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PP FIBERS SPUN WITH THE ADDITION OF PARAFFIN OIL

PP VLAKNA IZDELANA Z DODATKOM PARAFINSKEGA OLJA

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In the present study paraffin oil (10% of mass) was used as an additive in the spinning of polypropylene filament yarns on a laboratory spin-draw device. The oil was added to the polymer in the feeding zone of the extruder prior melting of the polymer. The PP filament yarns and the filament yarns to which the oil was added were spun at three different temperatures. The objective of the study was to investigate the influence of the addition of paraffin oil on the spinning process and on the properties of produced filament yarns.

Key words: polypropylene, additives, paraffin oil, melt spinning

V pričujoči raziskavi je bilo, kot dodatek pri izdelavi PP vlaken na laboratorijski predilno - raztezalni napravi, uporabljeno parafinsko olje v 10% masnem deležu. Parafinsko olje je bilo dodano pred vstopom polimera v polnilno cono ekstruderja. PP vlakna, izdelana z in brez dodatka olja, so bila oblikovana pri treh različnih temperaturah. Namen raziskave je bil raziskati vpliv dodatka parafinskega olja na predilni proces ter na tekstilne in mehanske lastnosti izdelanih PP vlaken.

Ključne besede: polipropilen, dodatki, parafinsko olje, predenje iz taline

1 INTRODUCTION

At present, polypropylene continues to penetrate new markets at the expense of other polymers. For this reason, higher productivity with lesser breakdowns in polypropylene fiber industry is required. Higher productivity and effectiveness of the polypropylene melt spinning process can be achieved also by the addition of different additives into the polymer. In the present study, paraffin oil was used as an additive in the spinning of polypropylene filament yarns on a laboratory spin-draw device[1]. The addition of paraffin oil, which at small concentrations and at higher temperatures acts as a plasticizer for polypropylene, could eliminate melt fracture or sharkskin effect, increase the throughput and lower the processing temperatures. The objective of the study was to investigate the influence of the addition of paraffin oil to the polypropylene polymer on the spinning process and the influence of spinning temperature on the textile and mechanical properties of the produced filament yarns.

2 EXPERIMENTAL

PP yarns were spun from commercial Hoechst Hostalen PPN polypropylene homopolymer, i.e. a low melt-flow rate polymer (MFI = 2g/10 min). The melt spinning of yarns was carried out on an Extrusion Systems Ltd. laboratory spin-draw device. The paraffin oil (10% of mass) was added to the polymer in the feeding zone of the extruder prior the melting of the polymer. The yarns were wound and subsequently additionally drawn at 100°C with a draw ratio of 3 and a limiting draw ratio of 3,4 on a Zimmer draw device. The designation of samples and spinning conditions is presented in **Tables 1 and 2**.

The textile mechanical properties, i.e. linear density, breaking force and breaking extension, elasticity modulus, as well as structural and thermal properties of filament yarns, i.e. orientation and melting temperature, were analysed.

Table 1: Designation of samples
Tabela 1: Oznaka vzorcev

As spun samples	PP1	PP2	PP3	PP4
Draw ratio 3	PP 1/3	PP 2/3	PP 3/3	PP4/3
Limiting draw ratio 3,4	P 1/3,4	PP 2/3,4	PP 3/3,4	PP 4/3,4

Table 2: Spinning conditions
Tabela 2: Pogoji predenja

		PP1	PP2	PP3	PP4
Adition of paraffin oil	(%)	/	10	10	10
Extruder temperature					
	zone 1	0°C	200°C	200°C	200°C
	zone 2	200°C	200°C	200°C	200°C
	zone 3	220°C	220°C	220°C	220°C
Gear pump temperature		235°C	235°C	225°C	180°C
Spin pack temperature	zone 1	250°C	250°C	242,5°C	235°C
	zone 2	250°C	250°C	242,5°C	235°C
Quench chamber temperature	(°C)	6°C	6°C	6°C	6°C
Winding speed	(m/min)	437	437	437	437

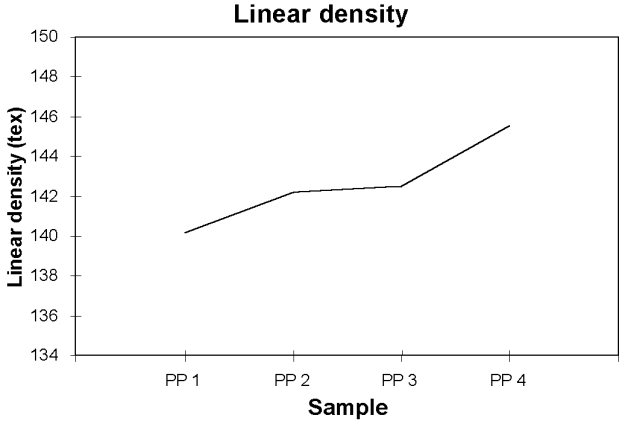

Figure 1: Linear density of samples
Slika 1: Dolžinska masa vzorcev

3 RESULTS AND DISCUSSION

The results of textile mechanical analyses (linear density, breaking force and breaking extension, specific stress and elasticity modulus), melting temperatures and orientation factor calculated from the birefringence of samples are presented in **Table 3**.

As can be seen from the results, the linear density of the as spun samples with added paraffin oil increases with decreasing spinning temperature, which can be a consequence of increasing pressure in the spinning head **(Figure 1)**. The linear density of sample PP 2, to which the paraffin oil was added, is higher when compared to the sample PP 1, which was spun at the same spinning conditions as PP 2, only without the addition of paraffin oil.

The breaking extension of as spun and drawn samples with added paraffin oil is higher compared to pure samples. Higher breaking extension is a consequence of the plasticizing activity of paraffin oil. This proves that, theoretically, with the addition of paraffin oil higher draw ratios can be achieved.

Samples with added paraffin oil have lower values of tenacity **(Figure 2)**, elasticity modulus **(Figure 3)** and orientation factor compared to pure samples. The values of these properties of samples with added paraffin oil increase with lowering the spinning temperature and are comparable to pure samples when spun at the lowest temperature.

Table 3: Textile mechanical properties (linear density, breaking force and breaking extension, tenacity and elasticity modulus), melting temperatures and orientation factor calculated from the birefringence of samples
Tabela 3: Tekstilno mehanske lastnosti (dolžinska masa, pretržna sila, pretržni raztezek, pretržna napetost in modul elastičnosti), temperatura taljenja in faktor orientacije izračunan iz dvolomnosti

sample	linear density (tex)	breaking force (N)	breaking extension (%)	tenacity (cN/dtex)	elasticity modulus (GPa)	melting point (°C)	orientation (/)
PP1	140,20	295,80	326,60	2,11	0,46	167,04	0,55
PP2	142,23	239,20	371,10	1,68	0,36	163,57	0,40
PP3	142,50	270,60	362,40	1,90	0,43	165,44	0,48
PP4	145,50	283,30	367,40	1,95	0,46	164,70	0,51
PP1/3	55,93	305,10	49,00	5,46	3,44	166,02	0,96
PP2/3	54,97	237,60	53,80	4,33	2,44	160,03	0,77
PP3/3	53,00	268,80	54,17	5,07	2,96	161,23	0,83
PP4/3	55,07	278,70	52,93	5,06	3,60	161,15	0,84
PP1/3,4	46,07	314,20	30,24	6,82	4,80	165,45	0,80
PP2/3,4	50,07	232,90	37,83	4,65	2,88	159,48	0,83
PP3/3,4	49,07	275,10	40,13	5,61	3,46	161,48	0,90
PP4/3,4	49,50	288,60	30,17	5,83	4,52	160,65	0,86

4 CONCLUSIONS

It was expected that with the addition of paraffin oil into the polypropylene polymer the viscosity of polymer would decrease, the mass flow would be higher and therefore PP filament yarns could be drawn to higher draw ratios. It was also expected that, with the addition of paraffin oil, PP filament yarns could be spun at lower temperatures compared to samples spun from pure polymer.

The research clearly showed that, with the addition of paraffin oil, PP filament yarns could be spun at lower

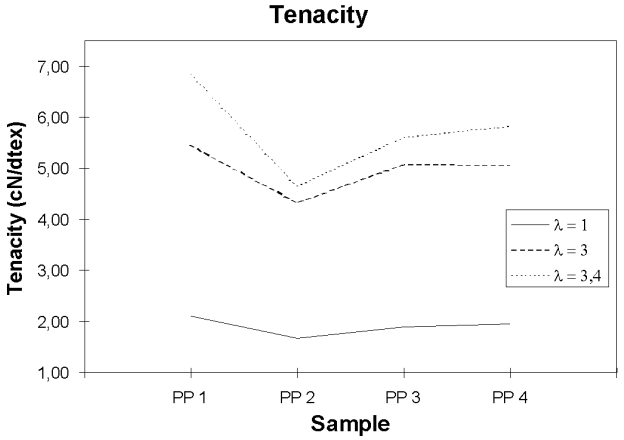

Figure 2: Tenacity of samples
Slika 2: Pretržna napetost vzorcev

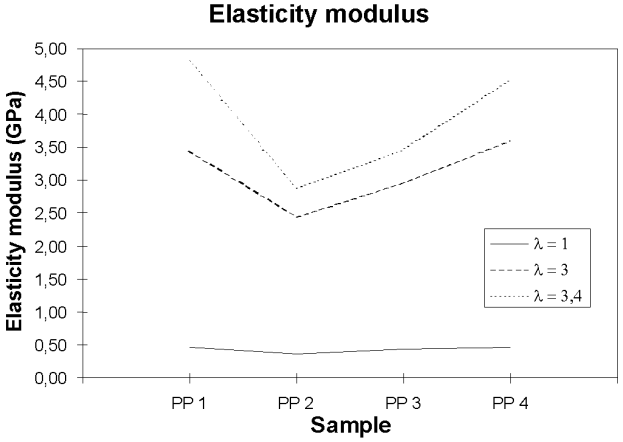

Figure 3: Elasticity modulus of samples
Slika 3: Modul elastičnosti vzorcev

temperatures without melt fracture or sharkskin effect. The textile mechanical properties, such as linear density, breaking force, tenacity, elasticity modulus and orientation factor of samples with added paraffin oil, increase with the lowering of the spinning temperature. It was also shown that it is not possible, at the applied drawing conditions, to draw samples with added paraffin oil to considerably higher draw ratios compared to samples without added paraffin oil.

The presented results of the influence of paraffin oil addition to polypropylene filament yarns are the initial findings of the study. Future work might provide the basis for a widespread use of paraffin oil in the polypropylene industry.

5 REFERENCES

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