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Contributions for Producing Biodegradabile Shock Absorbent Packaging

Nicolae CIOICA[1)], Maria TOMOAIA-COTIŞEL[2)], Mihaela NAGY[1)], Ossi HOROVITZ[2)], Constantin COŢA[1)]

[1)] INMA Bucharest, Branch Cluj-Napoca, Al. Vaida Voievod Street, No. 59, Cluj Napoca, Romania,
[2)] Babeş-Bolyai University of Cluj-Napoca, Faculty of Chemistry and Chemical Engineering, Department of Physical Chemistry, Arany Janos Street, No. 11, Cluj-Napoca, Romania,
e-mail: inmacj@click.net, mcotisel@chem.ubbcluj.ro

Abstract: Making biodegradable plastics is a concern of recent years, research in this field from universities, research institutes and enterprises are continuously developing. Biodegradable loose fill shock absorbent packaging are also part of the large class of biodegradable plastics and it is necessary for them to ensure, besides biodegradability, a number of technical requirements deriving from their utilization purposes: protection of breakable products during handling and transport. Packaging properties depends on both the type and proportion of materials that are part of the formula and the technology used in its manufacture, process characterized by certain technological parameters.

This paper presents some results obtained making a biodegradable loose fill packaging by corn-starch extrusion in the presence of plasticizers.

Key words: packaging, protection, shock absorbent, biodegradable.

INTRODUCTION

Plastic products have become, in the last half century, important components of daily life. The synthetic plastic materials are very resistant, they can be processed in many ways and are also lighter and cheaper than other materials. Therefore they are used in industrial and commercial applications.

Besides their advantages, the synthetic plastic materials creates serious problems worldwide, on one hand due to high consumption of petroleum, a resource ever more poor and more expensive, needed to produce them and, secondly, due to their negative environmental impacts

Viable solution for solving these problems and leading to lower petroleum consumption and to reduce environmental pollution are the *bioplastics*, that are biodegradable materials obtained from renewable raw materials, such as biodegradable polymers, derived from agricultural resources. Being biodegradable, bioplastics returning soon, under certain conditions of moisture, heat and light, by decomposition in simple elements, in the natural circuit.

The most common raw material used in making bioplastics is the starch. It is abundant in corn, potatoes, wheat and tapioca. Only in Europe are produced approx. 8 million tons of starch annually, of which only approx. 55% are used in food industry. (Fang, J., P. Fowler, 2003). Annual production capacity of starch factories in Romania is about 20 000 tones.

In its natural state dry, the starch, which has in its composition the amylose and amylopectin is not thermoplastic and can not be used to manufacture bioplastics. Researches conducted globally had and have aimed finding solutions for the use of starch in industrial applications. These include the addition of plasticizers, blending with thermoplastic polymer or to make some chemical changes.

The object of this paper is to present some results to achieve an shockproof biodegradable packaging by extruding starch in the presence of plasticizers

MATERIALS AND METHODS

The formula used contains starch, glycerin and water.

The starch used was corn starch manufactured by SC Amylon Sibiu, having moisture on dry wet of 10.76%, particle sizes between 2.3 and 37.3 μm and a density of 0.561 g/cm^3.

The glycerin used in recipe had a concentration of 99.5% and a density of 1.262 g/cm^3.

The water used was from the water supply system.

The technical equipment used is presented in Fig. 1, and it has as main components:

- dosing pump (A);
- extruder (B);
- feeder (C).

The dosing pump used to feed with plasticizers was a peristaltic pump PERIPUMP, D' 5187 type, of low capacity and high precision dosing, with a power flow between 1 and 42 ml/min.

Equipment purchased and used in experiments was a Collin ZK 25 extruder with two co-rotating screw, with a maximum productivity of 15 kg/h, screw diameter D=25 mm, screw length L=30 D, screw speed: max. 400 rpm and having six independent heating and cooling areas.

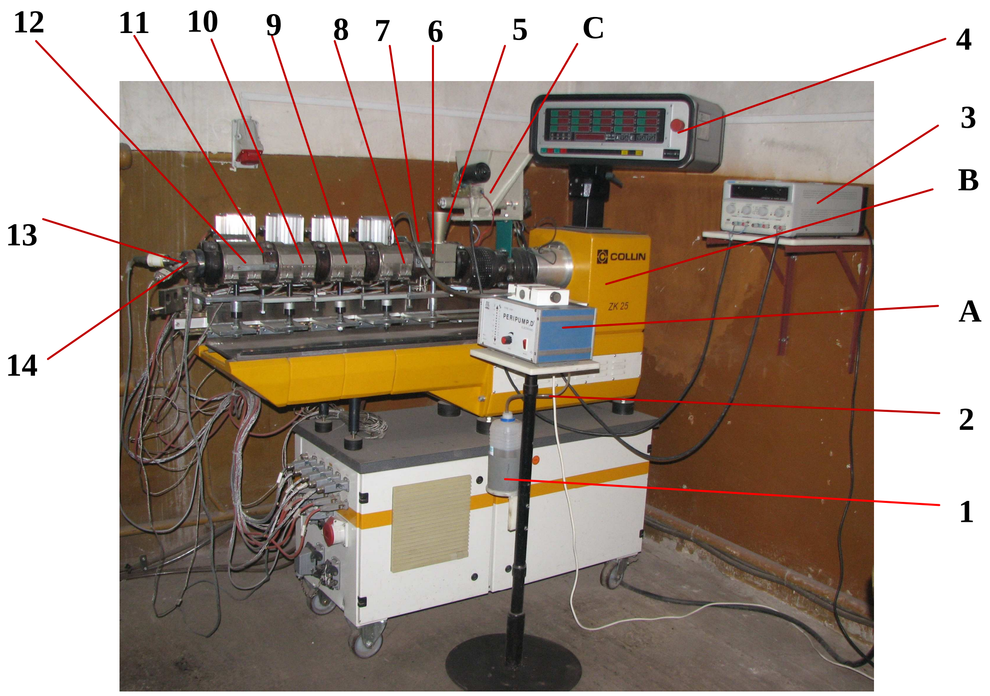

Fig.1 Extruding installation – general view
A – Dosing pump; **B** - Extruder; **C** – Feeder;
1-Plasticizer tank; **2**–Plasticizer feeding pipeline; **3**-Power source; **4**–Control panel; **5**-Starch supply hopper; **6**-Area 01; **7**-Plasticizer pipe connection; **8,9,10**-Area 02, 03, 04; **11**-Cooling fan; **12**-Area 05; **13**-Area 06-Die; **14**-Heater

The feeder used in experiments was a volumetric feeder with 1 screw.

Area 01 of the extruder, is the supply area, without heating, but can be cooled with water. The areas 02-05 are equipped with electric heaters (Pos. 14) and cooling fans (Pos.11)

Each of this five areas is equipped with one temperature sensor to measure temperature and control starting or stopping of the heaters or fans to maintain the temperatures set in each area. Area 06 is the die area - it has its own heater,and no cooling. Its temperature is measured and maintained at the value initially established by the temperature sensor (Pos. 5).

Also in the die area there are two sensors that are in direct contact with the material that is processed and measure its temperature and pressure. These two parameters are very important, for them relying largely the quality and cross size of the extruded product.

Temperature values in this six areas of the extruder are initially set, achieved and maintained during extrusion plant operation with a program whose interface is the control panel of the extruder.

The starch was introduced into the extruder with the dosage dispenser and for supply plasticisers a peristaltic pump was used. In order to use a single dosing pump, both plasticizers, glycerin and water, being miscible, were mixed in the proportion of the formula and put in the plasticizers tank (see Fig. 1, Pos. 1).

The plasticizers were added into the working area through a pipe connection located at 170 mm from axis of the supply hooper.

Both, starch supply and plasticizers supply, were made continuously, any interruption to supply are leading to changes in flow and in the properties of the finished product. The ratio of the three components in the formula, based on which have been established the flows of starch and plasticisers supply, was that in the Tab. 1.

Tab. 1

The ratio of components in the formula

Starch [g]	Water [g]	Glycerin [g]	Water [% wet s.]	Glycerin [% wet s.]	Water [% dry s.]	Glycerin [% dry s.]
57,14	14,29	28,57	14,29	28,57	25	50

Meanwhile, along the extruder are provided conditions for thermal processing of the material through the existing temperatures in the six areas of the extruder, shown in Tab. 2. Screw speed was 220 rpm.

Tab. 2

Temperature of the 6 areas of the extruder

Temperature [^{0}C]					
Area 01	Area 02	Area 03	Area 04	Area 05	Area 06
30	50	100	130	150	150

Temperature values were chosen taking into account the important points of the DSC termograma mixture. For starch-water-glycerin mixture, in the ratio of the formula, the glass transition temperature is approx. 71ºC and the melting temperature is approx. 140ºC.

RESULTS AND DISCUSSION

Loose fill shock absorbent packaging accomplished, shown in Fig.2. For its characterization were used current physical and chemical methods. The degree of expansion was calculated using the dedicated formula: IET = $(De/Dm)^2$ [%], where: De = cross-sectional diameter of the extruded product and Dm = cross-sectional diameter of the die hole.

Fig.2 Loose fill package

Mechanical tests were done on a traction and compression testing machine, Instron-3366. Were also used methods of particular importance for the intended purpose, namely scanning electron microscopy, SEM, and differential dynamic calorimetric analysis (scanning) DSC (M. Tomoaia-Cotisel, *et al.* 2010).

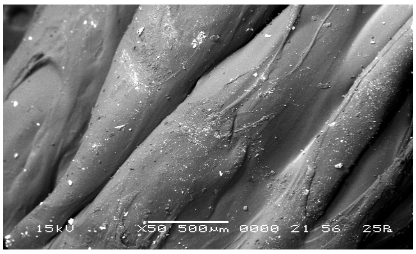

Fig.3 Loose fill package-SEM image

Biodegradability was determined using measurements of carbon dioxide released from the packaging developed and measuring the oxygen demand in a closed respirometer (Paul M. *et al.* 2010).

The main characteristics of the package developed, were:

Degree of expansion:	5,4 %
Density:	1,16 g/cm^3
Stretching breakdown tension:	0,240 kgf/mm^2
Biodegradability (in 30 days):	56,5 %

CONCLUSIONS

Applied technology allows obtaining for a biodegradable shock-absorbent packaging (loose fill) using as row materials starch, glycerol and water, used in well established percents and defined by specific physico-chemical and organoleptic properties. The tehnical equipment used to obtain packaging through the presented technology, enables the succesive realization of specific execution phases of the technological processes and achivement and maintaining working parameters (flow rate, temperature and pressure) in all six areas of the extruder, providing the necessary conditions to achieve a quality finished product.

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