Copper Number – Carbonyl Content of Pulp Fibers
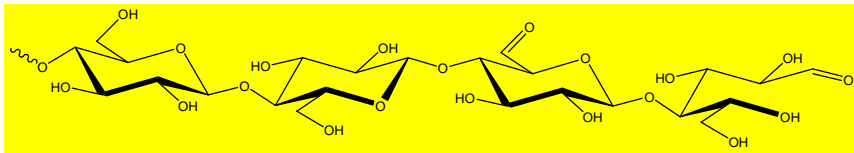

Copper number (Cu#) was measured following the Tappi standard method T 430. Copper number is defined as the number of grams of metallic copper (as Cu_2O) resulting from the reduction of $CuSO_4$ by 100.00 g of pulp fibers. Four solutions were prepared before any of the experiments began.

- Copper sulfate solution. 100.00g $CuSO_4 \cdot 5H_2O$ was dissolved in deionized water and diluted to 1000.00 ml.
- Carbonate-bicarbonate solution. 129.00 g anhydrous Na_2CO_3 and 50.00 g $NaHCO_3$ were dissolved and diluted to 1000.00 ml.
- Phosphomolybdic acid solution. 100.00 g $Na_2MoO_4 \cdot 2H_2O$ and 75.00 ml phosphoric acid (85%) were dissolved in a mixture of 275 ml concentrated H_2SO_4 and 1750.00 ml H_2O.
- 5% Sodium carbonate solution. 50.00 g Na_2CO_3 was dissolved and diluted with 950.00 ml H_2O.

Air dry fibers equivalent to 1.500 g of oven dry fibers were disintegrated in a blender for 1 min and transferred to a flask containing 5.00 ml $CuSO_4$ solution and 95.00 ml carbonate-bicarbonate solution were mixed and heated to a boil for 2 min. The mixture was poured into a flask and stirred well. The flask was placed in a water bath at 100^oC and shaken every 15 minutes. After 3 hours of treatment, the flask was removed from the bath and filtered in the Büchner funnel with suction. The fibers were washed with 100.00 ml 5% Na_2CO_3 solution and then flooded with 250.00 ml of hot water at 95^oC. The fibers along with the filter paper were transferred to a 500.00 ml plastic beaker, and 25.00 ml of the phosphomolybdic acid solution was added. A glass rod was used to macerate the mixture well. The mixture was transferred to a clean Büchner funnel and washed thoroughly with water until the blue color of the fibers was removed. The filtrate was collected and diluted to approximately 700 ml. The solution was titrated with 0.05N $KMnO_4$ to a faint pink end point. A blank test was also performed following the same procedures. The copper number was calculated using equation 3.2.

$$Copper\ number = \frac{6.36 \times (V - B) \times N}{W} \qquad (3.2)$$

Where:
V = The volume of $KMnO_4$ solution to titrate the filtrate from the specimen, ml.
B = The volume of $KMnO_4$ solution to titrate the blank filtrate, ml.
N = Normality of $KMnO_4$, 0.05N.
W = The o.d. weight of pulp fibers, g.

The copper number of each sample was measured in duplicate with an error of less than ±5%. The copper number is an indication of aldehyde groups in fibers. It has been reported by Röhrling, J.; Potthast, A.; Rosenau, T.; Lange, T.; Borgards, A.; Sixta, H.; & Kosma, P. [A novel method for the determination of carbonyl groups in cellulosics by fluorescence labeling. 2. Validation and applications. *Biomacromolecules.* 2002**,** *3*(5), 969-975] that there is a linear relationship between the carbonyl group content and copper number shown in equation 3.3.

$$Carbonyl\ Group\ Content\ (mmol\ /100g\ o.d.\ pulp) = (Cu^{\#} - 0.07)/0.6 \qquad (3.3)$$