The Study of the Physical Characteristics of Poplar’s Wood-polymer Multi Composite

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Abstract—The aim of this research was to provide Poplar’s Wood-polymer Multi Composite in order to improve its physical characteristics and its practical use in industry. In order to reach such a goal, a sample test is done with Monomer Styrene with the method of filled cell saturation and then heating in the iron machine to be polymerized. After providing Poplar’s Wood-polymer Multi Composite, the physical characteristics of Poplar wood (such as porosity, special mass, contraction and expansion) were analyzed. The results taken from one-way variance show that the changes mostly were not significant. In temperature changes, only the percentage of polymer establishment was significant and in time changes no percentage was significant. In the analysis of factorial variance, the dependent effect of temperature and time, the only significant one was percentage of polymer establishment. Moreover, because of the mutual effect of time and temperature, only the percentage of polymer establishment was significant and other characteristics were not significant.

Index Terms—poplar, physical characteristics, styrene, wood-polymer

I. INTRODUCTION

Poplar is a kind of tree which grows in semi hot regions very good and is mostly interested in clay that has enough water. It is considered as a rapid growth plant. Because of the rapid productivity of this plant, farmers are eager to plant it in their field and gardens [1]. Moreover, because of the reason that in west of Iran, there is a good condition for this plant, it has been planted a lot in a way that the area under plantation of poplar is about 120000 hectares in the whole country and about 3500 hectares in Lorestan Province. In Borujerd, this number is about 500 hectares for the Department of Natural Resources and for the ordinary people is about 1000 hectares. This capacity of wood is mostly used in box making.

Wood-polymer multi composite is made by the saturation with monomers of vine like Styrene and Metile Meta. After these monomers enter into the wood and some procedures such as (Gamma Ray or Heat), they become polymerized and then tough and hard [2], [3].

Wood-polymer multi composite was known approximately in 1960 and by means of many researches; many new chemical materials such as vinili monomers were used to fill the porosity and its polarization. The first research in this field was done by Karpove and Henja independently [4].

Composite is a kind of material that at least is made of two different parts. The parts of composite in terms of their shape, chemical mixture, and characteristics are different from each other. On the whole, the characteristics of composite are better than the characteristics of parts. Sometimes, these two parts are called as phases: non-constant phase or supporter, and constant phase or matrix. The role of matrix: it is to transform power to supporter, resistance against heat, and resistance against chemical material. Role of supporter: it is to increase the quality oriented physical and mechanical characteristics [5], [6]. In this study, therefore, wood is as the matrix and Styrene polymer is as supporter.

II. MATERIAL AND METHOD

In order to do this research, the researchers used a skinned poplar with the height of 2.20 meters and the diagonal of 35 centimetres from Borujerd area. Then the horizontal slices of about 3 cm were cut in order to analyse the characteristics mentioned above. After cutting, the slices that were near the core were omitted and the rest of the slices were waxed by melted paraffin in order to avoid evaporation of water and fraction. The humidity of the slices (lumbers) was 80 percent. Then they have been categorized and placed into a good place with air conditioner in order to reduce the percent of humidity. After 45 day when the slices were dry, the humidity was 10 percent and they were ready for the test.

The level of saturation is performed with Monomer Styrene of Tabriz Refinery. For such a reason, the samples are placed into special pots and the doors of the cylinders were tightly closed. Then, we used vacuum pomp and opened its bottom lid until the air pressure within the cylinder reached to be 0.5 times. After half an hour and the act of vacuuming on samples, the lid...
between two cylinders was opened until the monomer covered the surface of the wood samples. After the upper cylinder was completely emptied and the samples were soaked, we closed the lid and open the pressure pomp until the pressure meter showed the number pressure of 2 and then we closed the lid. The samples by the size of 2*2*2 were chosen and weighted. Then three temperatures of 140, 150, and 160 degrees of centigrade and three times of 5, 6, and 7 minutes were chosen for the level of heating [7], [8], [9].

Moreover, regarding the determination of time effect, there are not significant effects while only for the characteristics, the percentage of polymer establishment was significant and for the other characteristics (the characteristics of monomer absorbance, dry especial mass, critical especial mass, porosity, contraction and expansion) was not significant in the level of 5 percent. The comparisons between the means regarding time variable (5, 6, and 7 hours) are not significant for all the characteristics.

### TABLE I. ONE-WAY VARIANCE ANALYSIS OF SAMPLE, TEMPERATURE AND TIME

<table>
<thead>
<tr>
<th></th>
<th>Monomer Absorbance</th>
<th>Polymer Establishment</th>
<th>Dry Mass</th>
<th>Critical Mass</th>
<th>Porosity</th>
<th>Contraction</th>
<th>Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperature</strong></td>
<td>n.s</td>
<td>*</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
</tr>
</tbody>
</table>

According to Table I, for the difference between the characteristics of monomer absorbance, dry especial mass, critical especial mass, and the percentage of porosity, there are not significant effects while only for the establishment of polymer there are significantly in the level of 5 percent. Regarding the temperature changes for the characteristics, the percentage of polymer establishment was significant and for the other characteristics (the characteristics of monomer absorbance, dry especial mass, critical especial mass, porosity, contraction and expansion) was not significant in the level of 5 percent. The comparisons between the means regarding time variable (5, 6, and 7 hours) are not significant for all the characteristics.

The comparison between the characteristics from the analysis of one way variance and Duncan test showed that only the percentage of polymer establishment was significant and could be placed in three groups in a way that in the first group (140°C), second group (150°C), and third group (160°C), there was no significant difference (Table I). Moreover, in Table II, we can see the mean, peak and least amount of t-test.

### TABLE II. THE MEAN, PEAK AND LEAST OF CHARACTERISTICS, THE FACTORIAL VARIANCE ANALYSIS BETWEEN THE MAIN AND ALTERNATIVE EFFECTS OF SAMPLES, TEMPERATURE AND TIME

<table>
<thead>
<tr>
<th></th>
<th>Monomer Absorbance</th>
<th>Polymer establishment</th>
<th>Dry mass</th>
<th>Critical mass</th>
<th>Porosity</th>
<th>Contraction</th>
<th>Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>155.01</td>
<td>118.51</td>
<td>0.44</td>
<td>0.39</td>
<td>46.46</td>
<td>10.60</td>
<td>12.08</td>
</tr>
<tr>
<td><strong>Peak</strong></td>
<td>160.72</td>
<td>126.31</td>
<td>0.46</td>
<td>0.40</td>
<td>47.68</td>
<td>11.67</td>
<td>13.43</td>
</tr>
<tr>
<td><strong>least</strong></td>
<td>149.31</td>
<td>110.71</td>
<td>0.43</td>
<td>0.38</td>
<td>45.24</td>
<td>9.52</td>
<td>10.73</td>
</tr>
</tbody>
</table>

According to Table III, the multi-side variance analysis in the determination of independent effect of temperature is significant in the level of 5 percent for the establishment of polymer and for the other characteristics, it is not significant. It is also observable between the temperature of 140 degree (88.65) and 160 degree (148.94). Moreover, among the levels of polymer establishment there is no significant effect. Regarding the determination of independent effect of samples, the percentage of monomer absorbance, dry mass, critical mass, and porosity have significant effects. The least amount of monomer establishment is for the second sample (145.35) and the peak amount is for the fourth sample (169.49). It is not significant in the first level and not significant in the second level. For dry mass it is the least amount in the first sample (0.47) and the peak in the second sample (0.53). Among the levels, the first level was not significant and the second level was significant. Regarding critical mass, the least amount was in the fourth sample (0.42) and the peak amount was in the second sample (0.46). The first level was not significant and the second level was significant. For the porosity, the least amount was in the first sample (44.32) and the peak amount was in the second sample (49.65). Therefore, the first level was not significant and the second level was significant. Nevertheless, the characteristics of polymer establishment, contraction and expansion have no significant effect.

Moreover, regarding the determination of time effect, all the characteristics were significant in the level of 5 percent.

Regarding the independent effect of temperature for the characteristics that own significant differences, it should be noted that the percentage of polymer
establishment is in its least amount (88.65) by the temperature of 140 degrees and is in its peaks amount (148.05) by the temperature of 160 degrees. For the independent effect of time, no characteristic was significant.

According to Table IV, only the characteristic of polymer establishment was significant in the level of 5 percent and no other ones was significant. Moreover, regarding the mutual effect of time and samples, all the characteristics have non-significant effects.

**TABLE IV. MULTI-SIDE VARIANCE ANALYSIS FOR INTERACTIONS EFFECTS OF SAMPLES, TIME, AND TEMPERATURE**

<table>
<thead>
<tr>
<th></th>
<th>Monomer absorbance</th>
<th>Polymer establishment</th>
<th>Dry mass</th>
<th>Critical mass</th>
<th>Porosity</th>
<th>Contraction</th>
<th>Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature and time</td>
<td>n.s</td>
<td>*</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
</tr>
<tr>
<td>Temperature and sample</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
</tr>
<tr>
<td>Time and sample</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
<td>n.s</td>
</tr>
</tbody>
</table>

**Percentage of polymer establishment:** The changes in the percentage of polymer establishment for poplar wood and in two variables of temperature and time are in a way that when the temperature and time are increased, the percentage increases and this has a regular routine. These changes are significant for temperature and are not significant for time. In polymerization, when the temperature is increased, the polymerization also increases, and the more we have time, the more we have polymerization which is a subordinate of temperature [10], [3].

**The percentage of monomer absorbance:** The percentage of monomer absorbance in the wood is in a way that in different temperatures, with the increasing of temperature the absorbance percentage also increases and this routine is not significant. Moreover, for the time variable, we see a non-significant routine which is decreasing.

**Dry mass:** The changes in the dry mass are in a way that we see the increasing routine and this increasing is irregular about the temperature variable and it is regular for time variable. Nevertheless, this is not significant for both temperature and time variable.

The more we have polymer establishment, the more we have dry mass. This is because of the reason that dry mass is a subordinate of polymer establishment and can fulfill the empty space which is full of air and increase the wood dry mass.

**Critical mass:** The changes in the critical mass are in a way that we see the increasing routine and this increasing is irregular about the temperature variable and it is regular for time variable. Nevertheless, this is not significant for both temperature and time variable.

Critical mass is a subordinate of dry mass and peak capacity. Therefore, with the establishment of polymer, critical mass increases.

**Porosity:** The changes in the porosity are in a way that we see the increasing routine and this increasing is irregular about the temperature variable and it is regular for time variable. Because of the reason that porosity is a subordinate of critical mass, with the increasing of monomer absorbance the porosity also increases.

**Changes in dimension:** The changes for contraction and expansion in two variables of time and temperature are almost fixed and these changes are not significant.

On the whole, for all the subjects such as monomer absorbance, dry mass, critical mass, porosity, contraction, and expansion, the effects of temperature and time were not significant and they were only effective for polymer establishment. The reason may refer to the idea that for the start the reverse pressure and catalysis substance were not used. But in other researches, they used other factors [11], [12], [13]. Therefore, we can conclude that two factors of reverse pressure and catalysis are very important and influencing in the absorbance and establishment of polymer and consequently increase physical characteristics of wood.

**IV. SUGGESTION**

In other researches we can use additive materials for Monomer Styrene to improve its characteristics.

We can use different monomers for different types of woods.

We can test different characteristics of wood such as mechanical one.

**REFERENCES**


**Hooman Abbasi** studied B. Sc. of Forestry in Chalus Branch, Islamic Azad University, Chalus, IRAN and M. Sc. of Forestry in Chalus Branch, Islamic Azad University, Chalus, IRAN.

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