Pyrolytic Carbon Black as Alternative Filler in Rubber Compounds for Rubber Cover of Conveyor Belts

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This work deals with the possibility of replacing the commonly used commercial carbon black filler type N550 with an alternative carbon-based filler resulting from the pyrolysis treatment of waste from the rubber industry in applications for conveyor belts rubber cover grade L. In the prepared compounds, the content of the carbon black filler type N550 was gradually replaced with an alternative carbon-based filler in volumes of 25%, 50%, 75% and 100%. Rubber cover grade L of conveyor belts must meet the minimum prescribed requirements (tensile strength, elongation at break, abrasion loss) even after thermo-oxidative aging of the compounds (168 h, 70 °C) according to ISO 10247. The research results indicate that the alternative carbon-based filler can be used as a complete replacement for carbon black type N550 in terms of tensile strength and elongation at break values, but in terms of abrasion loss when using the basic recipe (without modification) only up to a content of 50%.

Tab. 1 Designation and composition of prepared compounds

Ingredients (phr)	Blend designation				
	DP_1	DP_2	DP_3	DP_4	DP_5
NR	60	60	60	60	60
SBR	40	40	40	40	40
ZnO	2	2	2	2	2
Stearic acid	1.3	1.3	1.3	1.3	1.3
Plasticizer	1	1	1	1	1
CB N550	**40**	**30**	**20**	**10**	**0**
TBBS	1.5	1.5	1.5	1.5	1.5
Sulphur	2	2	2	2	2
AFC	**0**	**10**	**20**	**30**	**40**
Antioxidant	0.5	0.5	0.5	0.5	0.5

Minimum requirements for mechanical properties according to ISO 22721 for the conveyor belts cover layer of class L :

- Tensile strength of at least **15 MPa**
- Elongation at break of the compound must be **higher than 350%**
- Loss of sample volume due to abrasion (abrasion loss) of **maximum 200 mm³**
- Maximum change in tensile properties after thermo-oxidative aging (70°C/168h) **25%**

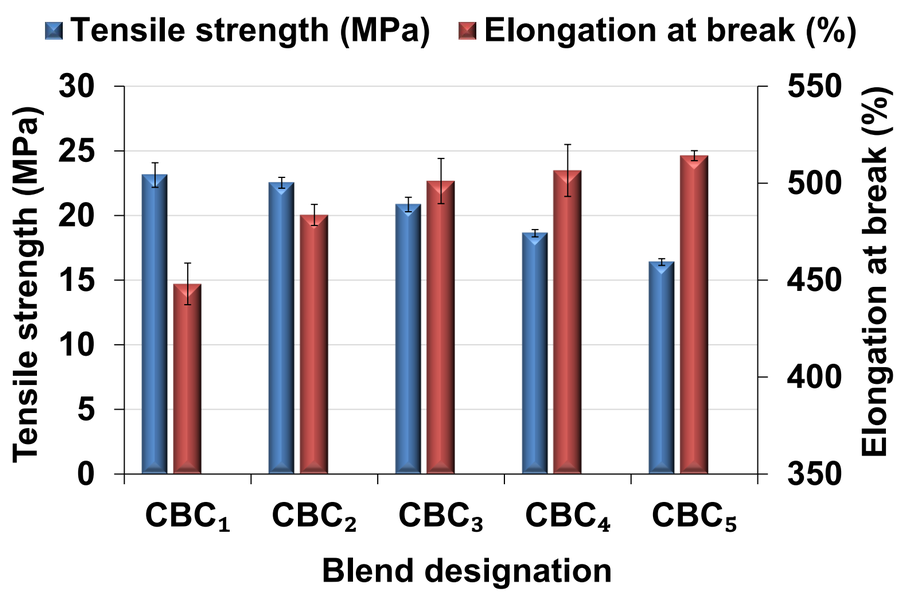

Fig. 1 Tensile properties of prepared compounds

- All prepared compounds meet the requirements of ISO 22721 despite the reduction in tensile strength
- Replacing N550 with AFC reduces tensile strength due to the lower number of particles per unit volume and the lower reinforcing effect of the filler
- Elongation at break increases with higher AFC content in the compounds
- The effect of AFC on elongation at break is due to the lower restriction of matrix chain mobility

- Up to 50% replacement of the commonly used N550 filler with the alternative AFC filler, the compounds meet the requirements of industrial application
- After exceeding the 50% AFC filler limit (CBC_4, CBC_5), the abrasion loss value increases above the maximum possible limit

All prepared compounds met the condition for tensile properties after thermo-oxidative aging and achieved a lower percentage change than 25%.

Tab. 2 Percentage change in tensile properties after thermo-oxidative aging

Properties	Blend designation				
	CBC_1	CBC_2	CBC_3	CBC_4	CBC_5
Change in tensile strength value (%)	1.69	7.72	5.08	2.25	2.26
Change in elongation at break value (%)	12.93	18.08	13.91	11.57	9.40

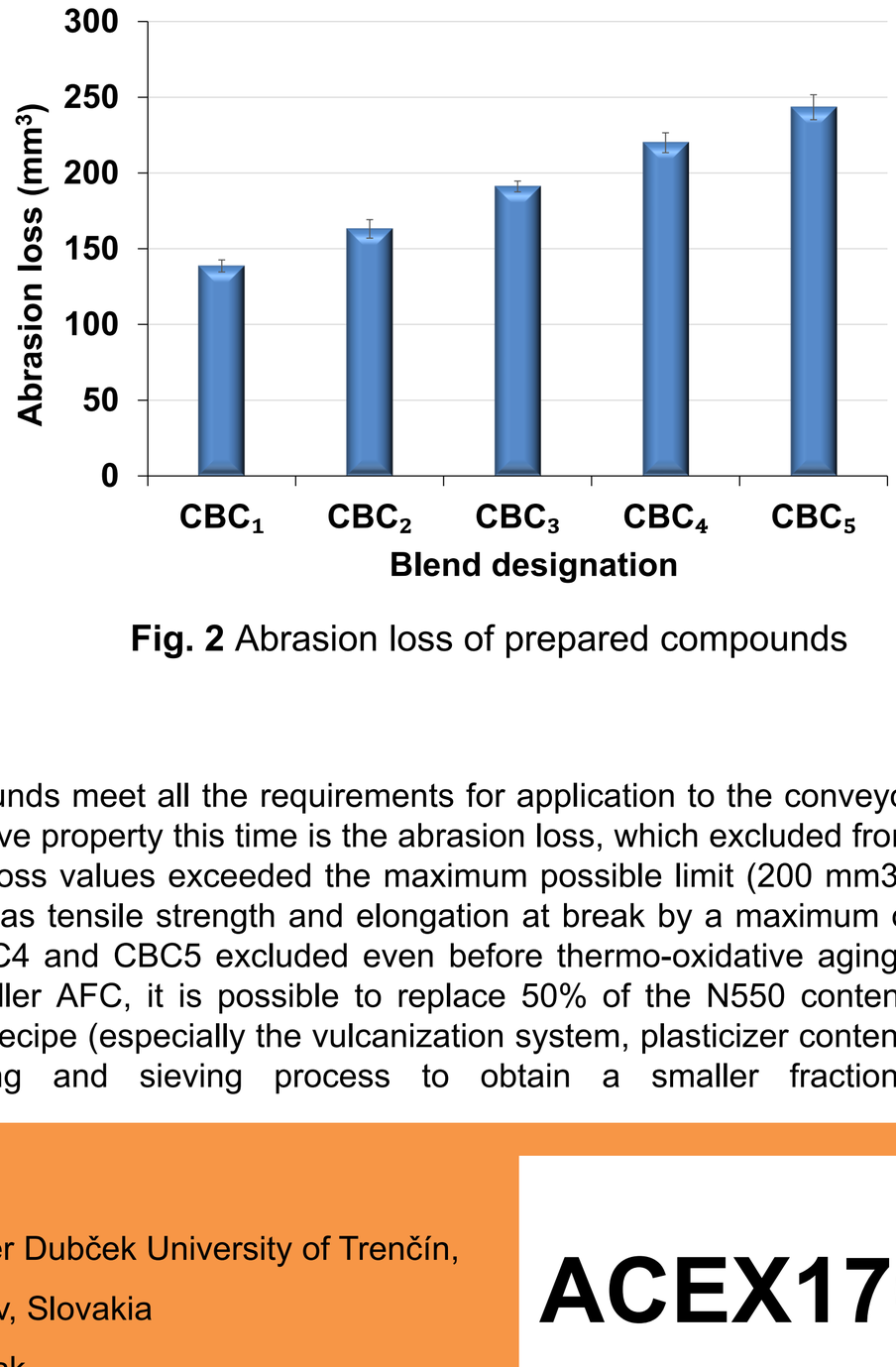

Fig. 2 Abrasion loss of prepared compounds

-Conclusion-

By summarizing the determined properties, it can be concluded that the prepared compounds meet all the requirements for application to the conveyor belts cover layer of class L in terms of tensile strength and elongation at break. The decisive property this time is the abrasion loss, which excluded from the possibility of application two compounds, namely CBC4 and CBC5, whose abrasion loss values exceeded the maximum possible limit (200 mm3). After thermo-oxidative aging and the condition of changing the values of properties such as tensile strength and elongation at break by a maximum of 25% from the originally determined, all prepared compounds met the requirements (CBC4 and CBC5 excluded even before thermo-oxidative aging). Despite the unsuccessful complete replacement of the N550 filler with the alternative filler AFC, it is possible to replace 50% of the N550 content. Complete replacement of the N550 content will be possible after adjusting the compound recipe (especially the vulcanization system, plasticizer content) as well as by reducing the particle size of the AFC filler (using a grinding and sieving process to obtain a smaller fraction).

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