensation unit of ammonia production as control objects is carried out. There is a well-founded need to minimize the cooling temperature of the circulating gas, the reduction of which increases the energy efficiency of ammonia production by reducing consumption of natural gas.

Algorithmic support for optimizing the operation of the evaporator of absorption-refrigeration units in the conditions of multiparametric action of disturbing factors with the determination of the optimal flow of phlegm to minimize the cooling temperature of the circulation gas in the evaporators has been developed.

Key words: *ammonia production, evaporator, phlegm consumption, absorption-refrigeration plant, optimization algorithm, energy efficiency.*

Introduction. Formulation of the problem. The final removal of production ammonia is provided by the technological complex of secondary condensation, which is one of the main ones in the synthesis department of ammonia production. As a part of many complexes of this production, as well as in the complex of secondary condensation, air and water cooling devices are actively used, which sometimes has a very negative effect on the quality of work of individual departments, and therefore on the production of ammonia in general. The disadvantage of such devices is the significant impact on their work of seasonal and daily fluctuations in temperature and humidity of the surrounding air [1].

In particular, the use of air cooling devices in the refrigerant condensation unit of absorption refrigeration units (ARU) included in the secondary condensation complex causes constant disturbances in their operation. This, in turn, leads to significant fluctuations in the cooling temperature of the circulating gas (CG) in the evaporators of the ARU (-8°C ÷ +4°C) [2]. Such fluctuations lead to significant changes in the flow of natural gas into the additional steam boiler, and an increase in this temperature, as is known [3], due to an increase in the flow of natural gas causes a decrease in the energy efficiency of the synthesis unit in general.

Therefore, the minimization of the temperature regime of cooling of CG in the evaporators of ARU is an urgent task in the general process of increasing economic efficiency of ammonia synthesis units.

The peculiarity of the operation of the evaporator is connected with the inflow of refrigerant (ammonia)