New Method for Recycling of Waste Paper in Useful Products

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ABSTRACT

Waste paper recycling is a process by which waste paper or waste cellulose fibers are processed together with some chemical additions to produce another product such as file cover, greeting card paper board and duplicating paper for goods.

A new efficient and simple method has been designed then applied in a present work. Different types of waste papers are introduced as (writing paper WT, news paper NT and magazine paper MT) during an experimental design apparatus stages of collecting, separating, cutting, digesting / cooking, bleaching, lifting couching, pressing and drying, finishing for final applications at operation conditions.

The finish products go to checking their characteristics properties, physical and mechanical properties such as specific gravity, moisture content, brightness color, porosity, stiffness, tensile strength, tensile breaking, elongation, and tearing resistance. The result for these properties proved that all types give good mechanical properties for application in another utilization use as saving pads for goods with optimum application of newspaper samples.

Keywords: Recycling, Waste Paper, Character's Properties, Application.

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طريقة جديدة لتدوير النفايات الورقية الى منتجات مفيدة

الخلاصة

ان عملية تدوير النفايات الورقية سواء كانت النفايات الورقية او السيليلوزية تتم باضافة بعض الاضافات الكيمياوية الى العملية لانتاج مواد اخرى مثل اغلفة الفايلات، كارتات المناسبات، والاوراق المستخدمة في التعريف بالبضائع.

تم تطبيق طريقة بسيطة وكفوءة في البحث الحالي وذلك بتطبيق انواع مختلفة من النفايات الورقية وهي (نفايات ورق الكتابة، نفايات الجرائد /الصحف، نفايات المجلات) في منظومة تجريبية مصممة لهذا الغرض وتتالف المراحل التحضيرية من الجمع والنقل والتقطيع، المفاعل/ الطبخ/ الانضاج، الغسل والقصر، الترك لغرض الاستقرار، الكبس لنموذج الرطب، ثم التجفيف والانهاء لاغراض التطبيق وحسب نوع التطبيق وفي ظروف التشغيل التطبيقية.

بعدها يتم ارسال المنتج النهائي الى مرحلة اختبار الخصائص العامة الفيزيائية، محتوى الرطوبة، البريق، المسامية، مدى نعومة السطح، اضافة الى الخصائص الميكانيكية وهي متانة الشد، قابلية الشد لحد الفشل، المرونة، الكثافة، ومقاومة التمزق.

ونتائج هذه الخصائص اثبتت ان كل انواع الورق المعاد اعطت خصائص ميكانيكية جيدة لتطبيقها في استخدامات مختلفة (صفائح حفظ البضائع) مع نتائج مثالية تطبيقية للنفايات الورقية الخاصة بالصحف/ الجرائد.

الكلمات المرشدة: اعادة التدوير، ورق النفايات، الخصائص، التطبيقات.

INTRODUCTION

Waste reduction and recovery act provides for the establishment of programs for the reduction recycling and reuse for significant volumes of paper-based material recovered or diverted from the waste stream. Paper-based material include a white paper, brown paper, colored paper, boxboard, corrugated card board, magazines, catalogues, newspaper egg cartons [1-5].

The method of making paper is essentially a simple one-mix up cellulose fiber and cook them in a hot water until these fibers are soft but not dissolved, then pass as crime-like material through mix the mixture afterward let the blot out additional water [3, 5].

Many researchers have been studied the recycling of waste paper by different techniques; where Mohammed O. et al [6], proposed an automated paper recycling system where ultrasonic sound is used to separate different grade of paper for industrial applications by others authors [7-11].

Brooklyn has been owned by the same method found the developed three recycling technology methods and these developed processes depending on the source of the paper, which comes in one of two streams is sorted office and mixed paper as chamber recycling process and rays paper process. Where the paper collected separated and then treated before applied in other industrial application [12].

According to market demand and impact environment economic for recycled paper also recently applied a new recycling techniques for production another paper products and have another application rather than writing and this technique applied by both Madras and Kurnool [13].

Finally used paper and card board are recycling by municipal or private organization and delivered to reprocessing plants, such as newspaper or other products application. The extent of removal depends on the destination of the paper and the location in the paper chain of the sorting operations and depending on other factors price, homogeneity, contaminates and final application for each type [14].
Therefore this research tries to discuss and investigate the following aims and reach an optimum conditions and applications for these types of wastes as:

1- Developed a new simple technology include recycling and treatment of waste paper.
2- Optimizations the conditions for treatment give high quality and reasonable quantity of waste paper.
3- Try different utilization uses for prepared treated products.
4- Characterization for final products according to final application such as physical and mechanical properties respectively.
5- After evaluation of products applied it for industrial or commercial application according to market development potential, job creation, practicality, feasibility, innovation and other economic factors.

EXPERIMENTAL WORK

Materials:

1- Locally waste paper from different sources newspaper, white sheet paper and magazine paper in Koya city / Kurdistan from different location activities commercial , technical, academia and so on.
2- Auxiliary materials involved caustic soda lime and titanium dioxide of commercial type.

Procedure:

The various sources of waste material; newspaper (NT), white sheet paper (WT) and magazine paper (MT) are collected from different activities location of Koya city, separating, and classified then removal all impurities such as non-fibrous such as nails, button woods chips etc. are eliminated. The remain useful material after this stage are cut in to small pieces of approximately (2x2 cm) and dusted through a dusting frame covered with four mesh wire. Afterward applied these dusting materials in to cooking or digesting stage where these wastes are carried out with a mixture of 3% of caustic soda (lime) and kept at boiling point (104°C) for about five hours by use of lab scale system in research center of Koya University at engineering college. Then they are washed thoroughly and sent to another stage where in another stage the wastes are washed with a large quantity of water in a bleaching stage where water are added gradually for a sufficient time for washing or bleaching by using of drum for 8 hours in order to give good hydration then a titanium dioxide as filler is added to give homogeneous color afterward a sufficient number of sheets have been formed by putting under a press to remove the washing water, then separated to avoid shrinkage placed under absorbent boards and pressed again, then hanging to dry for six hours, finally finishing the final products by sizing according to the final application [15]. And the diagram below show a simple treatment and recycling of waste paper.

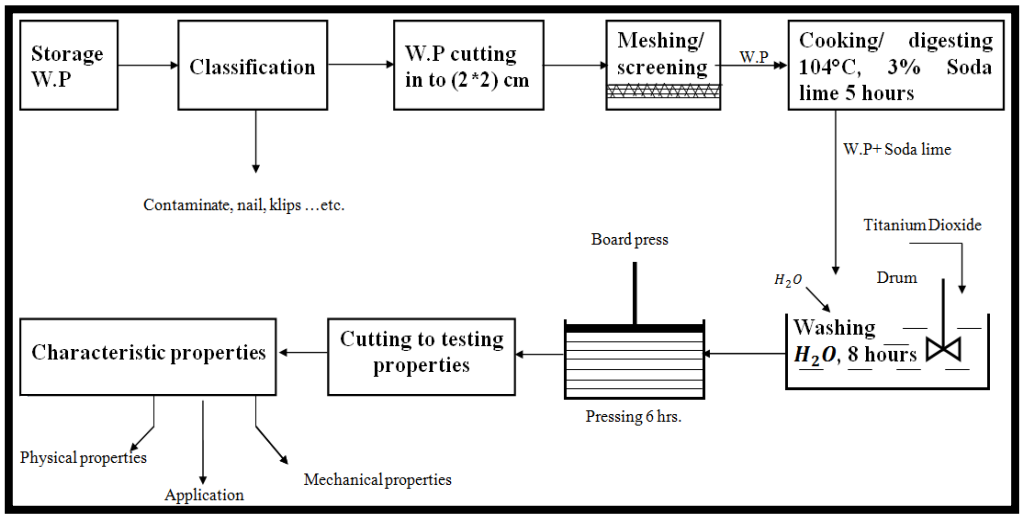

Figure (1) Show a block diagram for recycling of waste paper.

CHARACTERISTIC PROPERTIES

Physical properties

The physical properties of the final products are measured according to the testing method sp. gr. (ISO s36) moisture content (ISO 287) brightness and color (ISO 5631-2) porosity under vacuum and stiffness (ISO 8791-4) and estimate final values of testing according to the laboratory conditions at 20°C and 1 atm. or under vacuum for porosity test [15-16].

Mechanical properties

The mechanical properties of final products have been achieved according to T-404 and T494 by TAPPI test for tensile strength tensile breaking properties and elongation respectively also tearing resistance according to T-414 method for a single sheet board paper then applied a sever condition for the above test under changing temperature and humidity between (23°C and 50%) humidity to 40°C and 35% humidity percent) in order to achieve the suitable application properties for the final products [15- 16].

Results and discussion

During the preparation method we must be carefully to the following point:

1- From the preparation process it could notice that the optimum conditions required to get high quality and quantity are 104°C for boiling reaction step, 5 hours for high conversion and 3% concentration of soda applied.
2- The best time required for bleaching and washing step are 8 hours in order to get good hydration with a huge amount of water.
3- Applied titanium dioxide as a filler to give whiteness for products sheet white paper type.
4- Applicable time needed for drying are six hours under ambient condition 30°C for laboratory.
5- Check each test more than one trail in order to get accurate results values.
6- Apply the mechanical properties of final products under standard and sever conditions as temperature and moisture respectively.

CHARACTERISTIC PROPERTIES

Physical properties:

Figure (2) shows a comparison between waste type of paper (writing type WT, news type NT and magazine type MT) with standard types for each one where the waste paper types have high specific gravity than standard one according to the high thickness for wastes rather than standard with preference newspaper wastes that have 0.57 than standard one 0.45 [15].

Figure (3) shows comparison results between wastes and standard types (WT, NT, MT), where the values of waste moisture content large than standard types according to the breaking of cellulose bonds between fibers with high values for newspaper type of 3.5% H2O rather than 3% for standard one.

Figure (4) shows a comparison result for porosity between waste paper and standard one for all types (WT, NT and MT) respectively. The value of porosity are decreased in values for waste paper compared with standard one according to destroy the structure and change the ability to absorption with high values for newspaper wastes than other wastes at (3) than (2 and 1) respectively compared with standard one of (3.5) [15].

Figure (5) has been studied the stiffness property between waste types (WT, NT, MT) and standard one, the values of stiffness are decreased compared with standard type may be due to destroy the structure and change the appearance and nature of surface with high values for (MT) at (70) compared with standard of (75) respectively.

Also the brightness and color of wastes paper types after treatment are change between light gray compared with white to (WT) and dark gray for (NT) compared with light gray of standard one, also light black for standard one then dark black for (MT) respectively by application of wave length at 457nm [15].

Mechanical properties:

Figure (6) illustrates the compassion results between both recycling waste papers (WT, NT, MT) and standard one these results shows high tensile strength for recycling waste samples then standard one according the thickness of applied sample with high values for (WT) at 5.7KN/m rather than 3.4KN/m for standard one respectively.

Figure (7) shows the tensile of breaking for the above recycling wastes (WT, NT, MT) compared with standard samples. The results give high values for recycling wastes than standard one may be due to the same reasons above of high thickness with high value for (WT) at 5.5Km rather than 3 Km for standard one respectively [15- 16].

And finally figure (8) shows the compassion results between both wastes (WT, NT, MT) and standard samples then these results proved that decreasing the elongation percent for waste samples compared with standard one may be due to breaking and destroy the bond between cellulose fiber and change the structure with high thickness compared with standard one, with high value for standard one at (16%) compared with (15%) for (WT) recycling wastes respectively [15- 16].

Application of final product in a commercial and industrial utilization

It could applied a sever conditions for transportation of different food products such as eggs, vegetables and fruits, also the application of above products in transportation and saving of sensitive electronic machine such as TV, computer, laptop and so on in both high heat and cold of climate as (23°C, 50% moisture) and (40°C, 35% moisture) respectively and the effect of these conditions on the mechanical behavior as tearing resistance in both Figures (9 and 10). Figure (9) shows environmental effect conditions in both temperature and humidity at cooled climate on the tearing resistance of waste recycling paper compared with standard one. The results show optimum mechanical properties between both standard and waste samples at 60MN tearing resistance for both newspaper recycling wastes and standard samples at (23°C, 50% moisture).

And Figure (10) shows the environmental condition in both temperature and humidity at hot climate on tearing resistance of waste recycling paper compared with standard one, the results estimates an optimum mechanical properties between both standard and waste samples at 600MN tearing resistance for both newspaper recycling wastes and standard one at (40°C, 35% moisture) respectively according to the less change in structure bonds of these wastes than other applied waste of (WT and MT) respectively.

CONCLUSIONS

1- Optimum conditions for cooking (digesting) stage are (3% concentration of caustic soda time 5 hours, at 104°C) respectively.
2- The best time for bleaching (washing) stage is 8 hours in order to give good hydration and titanium oxide addition in order to give homogenous color.
3- Excellent characteristic properties (specific gravity, moisture content, brightness color, porosity and stiffness, tensile strength, tensile breaking, elongation, tearing resistance) are for both white writing paper (WT) and newspaper (NT) respectively.
4- Applicable recycling wastes are for newspaper wastes (NT) compared with standard one for environmental sever mechanical properties at both cold (23°C, 50% moisture) and hot at (40°C, 35% moisture) climate for transportation stages for all market goods applications.

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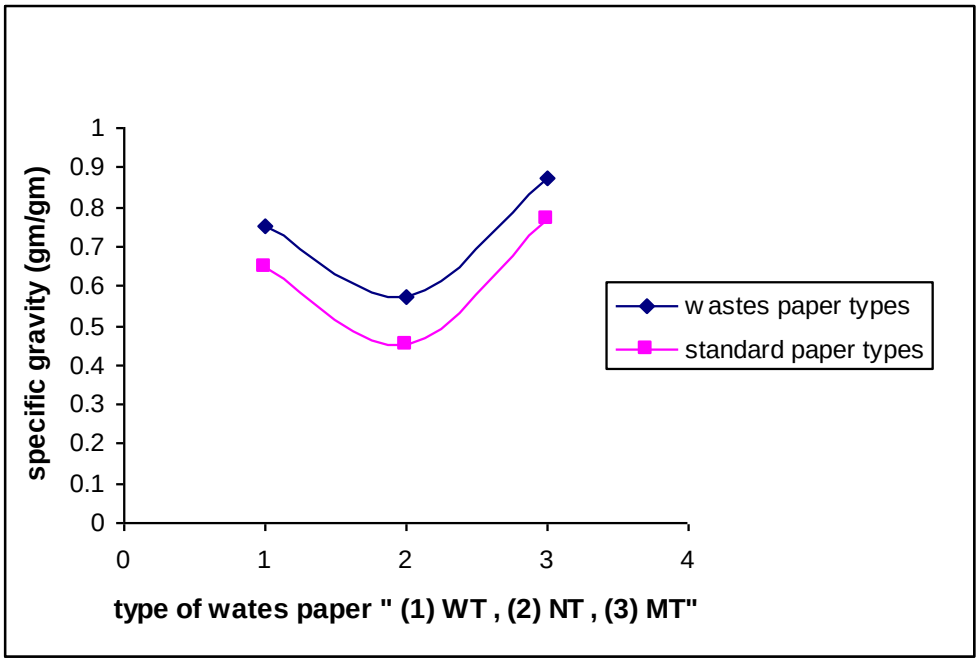

Figure (2) Estimate the specific gravity for both wastes and standard papers at 20°C.

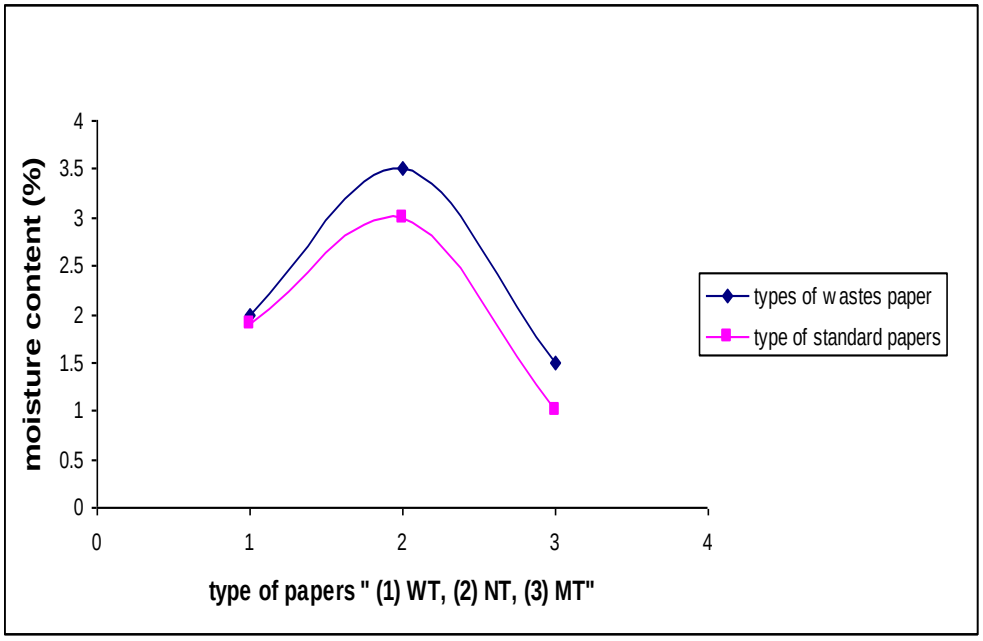

Figure (3) Estimate the moisture content for both wastes and standard papers at 20°C and 24 hours.

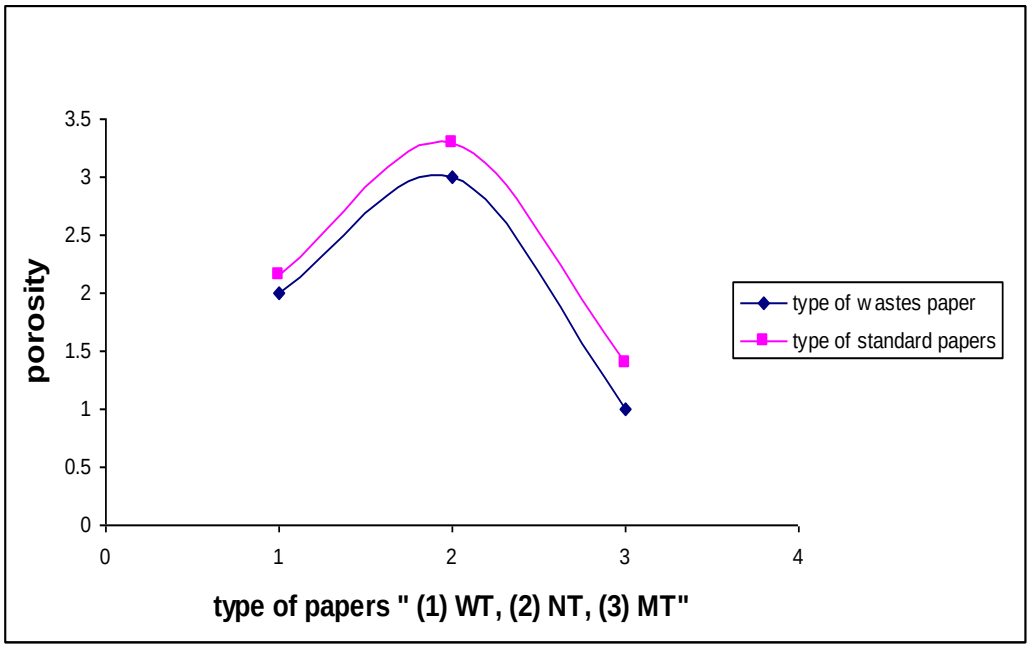

Figure (4) Estimate the porosity for both wastes and standard papers under 1 atm vacuum condition.

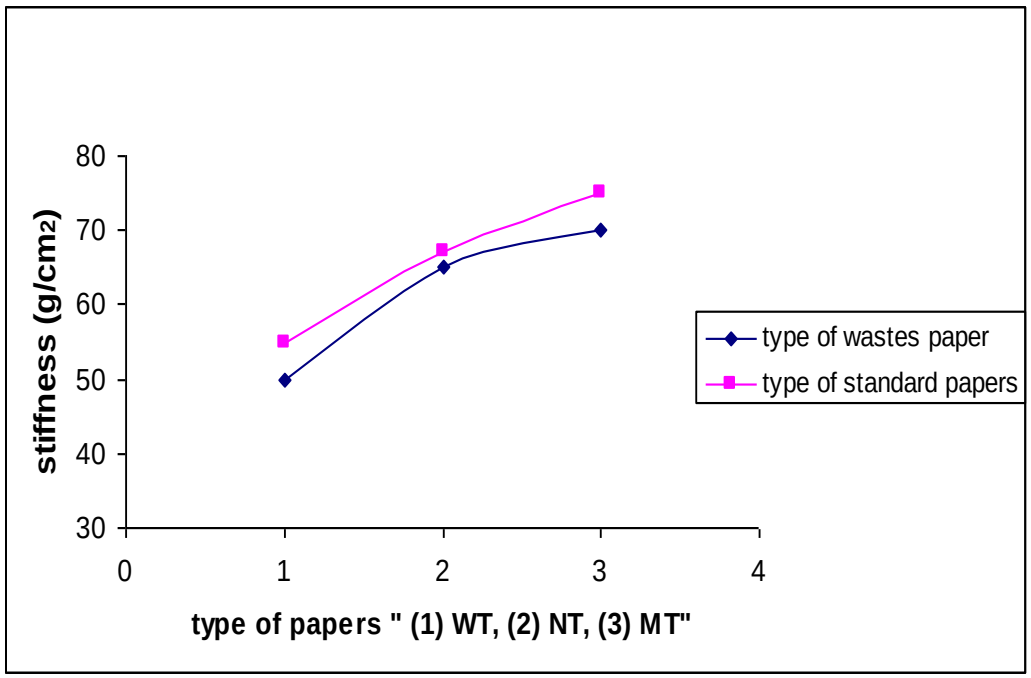

Figure (5) Estimate the stiffness for both wastes and standard papers at 20°C.

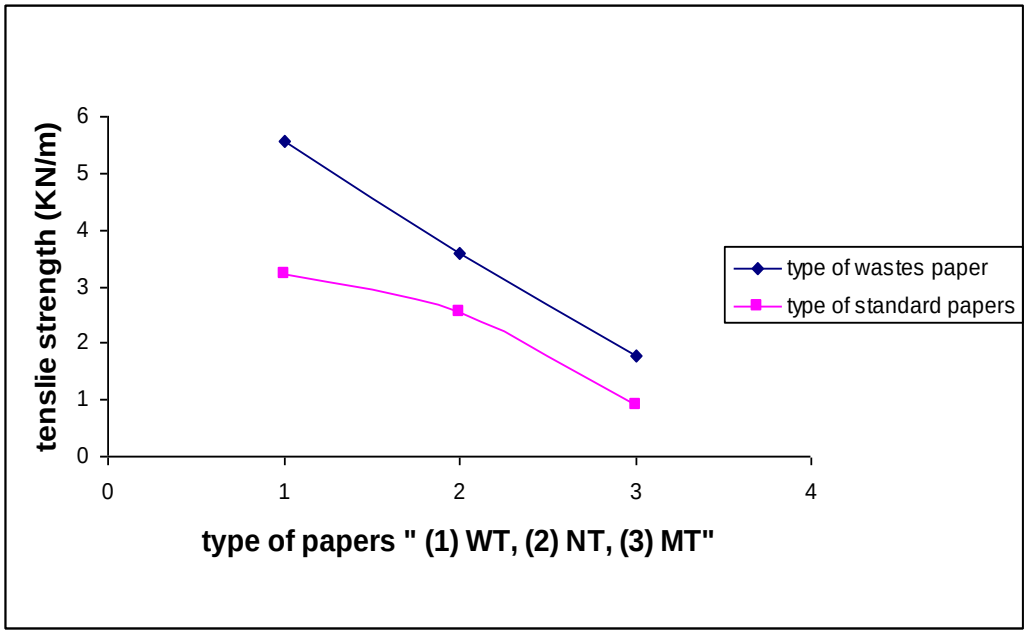

Figure (6) Estimate the tensile strength for both wastes and standard papers at 20°C.

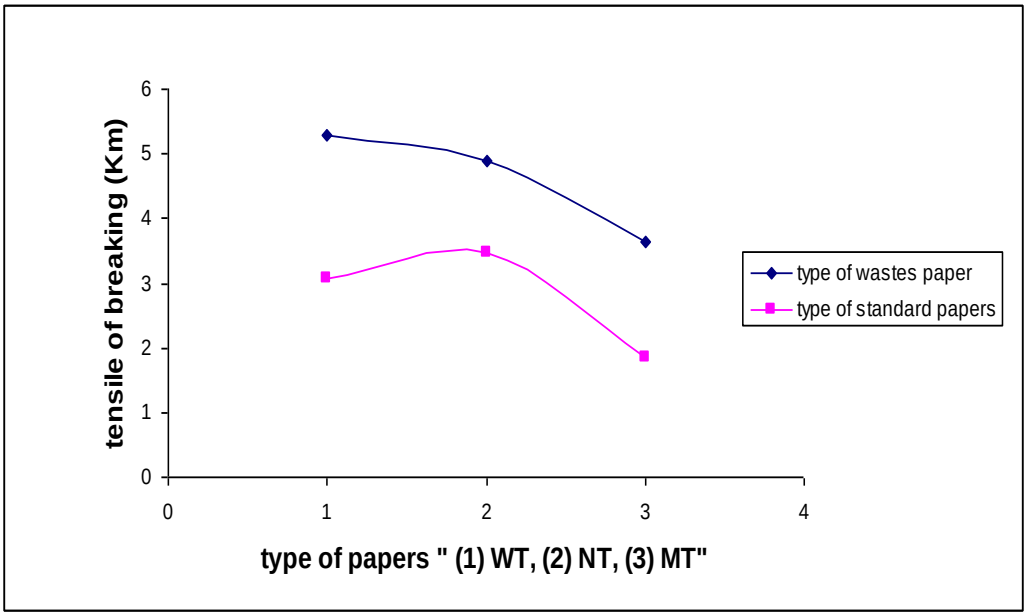

Figure (7) Estimate the tensile strength at breaking for both wastes and standard papers at 20°C.

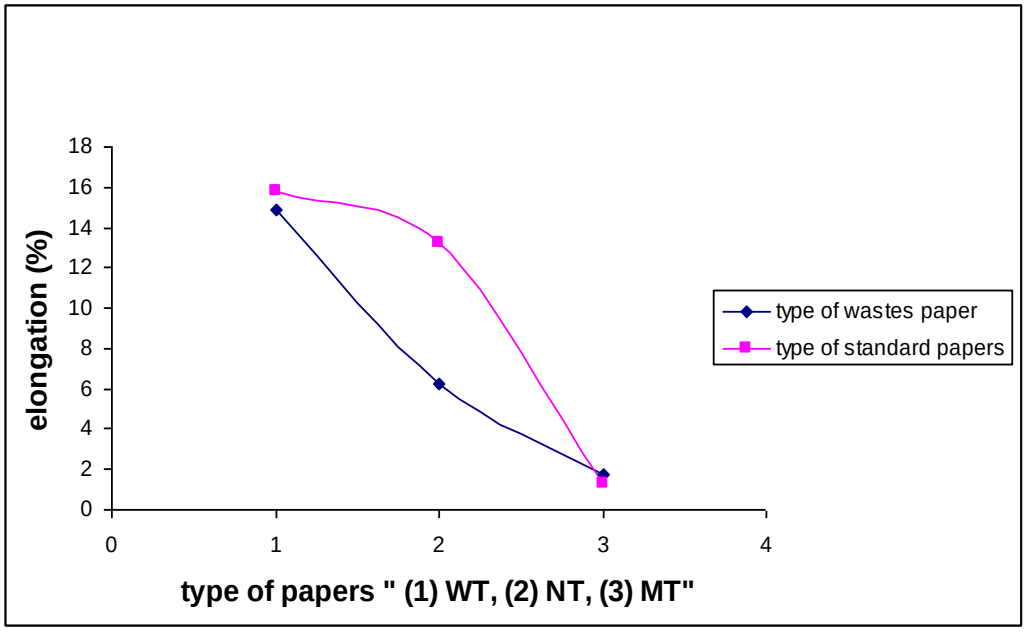

Figure (8) Estimate the percent of elongation for both wastes and standard papers at 20°C.

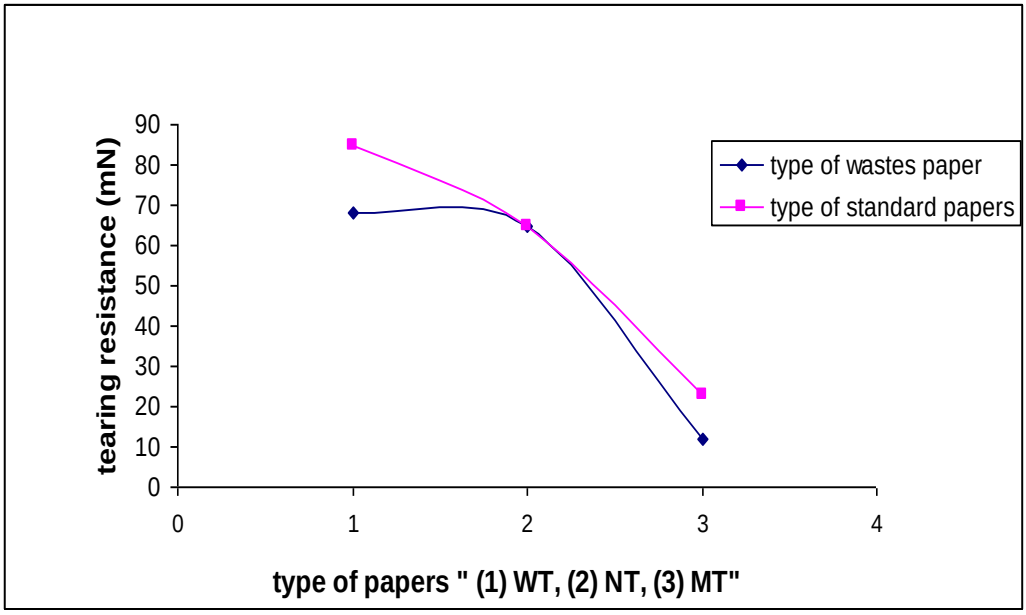

Figure (9) Estimate the tearing resistance for both wastes and standard papers at (23°C and 50% moisture).

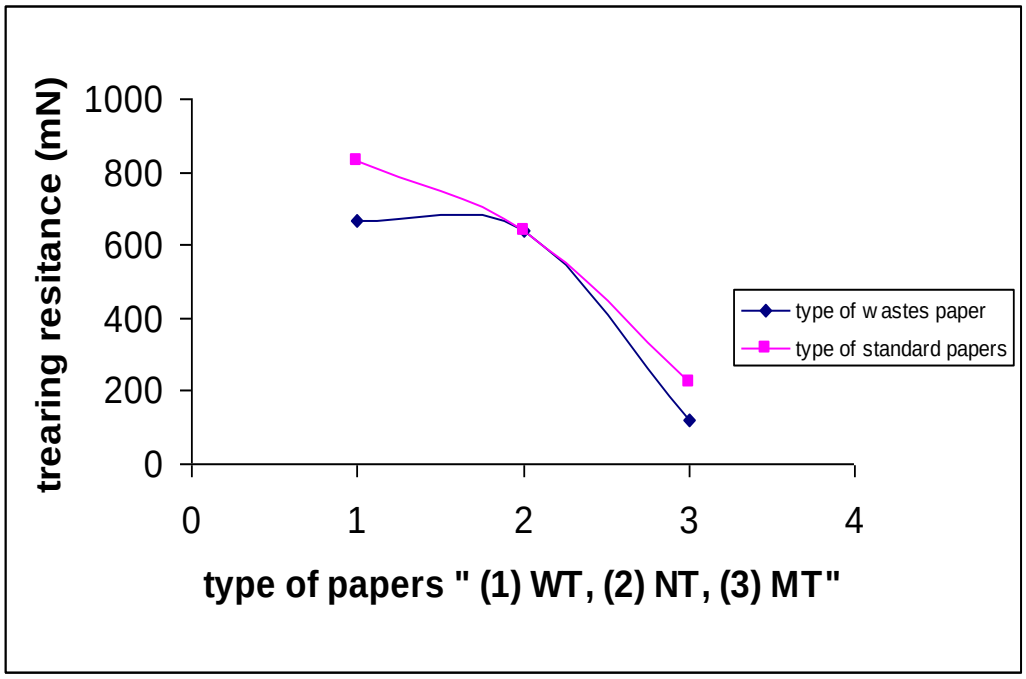

Figure (10) Estimate the tearing resistance for both wastes and standard papers at (40°C and 35%).