Egypt.J.Chem. **Vol. 60,** No.4, pp. 653- 665 (2017)

Utilization of Short-cut PET Fibers as Reinforcement Additive for Kraft Bagasse Paper Making

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ONE of the big challenges in Egyptian pulp and paper sector is the exploring of a new prospective for development and improvement of the properties of paper made from Kraft bagasse pulp. The study utilized polyethylene terephathalate (PET) as reinforcement to the pulp made from Kraft bagasse to improve the paper properties. Increasing the computability between PET fibers and Kraft pulp could be achieved by different partial hydrolysis processes for PET with sodium hydroxide, sulphuric acid, or ethanol amine. Optimum pretreatment conditions for different types of partial hydrolysis were identified to be used in the formation of blended paper sheets with Kraft bagasse pulp. The study has investigated the effect of kind of pretreatment and concentration of PET on the mechanical, moisture uptake, and thermal aging for blended paper sheets made from PET fibers and Kraft pulp. The blended paper sheets using alkali pretreated PET manifested superior mechanical, thermal, and moisture resistance properties in comparison with paper sheets manufactured from blending with acidic, or amine pretreated PET.

Keywords: Polyethylene terephathalate, Kraft bagasse pulp, Thermal aging, Moisture resistance, Mechanical properties

Introduction

In Egypt, agro-fibers are the main resources for pulp and paper industries due to the rarity of wood. Bagasse is the most available and sustainable alternative raw material considering the economic and environmental regulations. Although pulping of bagasse is easier than that of hard wood, the pulp quality produced from bagasse is far inferior due to its short fiber length. Egyptian pulp and paper is dependent on utilization of Kraft process for pulping of bagasse, which requires low chemical concentrations due to low lignin content. Expansion of using bagasse for paper pulp production is facing an essential challenge for exploring a new prospective to improve and develop the properties of paper made from bagasse pulp [1,2]. Addition of some kind of reinforcement is an effective approach to improve the properties of paper sheet made from Kraft bagasse pulp. A reinforcement role is different from that of filler, because the reinforcement is bonded to the matrix of paper sheet while filler is not [3]. Thus, the reinforcement can enhance the strength properties, which is dependent upon the bonding capacity [4]. Efficient additives to the pulp should meet fundamental requirements such as the presence of extensive interfacial molecular contact and /or occurring of wetting , *i.e.* the additive must have low surface energy [5]. Addition of chemically pulped fibers or soluble polymers can satisfy these requirements. Wood pulp which is a chemical pulp, basically cellulose fibers, can be blended with Kraft bagasse pulp through high density hydrogen bonds leading to improving the tensile properties [6]. Although tear property is negatively affected, addition of soluble polymer to the pulp can create a sheet with superior mechanical properties tensile strength as well as synergistic effect through intimately surface contact [7]. The soluble polymer is currently used as retention aids and wet strength agents [8]. Among different methods of reinforcement, long synthetic polymer fibers have been suggested to be a novel approach for developing and improving low quality paper. Addition of synthetic fibers to the chemical pulp has received attention through utilization of particular fibers such as acrylics, polyamides, polyolefines, and polyesters [9]. Due to their excellent mechanical properties, use of synthetic fibers could improve the wet tensile, tear, elongation, and fold resistance. Polyesters and polyolefines enhance the paper retarding for

DOI :10.21608/ejchem.2017.1115.1054

humidity, because these polymers do not absorb a considerable amount of water. The synthetic polymer fibers have hydrophobic nature further than relatively small surface area due to their non-fibrillated aspect. Consequently, synthetic fibers have no tendency for dispersion in water, and low compatibility with cellulosic fibers. Hence, limited bonding potential between cellulosic and synthetic fibers is considered an essential problem for making blended paper sheet from both types of fibers. One effective solution to solve this problem is the oxidation of synthetic fibers by ozone to generate carbonyl groups, which increase the hydrophilicity. The ozonation should be a limited treatment because vigorous degradation of the fibers can take place by excess dose of ozone. Polyethylene terephathalat (PET), which is commonly referred to polyester, is widely used for various applications such as bottle, fibers, and sheets because of excellent tensile strength, process ability, and thermal stability. PET fibers not only dominate over 50% of synthetic fibers market but also the majority of recycled PET is in fiber form. Increasing PET consumption, and its non- biodegradability led to focusing the social interest for PET recycling because of environmental issue [10]. Different products have been obtained by recycling of PET depending upon the chemical method performed such as glycolysis, methanolysis, aminolysis, or hydrolysis. Hydrolytic attack on polyesters involves scission of an ester linkage in the main chain by water. Each chain scission uses up one water molecule and creates one carboxyl group and one hydroxyl end-group [11]. Teteraphathalic acid (TPA) and ethylene glycol are yielded from the hydrolysis process through alkaline or acidic deplomerization. Aminolysis involves the reaction of PET with primary amine to produce ethylene glycol and terephathalamide. The complete hydrolysis or aminolysis (vigorous reaction conditions) can finely produce the moieties from which PET formed such as TPA, ethylene glycol, or terephathlamide [12]. Increasing the affinity of PET fibers toward the aqueous medium is an essential requirement for the addition of PET to pulp in paper making stage. The study aimed to create hydrophilic groups through controlled hydrolysis pretreatment of PET using dilute sulphuric and sodium hydroxide as catalysts to generate sites based on acidic groups. Also, the study aimed to explore the effect of aminolysis on PET fibers for increasing its tendency to be more combatable with cellulosic fibers formed the paper sheets. The task of the study was to optimize the pretreatment conditions for PET fibers. The study focused to blend pretreated PET fibers with Kraft bagasse pulp in paper making stage, and to determine the effect of the blending on mechanical properties, humidity uptake, and the thermal stability of paper sheets obtained.

Experimental

Materials

Raw materials used in the present work were Egyptian Kraft bagasse pulp and PET fibers. Kraft bagasse was delivered from Edfu Sugar and Paper Pulp Mills.

TABLE 1. Analysis of Kraft bagasse pulp.

Analysis	Klason lignin	α-cellulose	Hemice-lluloses	Ash
%	5.65	70.32	22.68	0.67

PET fibers had a cylindrical -shaped perfect circular cross section. The recycled PET long fibers (Denier 15, Strain at Break 250.9 %, Load at Break 12.8 KgF, Tenacity at Break 0.70 g/den) delivered from MAKARMTEX Co.6th October City, Egypt, were cut into very short cut fibers ranged from 1mm to 3mm. Other chemicals were used without further purification.

Methods

Partial hydrolysis for short-cut PET fibers

Hydrolytic depolymerization of short-cut PET was performed by partial hydrolysis processes, and aminolysis reactions.

Alkaline partial hydrolysis for PET

In a typical run, definite weight of sodium hydroxide pellets was dissolved in 100 ml distilled water and 20 ml from the resultant solution (weight /100 ml) was used for hydrolysis of the PET sample. Different concentrations of NaOH were prepared 5, 10, 15, and 20 % (w/v). After that time period, the round flask was cooled and the reaction mixture was kept under alkaline conditions to make sure the produced TPA was still soluble. Then, the reaction mixture was filtered by filter paper to remove the unreacted PET fibers. The unreacted PET sample was washed by hot distilled water followed by ethanol. The obtained unreacted PET sample was dried at 40 ^{o}C and weighted. The resultant alkaline filtrate solution (including TPA in salt form) was acidified (pH < 2) to precipitate the TPA in acid form. The solid

TPA was washed by ethanol followed by drying at 40 °C, and then weighted.

Acidic partial hydrolysis for PET

In a typical run, a definite weight of sulphuric acid was calculated by withdrawing certain volume from concentrated sulphuric acid. The withdrawn concentrated volume was diluted till 100 ml of to obtain sulphuric acid (w/v). Different acid solutions were prepared 5, 10, 15, and 20 % (w/v). The PET sample was subjected to the acidic hydrolysis by using 20 ml of prepared acid solution (w/v) for a specific time period. After the specific reaction time period, the reaction mixture was cooled, and changed to alkaline medium by adding sodium hydroxide (pH >8) to convert the resultant TPA salt form. Then, the unreacted PET was easily separated without TPA. The separated PET sample was washed by hot distilled water followed by ethanol and then dried at 40 °C. The alkaline filtrate was acidified again (pH, < 2) to precipitate TPA in acid form. The produced solid TPA was washed by ethanol and was dried at 40 °C. The dried weight for both unreacted PET and the resultant solid TPA was weighted.

Aminolysis pretreatment for PET

Aminolysis pretreatment for PET was performed using 20 ml of different concentrations of ethanol amine solutions 5, 10, 15, 20 % (v/v). After specific period of time, the reaction mixture was cooled and kept its pH >8. The unreacted PET sample was separated by filtration followed by washing with hot distilled water and ethanol, and then unreacted PET sample was dried at 40 °C and weighted.

Optimization of pretreatment processes for PET fibers

Optimization of pretreatment conditions were selected by considering the degree of PET degradation as well as the yield of TPA , which are calculated based on the following equations:

TPA Yield % = (MTPA / MTPAo) X 100

where, MTPA and MTPAo refer to the number of moles weighted and the theoretical number of TPA moles produced upon complete decomposition of PET, respectively.

PET degradation % = $[(W_i - W_f) / W_i]$ X 100

where, W_i , and W_f refer to the initial and final weight of PET, respectively.

Paper sheet formation

The paper sheets were prepared by blending beated Kraft bagasse pulp and short-cut PET associated with the optimum conditions of each pretreatment. The weight of paper sheet was kept constant at 60 g/m². A part of weight of paper sheet was the pretreated short-cut PET, which its represented percentage was based on the total weight of paper sheet. The other part was the pulp, which was represented by the remaining weight of 1.63 (total weight of paper sheet). Different percentages of pretreated PET (10, 20, 30, 40, 50 %) were added to the Kraft pulp, and then mixed in a mixer equipment during paper making stage. The prepared paper sheets were pressed for 4 min using hydraulic press 5 kg/cm². After pressing, the paper sheets were dried at 105 °C for 4 hr, and then the paper sheets were left for conditioning.

Determination of mechanical properties for prepared paper sheets

The treated and untreated paper samples were conditioned for 24 hr in a standard atmosphere, prior to testing for tensile strength. Tensile testing was carried out on 15 mm wide strips between jaws set 100 mm apart, using a Zwick universal testing machine.

Humidity (moisture) uptake of paper sheet

Humidity uptake was determined for blank paper sheet (only Kraft pulp) and paper sheets formed by blending pulp and optimum pretreated PET with different compositions [13]. Paper strips with constant area were subjected to 72% humidity environment (saturated solution of NaCl was placed in tilted desecrator). Depending on the environmental conditions, the paper sheets absorbed moisture as manifested by the weight gain. The moisture content of paper sheets M was determined as function of time.

M = M (t) = [(Weight of moist strip - Weight of dry paper strip) / Weight of dry paper strip] X 100

The moisture content of the paper sheets during absorption of moisture is:

$$M = G (M_m - M_i) + M_i$$

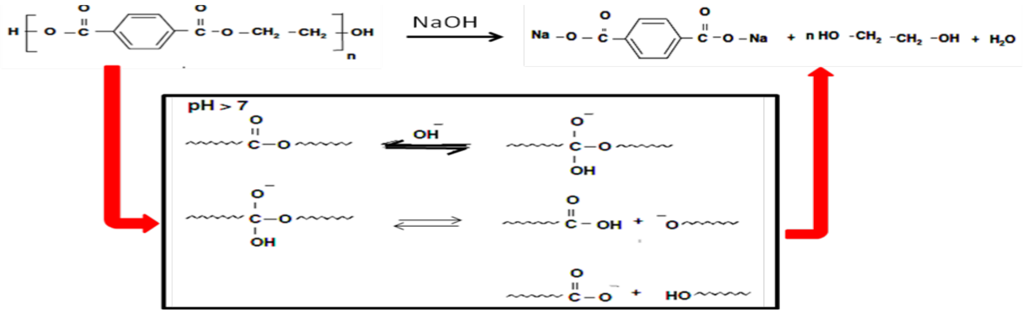
M_i and M_m are the initial and maximum moisture contents for paper sheets, respectively. G is the time dependent parameter. The diffusion coefficient (diffusivity), D is determined as follows: $G = 1 - \exp [- 7.3 (Dt / S^2)^{0.75}]$

Since both sides of paper sheet were exposed to the moisture, S is considered as twice the paper sheet thickness.

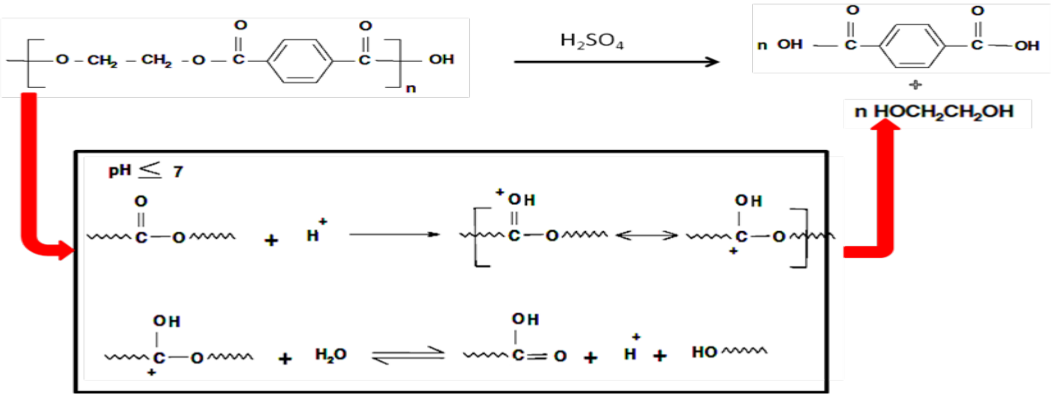
Results and Discussion

Short- cut PET pretreatment

Controlled hydrolytic depolymerization processes for short-cut PET were performed by two efficient pretreatment techniques in order to achieve specific degradation as illustrated in Fig. 1 [14-15]. Alkaline and acidic hydrolysis as well as aminolysis was carried out under different conditions of concentrations of hydrolyzing and aminolysis agents at different reaction temperatures for specific reaction time (120 min). Table 2 shows the effect of different pretreatment processes on the yield of PET (unreacted PET), and also the TPA percentage resulted from the pretreatment reaction. As expected, the degradation of PET was enhanced by increasing both reaction temperature and concentration of the pretreatment reagent [16]. At low pretreatment temperature, 70°C, the results for PET yields (90 to 97 %) and the percentage of produced TPA (1 to 5%) confirmed that a slight degradation occurred during the range of increasing the concentration of alkali, acid, and amine. At moderate reaction temperature, 80°C, a slight decrease of PET yields was achieved by increasing the alkali and acid concentrations until specific concentration after which abrupt severe degradation was noted. As shown in Table 2, concentrations of 15 and 10 % were the critical concentrations for alkali and acidic pretreatment, respectively; after these concentrations 30 and 35 % degradation of PET was achieved for alkali and acidic pretreatments , respectively.



(b) *Acidic hydrolysis*



(C) *Aminolysis*

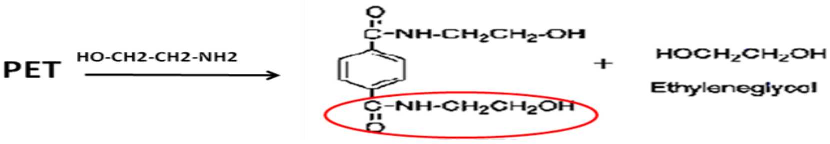


Fig.1. Controlled hydrolytic depolymerization processes for short-cut PET fibers, alkaline (a), acidic (b) hydrolysis, and aminolysis (c).

TABLE 2. Effect of the pretreatment processes on the yield of short-cut PET fibers and the resultant TPA.

Temperature (^{o}C)	Concentration	Alkali (NaOH g/v)		Acidic (H_2SO_4,g/v)		Aminolysis (ethanolamine, v/v)	
		Unreacted PET %	TPA %	Unreacted PET %	TPA %	Unreacted PET %	TPA %
70	5	96.50	1.00	93.60	2.20	97.00	-
	10	96.00	1.20	92,50	3.50	94.80	-
	15	95.50	1.50	91.00	3.80	92.50	-
	20	94.70	2.20	90.80	5.00	89.70	-
80	5	93.80	3.10	89.40	9.50	93.60	-
	10	90.60	4.70	86.40	12.30	94.50	-
	15	85.70	11.30	65.60	27.70	93.40	-
	20	69.80	25.80	58.80	35.80	89.60	-
90	5	92.60	3.40	90.70	5.20	92.80	-
	10	89.50	6.50	73.30	18.70	90.20	-
	15	71.30	24.50	62.40	36.60	87.50	-
	20	61.60	33.80	54.80	39.50	70.10	-

In the aminolysis pretreatment, the moderate reaction temperature was still causing limited degradation for PET as observed from the high yields of unreacted PET ranged in 90%. At higher pretreatment temperature, 90^{o}C, low degradation effect was observed within a range of 10 % alkali concentration, was indicated by high yield (90 %) of unreacted PET. Increasing the alkali concentration to 15 % resulted in a sudden decrease in the unreacted PET yield (71%), which indicated remarkable degradation of PET. Also, the acidic pretreatment manifested the same features at high reaction temperature, 90 ^{o}C, where a slight decrease in unreacted PET yield was observed at 5% acid concentration. Severe degradation was obtained (low unreacted PET yield) after 5% acid concentration. At 90 ^{o}C, the aminolysis pretreatment was effective to produce a desirable degradation at 15% amine concentration with unreacted PET yield 87%. On conclusion, optimum conditions of the pretreatment process could be detected by the yield of unreacted PET and TPA produced form the reaction. As shown in Table 2 the optimum conditions were dependent on the kind of the pretreatment, alkali, acidic, or aminolysis. The selected optimum concentrations and reaction temperature for alkali, acid, and amine were 15, 10, and 15 % and 80, 80, and 90^{o}C, respectively.

Mechanical properties

Table 3 shows the effect of different pretreatments of PET on mechanical properties of blended PET /Kraft paper sheets. The breaking length values for blended paper sheets pass through maximum in case of alkaline and acidic pretreatments of PET. The optimum value of breaking length depends on the amount of blending PET. In case of alkaline, the optimum value of breaking length was achieved at PET blending 30-40 %. The amount of PET as reduced for range 20-30 % for acidic pretreatment of PET. This can be attributed to high degradability of PET by acidic treatment which led to a low degree of polymerization which is making gathering of PET molecules on fibers in separated spots [17]. Consequently the high load of low DP of PET enhances the coalasnesses of on paper fiber leading to reducing the breaking length of the paper sheet. The optimum breaking length of alkaline pretreated PET is higher than that of acidic pretreated PET. This indicated that the alkaline pretreated PET possesses higher hydrophilic attributes than that of acidic pretreatment PET. Hence, the alkaline pretreated PET is more compatible with cellulosic fibers than that of acidic pretreated PET. Unlike the acidic or alkaline pretreatments, the pretreated PET with amine did not pass through maxima, but decreasing of breaking length was associated with increase of the load of PET. This may be attributed to the lower hydrophilicity of amine-pretreated PET than those in cases of acidic and alkaline pretreated PET. This causes least compatibility amine pretreated PET with cellulosic fiber of paper sheet. As shown in Table 3, the Young's modelus values are matching with the values of the breaking length of the blended PET- kraft paper sheets. For alkaline pretreated PET, the strain of paper sheet increases with the load of PET. These results can be agreed with the high compatibility of alkaline- PET with cellulose fiber, contributing higher deformation in paper sheets. The deformation (measured by strain %) is reduced by decrease of the hydrophilicity of PET as illustrated in the strain % for acidic and amine- PET.

TABLE 3. Effect of different pretreatment processes and PET load on the mechanical properties of paper sheets made from blending of PET and Kraft pulp.

Series	PET %	Breaking Length (m)	Young's Modules (MPa)	% Strain at Break
Blank	00	6100.50	3.30	2.3
Alkali Treatment	10	7150.83	3.80	2.76
	20	7800.41	3.10	4.45
	30	8400.00	6.50	5.09
	40	8800.71	5.90	5.60
	50	7500.04	4.30	2.54
Acidic Treatment	10	6700.90	8.20	2.52
	20	7750.05	6.20	3.49
	30	7889.67	4.50	4.67
	40	5241.51	3.40	2.85
	50	4174.57	3.70	1.64
Amine Treatment	10	7903.05	7.5	4.50
	20	7415.49	3.8	3.47
	30	6891.06	5.5	3.33
	40	6508.84	6.1	3.17
	50	6217.87	5.0	2.24

Thermally- accelerated aging of blended PET / Kraft bagasse paper sheets

The primary considerations when designing an accelerated ageing experiment are to increase the rate of degradation to measurable levels through controlled conditions [18]. The aim of thermally-accelerated was the choice of aging temperature (105 ^oC), which led to remarkable degradation rate revealing to kinetic model. The investigation of thermal aging kinetics [19] could be achieved by introducing kinetic variable α as; $\alpha = (B_o - B) / B_o$ where, B_o is the initial breaking length value, and B is the breaking length associated to the time of thermal aging. Thus, the variable α is defined as the relative decrease of breaking length in the course of process or as an extent of degradation resulted from thermal aging. The kinetic curves showing the change of α with time t, at the temperature value studied are presented in Fig. 2. Figure 2 shows α increases with time for all types of samples. This increase of the kinetic variable corresponds to the increase of the extent of thermal ageing, *i.e.* to the corresponding decrease of breaking length. It is also evident that the tendency towards ageing of the kraft paper sample is higher than the kraft samples blended with PET. This result is attributed to the higher stability of PET to thermal ageing than cellulosic fibers [20].

The kinetics of thermal ageing can be described as follows: $\nu = \nu_o e^{-a\alpha}$
where the current and the initial rate of the ageing process are designated by $\nu = d\alpha / dt$ and ν_o, respectively. It is valid for processes taking place on inhomogeneous surfaces where the active sites are distributed linearly in correspondence with their energy. For a paper sheet surface, which is heterogeneous, the rate of deterioration of the physical property (breaking length) decreases with (a) increase. The kinetic coefficient of inhomogeneity (a) accounts for the energy of the system.

All kinetic curves are linearized in coordinates α vs. ln t in correspondence with the approximate integral form of the exponential kinetic equation:

$$\alpha = 1/a\ [\ln (\nu_o a)] + 1/a \ln t$$

The linear dependences obtained are presented in Fig. 3. The slope value of the lines obtained

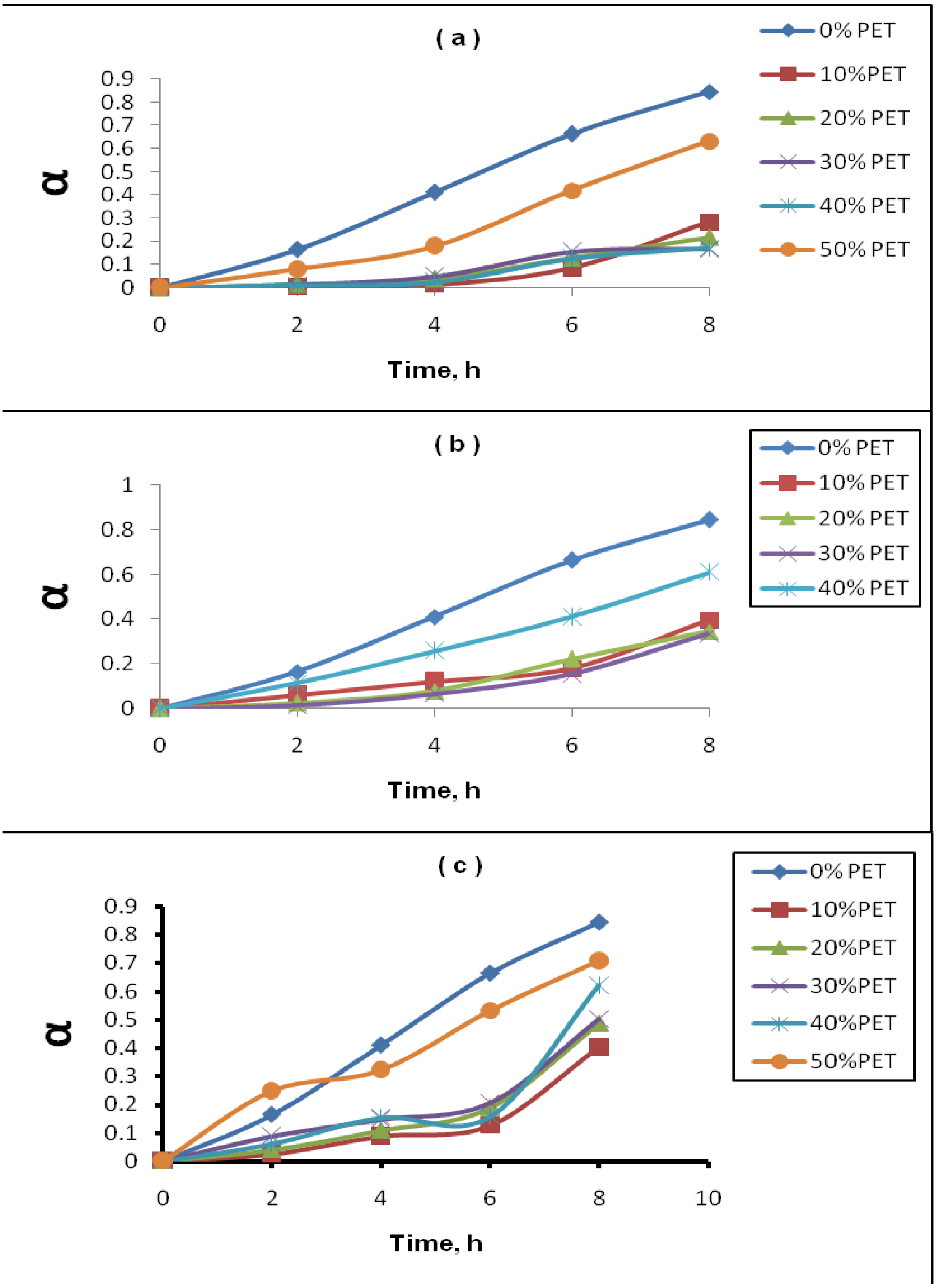


Fig. 2. Effect of aging time on the extent of thermal aging for kraft paper blended with (a) alkali pretreated PET, (b) acidic pretreated PET, (C) aminolysis pretreated PET

provides the determination of (a). It is seen that (a) decreases with increase of deterioration of breaking length of the paper sheet. According to:

$$\nu = \nu_o e^{-a\alpha}$$
$$\alpha = 1/a\,[\ln(\nu_o a)] + 1/a \ln t$$
$$\nu = \nu_o e^{-a[1/a\,[\ln(\nu o\, a)] + 1/a \ln t]}$$
$$\ln \nu = \ln \nu_o - a[1/a\,[\ln(\nu_o a)] + 1/a \ln t]$$
$$\ln \nu = \ln \nu_o - [\ln(\nu_o a) + \ln t]$$
$$\ln \nu = \ln \nu_o - (\ln \nu_o + \ln a) - \ln t$$
$$\ln \nu = \ln \nu_o - \ln \nu_o - \ln a - \ln t$$
$$\ln \nu = - \ln a - \ln t$$
$$\ln \nu = - (\ln at)$$
$$\nu = 1 / at$$

This relation demonstrates the dependence of the rate of thermal aging at definite time on the kinetic coefficient a. The study was interested to illustrate the differences among the rate of thermal aging at early time (2hr) for Kraft and blended paper sheets by calculation of the coefficient a for each sample as shown in the rate of thermal aging ν which is dependent on the kinetic coefficient a, where increasing a- values indicate that the paper sheet is more resistance for thermal aging (lower values of ν. Generally the presence of PET can acquire the paper sheets better thermal properties than that of Kraft paper sheet. In comparison, the blended paper sheets with alkali pretreated PET have the highest resistance for thermal aging with concentration of PET ranged from 10- 40 %. The superior of thermal property for alkali pretreated PET blended sheets can be attributed to high computability and good distribution of PET fibers through the cellulosic matrix.

Moisture uptake

The hydrophobic nature of PET derived us to investigate the effect of PET addition on the moisture uptake of blended paper sheets for different time intervals. Figure 4 shows the hygroscopic nature of Kraft paper sheet, which was demonstrated by the highest values of moisture uptake percentage for different time intervals. The high moisture uptake for Kraft paper has adverse effect on long-term performance. Increasing the moisture uptake of Kraft paper sheet led to a decrease in its mechanical properties, and provides the required environment for growing micro-organisms. For paper blended with alkali pretreated PET, the moisture uptake could be decreased by increasing the PET addition from 10 to 40%, while the moisture uptake get closer to that of Kraft sheet at higher PET concentration 50%. The coagulation and inhomogeneous distribution of PET fibers are considered the essential reason for increasing of moisture uptake at higher PET (50%). Improvement of moisture resistance of paper sheets can be achieved by increasing the concentration of acidic or amine pretreated PET, but the high concentration of amine pretreated PET showed comparable moisture uptake percentage to that of Kraft paper sheet. The dependence of moisture uptake on the concentration of PET in the paper sheet was demonstrated by illustrating the dependence of paper sheet diffusivity on the PET concentration.

Figure 5 shows the relation between the diffusion coefficient (D) values and the blended paper sheet with different pretreatment for PET. At each concentration used from different pretreated PET, the paper sheets blended with alkali pretreated PET have the lowest value of diffusion coefficient. Therefore, the blended sheets with alkali pretreated PET have higher moisture resistance than that for blended paper with acidic or amine pretreated PET. As shown in Fig. 5, 40% of PET is the concentration associated with the lowest diffusivity (lowest rate of humidity absorption) for alkali and acidic pretreated PET, while, 20% is the concentration for the lowest diffusivity in case of amine pretreated PET.

TABLE 4. Relation between kinetic coefficient (a) and rate of thermal aging (ν) at definite time (2 hours) of paper sheets made from blending of PET and Kraft pulp.

PET,%	Alkali pretreated PET		Acidic pretreated PET		Aminolysis pretreated PET	
	a - value	ν	a - value	ν	a - value	ν
0	2.04918	0.244	2.04918	0.244	2.04918	0.244
10	5.847953	0.0855	4.739336	0.1055	4.366812	0.1145
20	7.092199	0.0705	4.484305	0.1115	3.584229	0.1395
30	8.264463	0.0605	4.784689	0.1045	3.952569	0.1265
40	8.547009	0.0585	2.941176	0.196	3.095975	0.1615
50	2.57732	0.194	---	---	3.08642	0.162

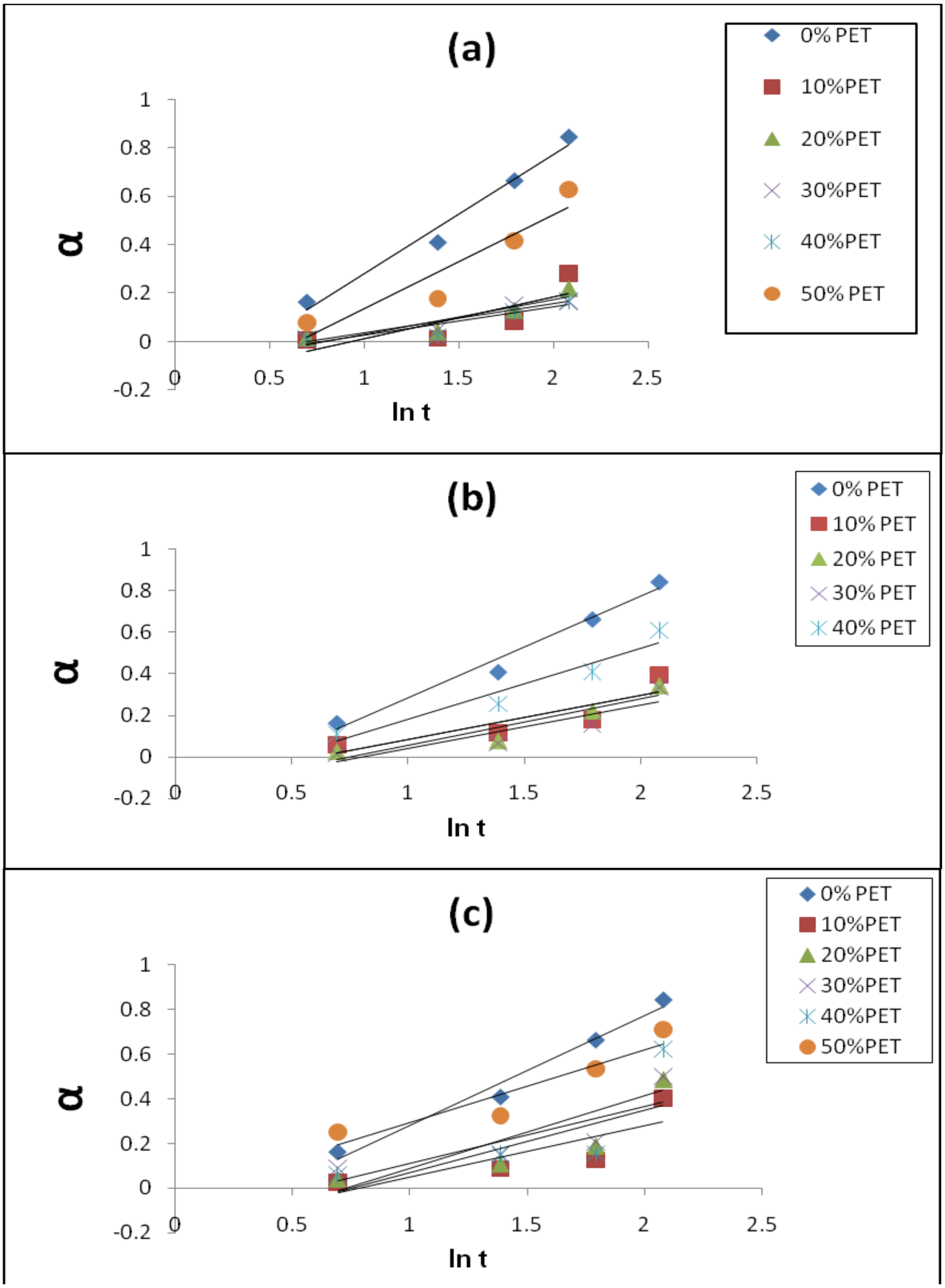


Fig. 3. Linearized kinetic curves in coordinate α vs. ln t for Kraft paper blended with (a) alkali pretreated PET, (b) acidic pretreated PET, (c) aminolysis pretreated PET

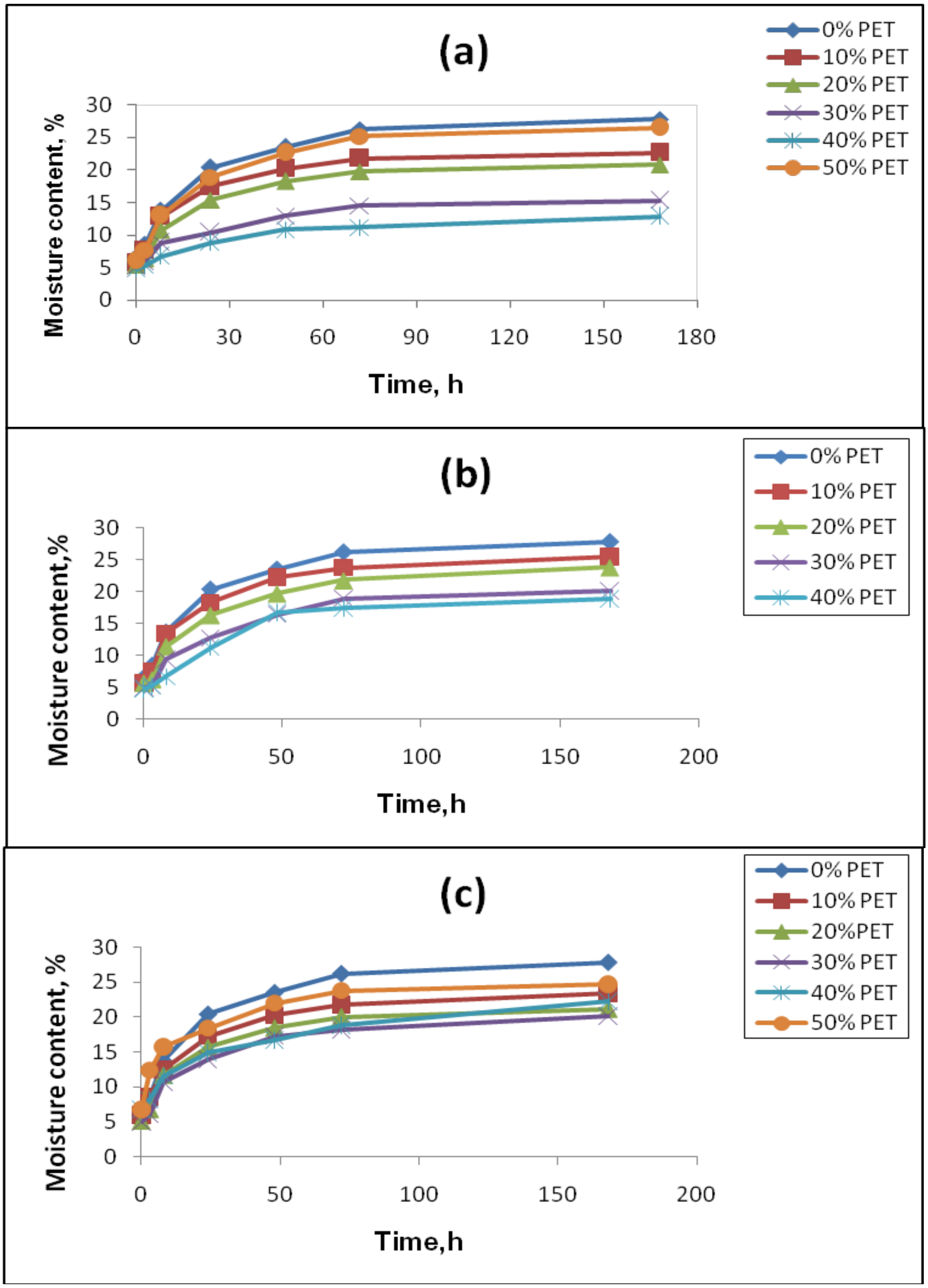


Fig. 4. Effect of time on moisture uptake by kraft paper blended with, (a) alkali pretreated PET, (b) acidic pretreated PET, (c) aminolysis pretreated PET.

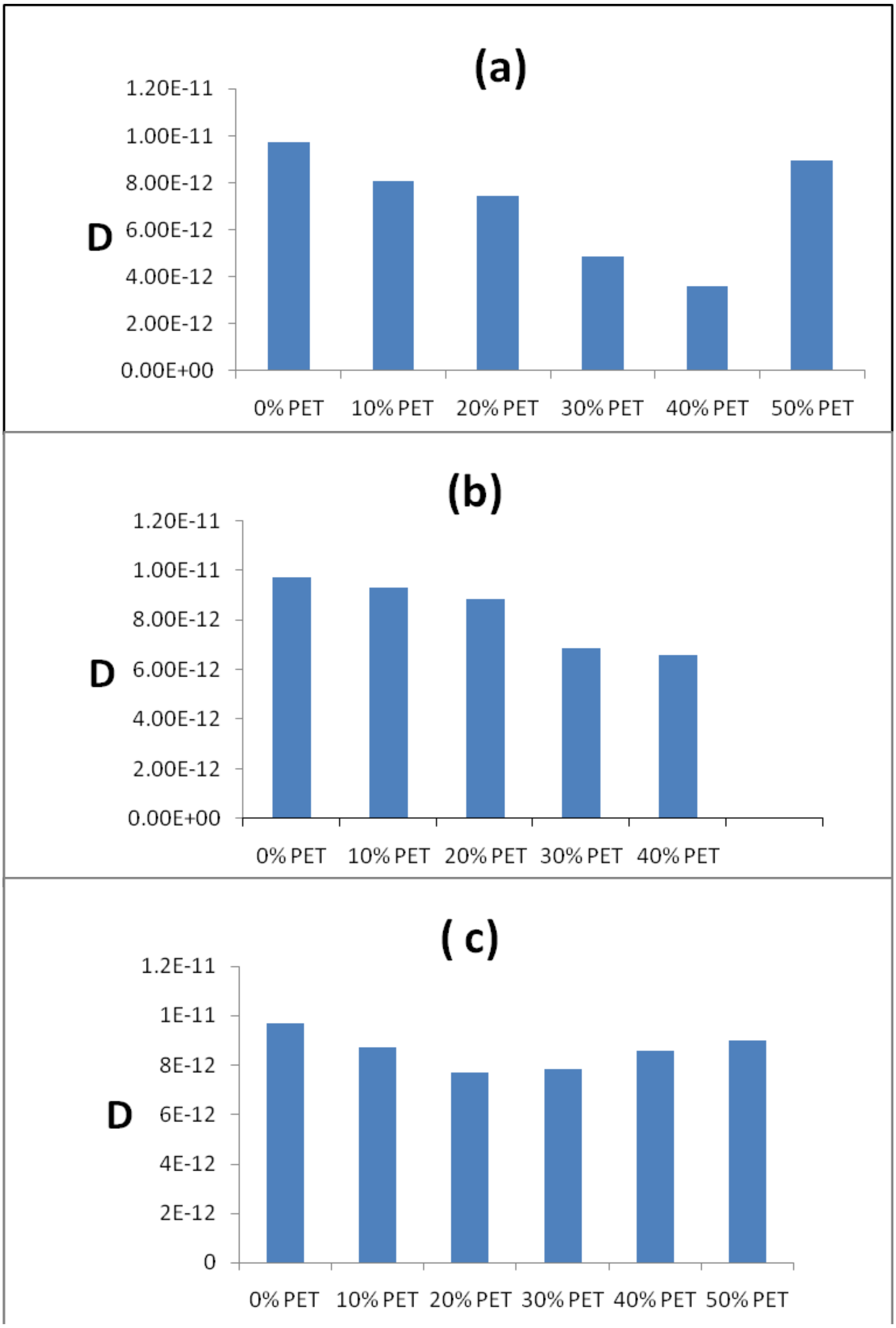


Fig. 5. Diffusivity dependence on the amount of PET blending with Kraft paper a) alkali pretreated PET, (b) acidic pretreated PET, (c) aminolysis pretreated PET.

Conclusion

This study looks at a new type of material, Kraft pulp/synthetic fibers composite sheet. The polymer fibers used was polyethylene terephathalate (PET). Controlled partial hydrolysis and aminolysis for PET fibers were performed to improve the compatibility between Kraft pulp and PET fibers resulting in bonding potential. Within a definite range of PET additions, the blended paper sheets have superior mechanical and physical properties to paper sheets of Kraft pulp alone.

Acknowledgement

The authors acknowledge the National Research Centre for financial support of the research activities related to project; contract grant number 10070106.

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(*Received:* 18 / 5 /2017 ;
accepted: 19 / 6 /2017)

إستخدام ألياف قصيرة من البولي إيثيلين تيرفيثالات لتقوية الورق المصنوع من لب مصاص القصب بطريقة الكرافت

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أحد التحديات الكبيرة في قطاع اللب والورق المصري هو استكشاف آفاق جديدة لتطوير وتحسين خصائص ورق الكرافت المصنوع من خامة مصاص القصب. استخدمت الدراسة البولي إيثيلين تيرفيثالات للخلط مع اللب المصنوع من مصاص القصب لتحسين خصائص الورق. ويمكن تحقيق زيادة في قابلية الإندماج بين ألياف البولي إيثيلين تيرفيثالات ولب الكرافت من خلال عمليات التحلل الجزئي المختلفة للبولي إيثيلين تيرفيثالات مع هيدروكسيد الصوديوم، حامض الكبريتيك، أو إيثانولامين. تم تحديد ظروف المعالجة المثلى لأنواع مختلفة من التحلل الجزئي لاستخدامها في تحضير ورق من لب الكرافت والبوليمر المعالج. وقد تم دراسة تأثير نوع المعالجة الأولية وتركيز البولي إيثيلين تيرفيثالات على الخواص الميكانيكية والفيزيائية (امتصاص الرطوبة والتقادم الحراري) لعينات الورق المصنوعة من لب الكرافت والبوليمر المعالج. وأوضحت الدراسة بأن عينات الورق المصنوعة من البوليمر المعالج بهيدروكسيد الصوديوم له خصائص ميكانيكية وفيزيائية تفوق نظيرتها المستخدم فيها البوليمر المعالج بحامض الكبريتيك، أو إيثانولامين.