Evaluation of Waste Papers in Producing Newspaper

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Abstract:

Paper recycling is the process of turning waste paper into new paper products such as newspaper, corrugated boxes, tissue products and egg boxes. Thermomechanical pulp (TMP) and chemi-thermomechanical pulp (CTMP) were also used in the manufacture of newspaper, lightweight coated and sanitary papers. The aim of this study is to produce newspapers from waste papers. For this reason, waste papers were bleached in 3 stages which were oxygen, hydrogen peroxide and sodium dithionite bleaching. Optical and physical properties of bleached waste papers were determined and compared with CTMP newspaper. So that in an increase of brightness of bleached pulps with three-stage from 31.32 (%) to 50.14 % erelpho and in a decrease of yellowness from 34.89% to 33.50% erelpho. Brightness, yellowness and opacity of bleached waste papers’ pulps were found higher than those of unbleached waste papers’ pulps. Waste papers’ pulps bleached by hydrogen peroxide can be used in the production of newspapers.

Keywords: waste paper, bleaching, oxygen, sodium dithionide, hydrogen peroxide, recycle, newspaper

Introduction:

Bleaching is the treatment of cellulosic fiber with chemicals to increase brightness. Purpose of the bleaching process is to modify or remove the lignin, extractive contents, metal ions and coloring agents from pulp by using chemicals (Imamoğlu, 2012).

Mechanical pulp is used without bleaching or after one or two stage bleaching because of high yield and low cost mechanical pulp is used in the manufacture of cheap and short life papers and paper boards. The use of mechanical pulps brightness is insufficient and their color reversion is rapid. (Tutuş and Usta, 2004; Usta and Tutuş, 1999).

Thermomechanical pulp (TMP) and chemi-thermomechanical pulp (CTMP) are in large measure used in the manufacture of newspaper. (Gagne et al., 1988).

Oxygen exists as a ground state triplet state, which is relatively unreactive and needs free radicals or very electron-rich substrates such as deprotonated lignin phenolic groups. The production of these phenoxide groups requires that delignification with oxygen be carried out under very basic conditions (pH >12).(wikipedia) Oxygen delignification in the prebleaching stages decreases the kappa number prior to chlorination and therefore the effluent load (BOD, COD, colour, AOX, chlorinated phenolics and toxicity to fish) emanating from the bleach plants is reduced.(Bajpai, P. 2005)

Hydrogen peroxide is one of the most important bleaching chemicals. It is a strong oxidising agent, which has variety of different applications in all kinds of pulp produced in the pulp and paper industry. One of the biggest advantage of hydrogen peroxide is that it is environmentally friendly bleaching agent (USTA et al., 1999).

Hydrogen peroxide is a versatile and widely used oxidative bleaching agent in the pulp and paper industry. It decomposes to give water and oxygen only, so it is ideally suited to applications where the effect on the environment of effluents has to be minimal. (Bajpai, P. 2005). Hydrogen peroxide in alkaline extractions reduces the generation of chlorinated compounds and gives a number of quality improvements to the pulp and the bleach plant effluents (Walsh et al., 1991).

Material and Methods:

Waste papers used in this study were obtained from packaging papers, office papers and newspapers. Waste papers’ whiteness, brightness, yellowness, opacity, breaking
length, burst and tear index of the pulp were 41.23 ISO, 31.32 ISO, 34.89 E313, 99.42 ISO, 3009 meter, 1.65 kPa.m²/g, 1.74 mNm²/g, respectively.

In this study, waste papers are bleached in three levels. These are oxygen bleaching, peroxide bleaching and dithionite bleaching, respectively.

I. Oxygen Bleaching: Oxygen bleaching conditions of waste papers are given in Table 1.

<table>
<thead>
<tr>
<th>Bleaching Stage</th>
<th>Oxygen (Bar)</th>
<th>NaOH (%)</th>
<th>MgSO₄ (%)</th>
<th>Temperature (°C)</th>
<th>Time (minute)</th>
<th>Concentration (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Oxygen</td>
<td>6</td>
<td>3</td>
<td>0.5</td>
<td>100</td>
<td>60</td>
<td>10</td>
</tr>
</tbody>
</table>

II. Peroxide Bleaching: After oxygen bleaching, waste papers were bleached with peroxide. Peroxide is second bleaching sequence.

Table 2. Peroxide bleaching conditions of waste papers.

<table>
<thead>
<tr>
<th>Bleaching Stage</th>
<th>Peroxide (H₂O₂)(%)</th>
<th>NaOH (%)</th>
<th>Na₂SiO₃ (%)</th>
<th>MgSO₄ (%)</th>
<th>EDTA (%)</th>
<th>Temperature (°C)</th>
<th>Time (minute)</th>
<th>Concentration (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Peroxide</td>
<td>1</td>
<td>0.75</td>
<td>3</td>
<td>0.5</td>
<td>0.5</td>
<td>70</td>
<td>60</td>
<td>16</td>
</tr>
<tr>
<td>2 Peroxide</td>
<td>3</td>
<td>2.25</td>
<td>3</td>
<td>0.5</td>
<td>0.5</td>
<td>70</td>
<td>60</td>
<td>16</td>
</tr>
<tr>
<td>3 Peroxide</td>
<td>5</td>
<td>6.66</td>
<td>3</td>
<td>0.5</td>
<td>0.5</td>
<td>70</td>
<td>60</td>
<td>16</td>
</tr>
</tbody>
</table>

After being prepared bleaching liquors quantities shown Table 2, they were placed in polyethylene bags. Then, the mixtures were put in a circulation water bath and the temperature was controlled by a thermostat. At the end of bleaching the pulp was pressed up to 20-25% dryness. Later on, moisture content of pulps regulated to 20-25% and placed in polyethylene bags and moisture content was determined. Brightness, yellowness and opacity of the pulp were determined according to TAPPI test methods (Anonymous, 1992).

III. Dithionite Bleaching: Dithionite is the latest stage of bleaching. The conditions of dithionite bleaching are given in Table 3.

<table>
<thead>
<tr>
<th>Bleaching Stage</th>
<th>Dithionide (%)</th>
<th>MgSO₄ (%)</th>
<th>EDTA (%)</th>
<th>Temperature (°C)</th>
<th>Time (minute)</th>
<th>Concentration (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Dithionite</td>
<td>1</td>
<td>0.5</td>
<td>0.5</td>
<td>60</td>
<td>30</td>
<td>14</td>
</tr>
<tr>
<td>2 Dithionite</td>
<td>3</td>
<td>0.5</td>
<td>0.5</td>
<td>60</td>
<td>30</td>
<td>14</td>
</tr>
<tr>
<td>3 Dithionite</td>
<td>5</td>
<td>0.5</td>
<td>0.5</td>
<td>60</td>
<td>30</td>
<td>14</td>
</tr>
</tbody>
</table>

Handsheets of bleached pulps with grammage of 70 g/m² were prepared according to Tappi T 272 om-92 and made on a Rapid Kothen machine. Physical and optical properties of handsheets were measured according to Tappi Standart Test Methods given below.

- Tear Index: Elmendorf Tearing Tester (Anonymous, 1992)
- Burst Index: B.F. Perkins & Son, Mullen Tester (Anonymous, 1992)
- Brightness, Whiteness, Yellowness and Opacity: Datacolor Elrepho (Anonymous, 1997)

Result and Discussion:

7 bleaching trials were realised on the Three-Stage bleaching of waste papers’ pulps with H₂O₂,oxygen and dithionite. The results of the 7 trials were given in Table 4. Peroxide bleaching in three successive stages allows for higher brightness. For example while brightness was 40.06 with %1 peroxide, the same value was found to be 50.14 with %3 peroxide. The results of the bleaching of waste
papers’ pulps with three bleaching sequences were given in Table 4. As can be seen in Table 1, the bleaching yield decreased with increasing the numbers of stages. As can be seen from Table 4, when reaction time and reaction temperature were kept constant, bleaching yield decreased with increasing hydrogen peroxide ratio. For example, while bleaching yield was 93.66% with 1% peroxide, the same value was found to be 89.15% with 3% peroxide. In these trials reaction temperature, reaction time, MgSO₄ %, EDTA %, and concentration were constant at the levels of 70 °C, 60 min., 0.5%, 0.5% and 16% respectively.

Whiteness of bleached pulps increase in direct proportion to the increase of H₂O₂ and dithionide amount. For example while whiteness was 55.72 with % 1 peroxide, the same value was found to be 58.95 with %5 peroxide. At the same time while whiteness was 64.01 with %3 dithionide, the same value was found to be 66.12 with %7 dithionide.

Yellowness of bleached pulps decrease in inversely proportional to the increase of H₂O₂. Thus, while yellowness was 38.82 with %1 peroxide, the same value was found to be 33.50 with %3 peroxide.

Table 4: Some physical and optical properties of waste papers’ pulp bleached with multistage sequences

<table>
<thead>
<tr>
<th>Test No</th>
<th>Bleaching stages</th>
<th>Bleaching Yield (%)</th>
<th>Breaking Length (m)</th>
<th>Tear Index (mN.m² g⁻¹)</th>
<th>Burst Index (kPa.m² g⁻¹)</th>
<th>ISO Brightness (%)</th>
<th>Yellowness (E 313)</th>
<th>ISO Opacity (%)</th>
<th>ISO Whiteness (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>-</td>
<td>3009</td>
<td>1.74</td>
<td>1.65</td>
<td>31.32</td>
<td>34.89</td>
<td>99.42</td>
<td>41.23</td>
</tr>
<tr>
<td>2</td>
<td>O₂: 6 bar P: %1, NaOH: %1.33</td>
<td>89.87</td>
<td>3345</td>
<td>1.94</td>
<td>1.85</td>
<td>33.98</td>
<td>42.86</td>
<td>98.64</td>
<td>48.76</td>
</tr>
<tr>
<td>3</td>
<td>O₂: 6 bar P: %3, NaOH: %4</td>
<td>93.66</td>
<td>3317</td>
<td>1.83</td>
<td>2.17</td>
<td>40.06</td>
<td>38.82</td>
<td>97.66</td>
<td>55.72</td>
</tr>
<tr>
<td>4</td>
<td>O₂: 6 bar P: %3, NaOH: %5</td>
<td>92.25</td>
<td>3680</td>
<td>1.79</td>
<td>2.42</td>
<td>44.63</td>
<td>34.37</td>
<td>97.66</td>
<td>59.68</td>
</tr>
<tr>
<td>5</td>
<td>O₂: 6 bar P: %5, NaOH: %6.66</td>
<td>94.56</td>
<td>3934</td>
<td>1.88</td>
<td>2.27</td>
<td>44.20</td>
<td>34.06</td>
<td>97.49</td>
<td>58.95</td>
</tr>
<tr>
<td>6</td>
<td>O₂: 6 bar P: %3, NaOH: %2.25 S: %3</td>
<td>89.15</td>
<td>3354</td>
<td>1.81</td>
<td>2.21</td>
<td>47.33</td>
<td>34.74</td>
<td>96.51</td>
<td>64.01</td>
</tr>
<tr>
<td>7</td>
<td>O₂: 6 bar P: %3, NaOH: %2.25 S: %5</td>
<td>89.19</td>
<td>3845</td>
<td>2.11</td>
<td>2.72</td>
<td>48.68</td>
<td>34.11</td>
<td>96.64</td>
<td>65.58</td>
</tr>
<tr>
<td>8</td>
<td>O₂: 6 bar P: %3, NaOH: %2.25 S: %7</td>
<td>91.21</td>
<td>3385</td>
<td>2.08</td>
<td>2.08</td>
<td>50.14</td>
<td>33.50</td>
<td>96.26</td>
<td>66.12</td>
</tr>
</tbody>
</table>

P: Peroxide bleaching stage
S: Dithionide bleaching stage
Conclusion:
As a result of research, waste papers’ pulps can be bleached to 50.14% elrepho brightness with three-stage bleaching using H₂O₂ as bleaching agent. At the bleaching of waste papers’ pulps brightness of pulp increased from 31.32 to 50.14% elrepho and yellowness of pulp with bleaching decreased from 34.89 to 33.50 elrepho.

Consequently according to the data, the bleaching of waste papers’ pulp with multistage sequences offers the following advantages:

- Printing and aspect properties of bleached waste papers’ pulp are improved with brightness increase and yellowness decrease.
- Strength properties will increase during H₂O₂ bleaching.
- At the end of bleaching sequences achieved 50.14% final brightness.
- Dust amount of bleached poplar organosolv pulp decrease with increasing number of bleaching stage.
- The aging tendency of bleaching waste papers’ pulps will decrease with single or multistage sequences using H₂O₂.

In consequence of all these advantages, multistage bleached waste papers’ pulps can be used in newspaper manufacture as well as in high quality printing and papers as a mixture of soda, sulphate and sulphite pulps.

References