EXPERIMENTS FOR FABRICATION NETWORKS OF POLYMER MATRIX COMPOSITE MATERIALS AND PARTICLES FOR THE CABLE TEARING MACHINES’ ROLLS

Dumitru Dima, Olga Mitoşeriu

University “Dunărea de Jos”of Galaţi, Romania
dimadumitru@yahoo.com

ABSTRACT

The aim of this paper was the creating of a composite material which resists under the hard working conditions for the cable tearing machines’ cylinders, the efforts sustained by the composite material that covers the cylinders being mechano-thermal as well as chemical.

There have been experiments for very large production lots – of 100 rolls for every recipe – having as a base a polymer matrix, in two variants, and carbon particles of different concentrations. The interpretation of the experimental results was made by applying mathematical statistics, having as result an optimal, regarding the matrix, but most of all the concentration of carbon particles.

KEYWORDS: polymer matrix composites, polyurethanes, mechanical properties, carbon particles.

1. FABRICATION NETWORKS AND PARAMETERS, STUDIED FOR EXPLOITING CYLINDERS COATED WITH COMPOSITE

The program started from the urgent need, in the production field, for rolls covered in polymer rubber, for the other materials, such as the butadienstyrenic rubber, the butadiennytrilic rubber, the polyamide 6, etc., didn’t offer any good results when exploited.

This is why there has been established an interpretation of the results program for the working with the machine of different fabrication networks, a personal technology, statistically, that is in very large production lots, of 100 rolls, covered in composite material with polymer matrix and particles.

The pursuit, in production, of these lots, regarding the endurance (the actual hours of exploitation of the machine) has been co-related with different properties that give information on the physical parameters of the composite material. For example: the medium number of the cable wrappings around the cylinder gives information on the electrostatic charge of the supporting material.

This is essential in production because it causes dysfunctions in the working with the machine, and not switching it off at the right time leads, implicitly, to the destruction of the mark covered in composite material.

The introduction of sub-micronical carbon particles has had, as target, the improvement of the mechano-thermal properties, as well as those electrostatic of the composite material’s matrix.

It has been observed, at the same time, a better adherence of the covering material for the metal cylinders and a smaller number of rejections towards the non-additivated material.

The fabrication networks and the experimental results of the marks made up of composite materials with particles are shown in Table 1.

2. THE STATISTICAL PROCESSING OF EXPERIMENTAL DATA

To extend characterizing the functioning of cylinders covered in composite material with polymer matrix and carbon particles, it has been chosen as criteria the quality of the cylinders (%). The quality of the cylinders offers an optimal for the working with the machine, a sequence and it was calculated to be the percentage of cylinders which overcome the continuous functioning time of 72 hours.

There have been drawn the histograms: quality of the cylinders (%) – (%) carbon, using two types of codified polymer matrices, R and V. (R – type Romlan, made by CFS Sâvineşti, and V – type Vulkolan, made in Germany), in figures 1-8.
Table 1. Experimental results of marks made up of composite materials with particles (carbon) with polymer matrix used for cable tearing machines:

<table>
<thead>
<tr>
<th>No.</th>
<th>Fabrication recipe</th>
<th>No. of samples manufactured</th>
<th>No. of samples rejected</th>
<th>No. of samples that equip machines</th>
<th>Temperature of the cylinder while working with the machine (°C)</th>
<th>Hardness of the cylinder while working (Shore A)</th>
<th>Endurance (no. of samples with the time of working with the machine)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEYDEL</td>
<td>TEMATEX</td>
<td>SEYDEL</td>
</tr>
<tr>
<td>1.</td>
<td>R30-2.38-0.4-1.94/0</td>
<td>100</td>
<td>5</td>
<td>85</td>
<td>10</td>
<td>20</td>
<td>70</td>
</tr>
<tr>
<td>2.</td>
<td>R30-2.38-0.4-1.94/0.5</td>
<td>100</td>
<td>5</td>
<td>85</td>
<td>10</td>
<td>20</td>
<td>65</td>
</tr>
<tr>
<td>3.</td>
<td>R30-2.38-0.4-1.94/1.0</td>
<td>100</td>
<td>4</td>
<td>86</td>
<td>11</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>4.</td>
<td>R30-2.38-0.4-1.94/2.0</td>
<td>100</td>
<td>1</td>
<td>90</td>
<td>9</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>5.</td>
<td>V25-5/0</td>
<td>100</td>
<td>2</td>
<td>90</td>
<td>8</td>
<td>20</td>
<td>70</td>
</tr>
<tr>
<td>6.</td>
<td>V25-5/0.5</td>
<td>100</td>
<td>-</td>
<td>90</td>
<td>10</td>
<td>20</td>
<td>65</td>
</tr>
<tr>
<td>7.</td>
<td>V25-5/1.0</td>
<td>100</td>
<td>-</td>
<td>90</td>
<td>10</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>8.</td>
<td>V25-5/2.0</td>
<td>100</td>
<td>1</td>
<td>90</td>
<td>9</td>
<td>20</td>
<td>58</td>
</tr>
<tr>
<td>9.</td>
<td>R30-2.38-0.4-1.94/0</td>
<td>100</td>
<td>5</td>
<td>85</td>
<td>10</td>
<td>30</td>
<td>76</td>
</tr>
<tr>
<td>10.</td>
<td>R30-2.38-0.4-1.94/0.5</td>
<td>100</td>
<td>4</td>
<td>85</td>
<td>11</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>11.</td>
<td>R30-2.38-0.4-1.94/1.0</td>
<td>100</td>
<td>5</td>
<td>85</td>
<td>10</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>12.</td>
<td>R30-2.38-0.4-1.94/2.0</td>
<td>100</td>
<td>3</td>
<td>90</td>
<td>7</td>
<td>30</td>
<td>68</td>
</tr>
<tr>
<td>13.</td>
<td>V25-5/0</td>
<td>100</td>
<td>3</td>
<td>90</td>
<td>7</td>
<td>30</td>
<td>75</td>
</tr>
<tr>
<td>14.</td>
<td>V25-5/0.5</td>
<td>100</td>
<td>2</td>
<td>90</td>
<td>8</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>15.</td>
<td>V25-5/1.0</td>
<td>100</td>
<td>2</td>
<td>90</td>
<td>8</td>
<td>30</td>
<td>65</td>
</tr>
<tr>
<td>16.</td>
<td>V25-5/2.0</td>
<td>100</td>
<td>2</td>
<td>90</td>
<td>8</td>
<td>30</td>
<td>62</td>
</tr>
</tbody>
</table>
Fig. 1 Quality percentage of cylinders covered in composite material with matrix type R-30-2.38-0.4-1.94 with different content of carbon, used for the Sydell type of tearing cable machine, in winter system (20°C). The interpolation function of the quality percentage, statistically determined, is:
\[ f_{1\omega} = -48.2 x^3 + 127.5 x^2 - 37.7 x + 23.5 \]

Fig. 2 Quality percentage of cylinders covered in composite material with matrix type V-25-5 with different content of carbon, used for the Sydell type of tearing cable machine, in winter system (20°C). The interpolation function of the quality percentage, statistically determined, is:
\[ f_{2\omega} = -35.1 x^3 + 85.85 x^2 - 23 x + 38.8 \]

Fig. 3 Quality percentage of cylinders covered in composite material with matrix type R-30-2.38-0.4-1.94 with different content of carbon, used for the Tematex type of tearing cable machine, in winter system (20°C). The interpolation function of the quality percentage, statistically determined, is:
\[ f_{3\omega} = -50 x^3 + 115 x^2 - 25 x + 60 \]

Fig. 4 Quality percentage of cylinders covered in composite material with matrix type V-25-5 with different content of carbon, used for the Tematex type of tearing cable machine, in winter system (20°C). The interpolation function of the quality percentage, statistically determined, is:
\[ f_{4\omega} = -50 x^3 + 120x^2 - 32.5 x + 62.5 \]

Fig. 5 Quality percentage of cylinders covered in composite material with matrix type R-30-2.38-0.4-1.94 with different content of carbon, used for the Sydell type of tearing cable machine, in summer system (30°C). The interpolation function of the quality percentage, statistically determined:
\[ f_{5\omega} = -17.75 x^3 + 31.35 x^2 + 21.7x + 17.64 \]

Fig. 6 Quality percentage of cylinders covered in composite material with matrix type V-25-5 with different content of carbon, used for the Sydell type of tearing cable machine in summer system (30°C). The interpolation function of the quality percentage, statistically determined:
\[ f_{6\omega} = -53.4 x^3 + 137.9 x^2 - 44.5 x + 22.2 \]
Fig. 7 Quality percentage of cylinders covered in composite material with matrix type R-30-2.38-0.4-1.94 with different content of carbon, used for the Tematex type of tearing cable machine, in summer system (30°C). The interpolation function of the quality percentage, statistically determined:

\[ f_7(x) = 53.6 x^3 - 155 x^2 + 111.3 x + 40 \]

Fig. 8 Quality percentage of cylinders covered in composite material with matrix type V-25-5 with different content of carbon, used for the Tematex type of tearing cable machine, in summer system (30°C).

The interpolation function of the quality percentage, statistically determined:

\[ f_8(x) = -26.2 x^3 + 49.9 x^2 + 21 x + 42.8 \]

4. THE INTERPRETATION OF THE RESULTS

The histograms in figures 1-8 show the evolution in working with the machine of the cylinders covered in composite material with polymer matrices (R and V) with different concentrations for the additive carbon particles (0; 0.5; 1.0; 2.0) during two different temperature systems (winter 20°C and summer 30°C), in quality percentage (% cylinders which overcome 72 hours of functioning).

There have been two prime objectives:

- the determination of annual medium value for the quality percentage in annual prognosis according to the type of machine (S, T) and the composite matrix (R and V).

- the determination of the annual optimal network.

The functions \( f_1(x) \) – \( f_8(x) \) from Figures 1-8 have been remade into the following annual medium functions of the quality percentage of machine – matrix:

- \( S-R: f_9(x) = -32.9x^4 + 79.4x^2 - 8x + 20.6 \)
- \( S-V: f_{10}(x) = -44.2x^4 + 111.8x^2 - 35x + 30.5 \)
- \( T-R: f_{11}(x) = 1.8x^3 - 10x^2 + 48.1x + 50 \)
- \( T-V: f_{12}(x) = -38.1x^3 + 85.5x^2 - 5.6x + 52.6 \)

The values of the annual medium functions of quality percentage were calculated:

- Matrix type R:
  \[ f_{13}(x) = -15.5x^3 + 29.7x^2 + 17.5x + 35.3 \]

- Matrix type V:
  \[ f_{14}(x) = -41.15x^3 + 98.4x^2 - 10.3 + 41.5 \]

and in the end there was computed the global value for the function of percentage of quality, no matter the matrix used:

\[ f_{15}(x) = -28.3x^3 + 64x^2 - 1.4x + 38.4 \]

From this function, remaking it mathematically, it results an optimal concentration of carbon of 1.42% in the matrix of the composite material.

This type of recipe was used in the serial production, emphasizing an improved behavior in the technology of obtaining the cylinders covered in composite material, as well as in exploitation.

5. CONCLUSIONS

Comparing the working with the two types of machines (S and T), in figures 1-8 can be seen that the quality percentage is clearly in favor of the cylinders on the T type machine. The explanation is that these are machines from a more recent generation, with a better cooling of the metal support, which leads to a winter system temperature of the cylinder’s surface of about 35°C, compared to the type S machines which presents a medium temperature of 65°C.

This is the reason why these machines can be considered as a dynamic loading system of these composite materials with particles, offering the freedom of choice, under such conditions, for optimal recipes.

This especially refers to the dynamic efforts of shear, confusion, resistance to temperature and, most of all, the adherence at a metal or any other kind of support.
REFERENCES
