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# PLAN OF THE APPLIED RESEARCH PROJECT TO DETECT RHEOLOGICAL PROPERTIES OF THERMOPLASTICS

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***Abstract:*** *This project deals with applying optimal number of regranulate from thermoplastics in products manufactured for automotive industry, which are made by injection moulding technology. It also pays attention to climate conditions effect on the quality of thermoplastic products produced by this method. To detect their quality will be used climatic chamber and machines used to control and test physico-mechanical and physico-chemical features of products. Project of Department of Technological Systems Operation of the Faculty of manufacturing Technologies of Technical University of Košice with a seat in Prešov focuses to support production practice, from ecological and economical aspect in co-operation with LPH Vranov n/T, Ltd. and JMP Plast, Ltd., which are several years working in manufacturing of plastic components.*

***Key words:*** *rheological properties, thermoplastics, regranulate.*

## 1. INTRODUCTION

Nowadays, marked expansion of automobile industry in Slovakia classifies our country among prominent automobile manufacturers in the world. Mentioned fact evokes inevitability to assure material and technological equipment for investors that arrive to our market. A large number of different subcontract companies participate in process of manufacturing of individual parts of final product. Not only final product, in our case it is automobile, but also all its components must correspondent to demands which are required of them and fulfil its function, it was made for, during whole their running at the same time. Therefore it is necessary to know and in production process test individual technological parameters of given technology and also to know how its change impact on final quality of product.

At the present time is on Department of production process operation on Faculty of manufacturing technologies of the Technical University in Košice with a seat in Prešov built a laboratory for testing of rheological properties of thermoplastics. It is focusing on determining of mass and volume melt flow rate of thermoplastics. Process of determination comes from STN ISO 1133. Impulse to build up this laboratory came from producers and subcontractors of thermoplastics components for automobiles. By the reason to increase competitiveness on the market was an interest on the part of companies to control quality of delivered materials. From interested companies are most of analyses executed for LPH Vranov n/T, Ltd. From mutual cooperation and company needs was accrued design to extent co-operation. Was made a project which deal with utilization of waste in the form of regranulate in thermoplastics processing.

Execution of research results is in charge of collective of 20 researchers that consist of professors, prelectors, lecturers, research assistants but also inceptors from Department of production process operation. Next are on project also engaged managers, engineers and technicians from production practice.

## 2. RESEARCH CHARACTERISTIC

Intention of research is classify injection moulding of thermoplastics as closed-cycle technology. It means to use in production process at full fart recycled material from production, therefore regranulate. Here incept a question what is a lifetime of such products manufactured in a certain proportion of recycled material. Therefore it is necessary adapt these to experimental loading test in simulated climatic environment, which is able to create adequate conditions, similar to real one. Considering all this connections and numbers of producers of such products in Slovakia and in faculty region we decided to react on practise earnest appeal for help in solution of mentioned fact in designed applied research form.

By one of materials, which will be tested in our research, is polycarbonate with commercial name Makrolon 1260. It is global grade; MVR (300 °C/1.2 kg) 34 cm³/10 min; impact modified; low viscosity; easy release; injection moulding – melt temperature 280 - 320 °C; available in light colours only.

**Fig. 1.** Automobile headlamp hood produced in injection moulding process.

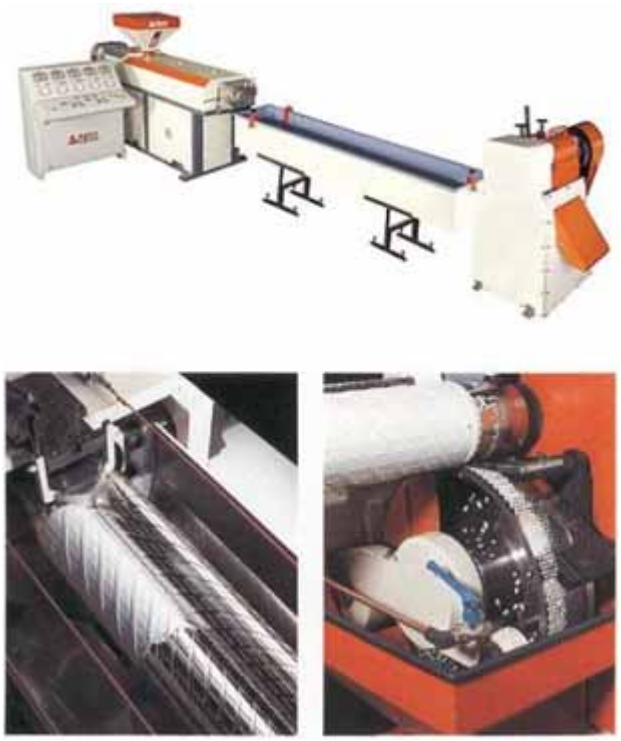

**Fig. 2.** Regranulated line.

It is used to produce thermoplastic product, concretely metal plated circuit in back headlamp hood, for automobile industry, Fig. 1.

Figure 2 shows regranulated line which is used for manufacturing of regranulate from original material in production process.

In Fig. 3 is for comparison displayed regranulate that was caused by production process as a processing scrap. Also is displayed original stock which was used as an entry material in manufacturing of this product. Its physical, mechanical, electrical and optical properties are listed in Table 1.

**Fig. 3.** Regranulate and original stock (polycarbonate).

In first step, project solution deals with examination of rheological properties of thermoplastics as enters materials for manufacturing of thermoplastic products with different contents of regranulate in neat material. Next steps of project solution are experimental reviewing of regranulate quantity impact in neat material on physico-mechanical and also on physico-chemical properties of given products at which that products will be exposed to different effects of climatic conditions of environment. Progress of project is planned at six phases within three years. In preparatory phase the project deals with objectives definition in conformity with strategy of faculty based on realisation of input opposition committee. In project planning phase is an objective to plan the project and its objectives so that it will be convenient to all co-solvers. Next three phases are realisation phases and describe concrete objectives of project self solution. Final phase includes processing results of made experimental examinations and its implementation in science and in technological practice in form of final work, which will be available to co-solver organizations and to consumers of project results.

*Table 1*

**Physical, mechanical, electrical and optical properties of Polycarbonate**

| **Physical** | **Nominal Value Unit** | **Test Method** |
|---|---|---|
| Density | 1200 kg/m$^3$ | ISO 1183 [1] |
| Apparent Density | 0,64 g/cm$^3$ | ISO 60 |
| Melt Mass-Flow Rate (MFR) (300°C/1,2 kg) | 36 g/10 min | ISO 1133 |
| Melt Volume-Flow Rate (300°C/1,2 kg) | 34,0 cm$^3$/10min | ISO 1133 [1] |
| Molding Shrinkage | | |
| Across Flow: 2,00 mm$^3$ | 0,70 % | ISO 294-4 |
| Flow: 2,00 mm$^3$ | 0,65 % | ISO 294-4 |
| Flow | 0,50 to 0,70 % | ISO 2577 [1] |
| Across Flow | 0,50 to 0,70 % | ISO 2577 [1] |
| Water Absorption | | ISO 62 [1] |
| Saturation | 0.30 % | |
| Equilibrium | 0.12 % | |

| **Mechanical** | **Nominal Value Unit** | **Test Method** |
|---|---|---|
| Tensile Modulus | 2350 Mpa | ISO 527-2 [1] |
| Tensile Stress | | |
| Yield | | ISO 527-2 [1] |
| Break | | ISO 527-2/50 |
| Tensile Strain | | |
| Yield | 5.8 % | ISO 527-2 [1] |
| Break | 100 % | ISO 527-2/50 |
| Nominal Strain at Break | > 50 % | |
| Flexural Modulus [2] | 2350 MPa | ISO 178 |
| Flexural Strength [2] | | ISO 178 |
| 3,5 % Strain | 72.0 MPa | |
| ---- | 93.0 MPa | |
| Flexural Strain at Flexural Strength (23°C, 2 mm/min) | 6.8 % | ISO 178 |

Notes:

[1] Tested in Accordance with ISO 10350.23°C/50% r.h. unless otherwise noted.

[2] 2.0 mm/min

## 3. CO-SOLVERS

Co-solvers of research are two companies, namely LPH Vranov n/T, Ltd. and JMP Plast, Ltd. On research they will participate in investing no small resources and also they will offer human and technical resources. Both of these companies will be main consumers of solution results. Company LPH Vranov n/T, Ltd. works on market manufacturer of plastic presswork since 1989. Company deals with production exact technical and tasteful presswork from thermoplastic and thermoses. To manufacturing program it shall LPH arrangement too plastic presswork cover thermotransfer technology, products exigent technology duo-inject as well as assembling combination and subassembly, containing besides pressed plastic parts too component from various technical material which are metals, urethane foams, plastic foils, magnet and others. JMP Plast, Ltd. is a company which is centred on manufacturing of thermoplastic and thermosetting presswork designed for different exploitation regions in several branches of industry. A part of manufacturing program of company is also surface treatment of injected products by application of protective coating on plastic surface and products made by two component injection moulding technology and mounting assembly and subassembly.

## 4. OBJECTIVES

Tendency of moulded plastic parts production with boom in automobile industry in Slovakia pass different development periods when it is necessary to react on market requirements and also try to utilize recycled material from production at full fart and by that assure economically effective production. Therefore we decided to enlarge our focus in plastic region with marked support of manufacturing practise. An advantage of the project will be maximal utilization of the scrap material in manufacturing process in limitations of new material buying.

Objectives of research are:

1. Creating a database of enters thermoplastic materials convenient for plastic injection moulding technology with appropriate number of regranulate in neat material

In this step it will be measuring rheological properties of selected thermoplastic materials which will be located in created database. Measurements will be made on MeltFlow indexers (Fig, 4) which will evaluate rheological properties of examined materials.

**Fig. 4.** Thermo Scientific HAAKE MeltFlow indexer.

**Fig. 5.** DEMAG EXTRA 120-430.

Thermo Scientific HAAKE MeltFlow indexers are ideal for injection molding companies to be used for incoming or outgoing quality control of polymers. Figure 4 shows indexer which will be used for determination of rheological properties of selected materials.
For production of examined samples it will be used injection molding machine DEMAG EXTRA 120-430 showed on Fig. 5.

2. Detection of number of regranulates impact on physical-chemical properties of thermoplastic products in action of different climatic conditions of environment.

In this step it will be measuring physical-mechanical properties of examined materials in dependency of additional quantity of regranulates in neat material and in dependency of change of climatic conditions. Simulated change of climatic conditions will be made by climatic furnace Vötsch which is showed on Fig. 6.

**Fig. 6.** Climatic furnace Vötsch.

3. Detection of number of regranulates impact on physical-mechanical properties of thermoplastic products in action of different climatic conditions of environment.

In this step it will be measuring physical-mechanical properties especially tests for tension and pressure. Graphical principle of these tests is showed on Fig. 7.

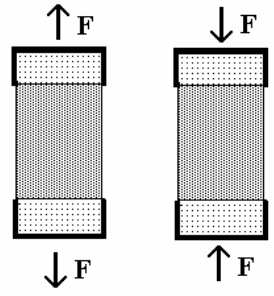


**Fig. 7.** Graphical principle of tests.

4. Quantification of regranulate in neat material by provision of optimal qualitative parameters of thermoplastic products designed for automobile industry.

## 5. CONCLUSIONS

Suspected asset of applied research on the part of production practise is development of methods of convenient regranulate ratio in thermoplastic products with preservation of qualitative products parameters. From economic aspect is expected asset in decreasing of costs on preparing of products by using of regranulate. From social aspect is asset in utilisation in part of input recycled plastic materials in thermoplastics production. Judged project by its access to the plastic injection moulding problem is original with focusing on support of production practise from ecological and economical aspect. It is in keeping with tendency of Slovakia in expansion of automobile industry.

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