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Fluff Non-Wood for Health Absorbent

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ABSTRACT

Kenaf fiber is long bast fiber which can give excellent quality for fluff pulp production. The fibre is obtained by mechanical processes by separating the parenchym cells and other substances in the stalk. Kenaf fiber which is obtained from the bundles of fibres like yarn of 2-3 meter length required of 3-5 cm cutting before pulping. The production of Kenaf fluff pulp was carried out in laboratory scale, using of soda process with active alkali of 12%, 14% and 16%, liquor to solid ratio is 1:4, maximum temperature is 165 oC with time to temperature and at temperature are 1,5 and 2 hours respectively. Bleaching was conducted in the ODoED1D2.sequences so-called the Elementally Chlorine Free (ECF) bleaching process. Fiberization of pulp to produce fluff pulp was done using either willeymill or shredder machineries with and without treatment using of super absorbent polymer (SAP) additives 10-30%. Techno-economy analysis on the production process is also carried out. Result of the lab scale Kenaf pulping experiment showed that pulp yield is in the range of 61.83–65.01%, Kappa number 10–14, brightness above 89 % GE, extractives content 0.01%, viscosity 4.76 cp, and knots 5 %. The absorbent capacity of Kenaf fluff pulp is 7.03 – 18.78 g/g, which depends on the active alkali charge, addition of the SAP, and pulp fiberization. Most of the properties can meet the requirements of commercial diapers properties. The addition of SAP is significantly increasing the absorbent capacity of the fluff pulp.

Keywords: Kenaf fluff, Absorbency, SAP, ECF.

1. INTRODUCTION

Utilization of pulp as absorbent agent or material or fluffed pulp such as feminine hygiene products or sanitary napkin, baby diapers or baby wrapper seems growing fastly in this modern age. Fluff pulp is a chemical, mechanical or combination of chemical/ mechanical pulp, usually bleached, used as an absorbent medium in disposable diapers, bed pads, and hygienic personal products, also known as "fluffing" or "comminution" pulp (Brunsvik ,1987; Jeni et all, 1992).

The condition of diapers bought in the local market largely is a prospective for the Indonesian pulp industry to develop. Currently, the world consumption of fluff pulp is more than 2 million ton/ year with a prediction of 0.5–1 % growth rate/ year (Brunsvik, 1987). Whereas the predicted Indonesian fluff pulp consumption in 2005 is 79.200 ton used by 3.3 million children below three years (BTY) from the 220 million population as shown in Table 8. Since there is no data accurate for BTY diapers consumption, the calculation is then based on the assumption that children BTY are 15% and the users are 10%. Therefore, fluff pulp consumption is 79.200 ton/ year. If this amount is produced by a pulp mill of 9,000 ton/ year capacity, Indonesia needs 9 new pulp mills. As a result, foreign exchange saving of Rp 752.4 billion/ year will be achieved as shown in Table 8.

Fibre materials used for diapers still rely on the fluff pulp imported from Europe, America, and Australia. In fact, this is an opportunity for the investors to put their capital in Indonesia. In addition, this is an opportunity cost in saving foreign exchange or forcing the diapers production costs down. Moreover, there is no Indonesian pulp mill producing Kenaf pulp and no interest in developing fluff pulp production as well. This can be caused of fears or

lack of know how that new raw material deserves new machineries or need high tech in the production process.The thought using regular raw material and machineries which is a common practice in the Indonesian pulp mill seems to be right in time. In fact, a joint study from the CPP-Leces Pulp and Paper Mill, and research from the Center for Research and Development of Tobacco and Fiber Plant (Balitas) showed some special quality of Kenaf plant. In addition, Australia and China have produced Kenaf pulp for high quality paper commercially with higher price than NBKP (Risdianto & Haroen, 2004).

The requirements of fluff pulp are low extractive but high cellulose content, high brightness, low viscosity, and more long fibre than fines (Soderhjelm & Nordfeldt, 1979). The extractives are hydrophobic which may hold back the water in the fibre surface. In fact, the extractives will decrease the absorbent capacity of the fluff pulp. Therefore, the more extractives in the fibre surface will lessen the liquid absorbency similar as the more fines will decrease the absorbency (Field, 1982).Diapers are initially made of cotton natural fibre. Since cotton is costly and difficult to obtain, therefore, substitution of cotton by other cellulose fibre is a challenge. In most cases, pulp is known as raw material for paper, board, and rayon. However, other use of pulp for instance as absorbent material can be considered because cellulose is hydrophilic (Gallary, 1973). Fluff pulp can be generated from plants of natural cellulose after having special process. The pulp is then fiberized to produce white pulp like cotton named fluff pulp. Later the fluff pulp is made flat sheet and pressed with a certain pressure into pad form which can function as absorbent or liquid holder (Risdianto & Haroen, 2004).

POTENCY OF KENAF PLANT AND FIBRE

Kenaf grows globally between 45° North Latitude (NL) to 30° South Latitude (SL), with the largest producers are Asia i.e.: India, Bangladesh, China dan Thailand (Mimms et al, 1993). Its distribution in Indonesia are in Central Java, East Java, Kalimantan, and Sulawesi. Kenaf is an annual plant growing as upright shrub. The height can reach up to 4 meters depends on the variety, age, and soil fertility. According to Berger in Kangiden et al (1996), Kenaf stalk in normal condition can reach 2.4–3.8 meter. The highest fibre content of Kenaf (75%) is concentrated under its lower stalk 1–1.25 meter height. The reason is that the plant growth fastly up to 60-90 cm, which then slower after. Kenaf plant can produce bond dry (bd) fibre 2–2.5 ton/ ha.

Kenaf have a wide tolerance growth against stagnant water or floods and do not require any particular requirements of soil and climate. From those special qualities, Kenaf can be used as alternative for long fibre source substituting softwood (Kertas Leces) , such as:

- growing fast of 150 days harvest compared to pines with 15 – 17 years harvest.
- bond dry fibre production is 2-2.5 ton/ ha, age 150 days compared to pines 175 m^3/ ha, 15 years or equivalent with 35 ton of b.d. pulp
- high cellulose but low lignin content

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2. OBJECTIVES OF THE STUDY

The objective of the study is to utilize Kenaf as fibre raw material for fluff pulp by using of pulping and bleaching technology, forest conservation substituting wood into non-wood, and reducing or ending import of fluff pulp diapers. *Scope of the study* is laboratory scale research on Kenaf fibre with soda pulping process, ECF bleaching, and treatment of *super absorbent polymer* (SAP) additives followed by techno economic analysis. *Expected result of the study* is to attain into the fluff pulp import quality standard which then will substitute the long fibre of kenaf

3. LITERATURE REVIEW

Current fluff pulp used in the commercial diapers is obtained from softwood long fibre. Long fibre can generate fluff materials with the absorbency higher than the cellulose of short fibre (Field, 1982). Indonesia is rich with several of non-wood long fibre plant resources which grow extensively and annually harvests so that feasible to be developed as raw material for fluff pulp. Kenaf or *Hibiscus canabinus* L. has the properties and prospective to be expanded as fluff pulp raw materials. The fibre is obtained from the bast which can be harvested within 140 – 150 days (Mimms et al, 1993), whereas for the long fibre of softwood needs 15 years. Kenaf fluff pulp process production can be conducted with soda pulping since it has lower lignin content than wood, besides it is more economical and suitable with the commercial fluff pulp properties. These facts are supported by previous studies which revealed that soda pulping is suitable for Kenaf fibres with treatable effluent that gives minimum impact on the environment. Recently, Kenaf fibre is used as raw material for jute bags, carpets, and non-woven with high-quality fibre. While for fluff pulp production, Kenaf fibre does not have to be high quality but the modest quality or discarded fibre are also attuned. For that reason, the economic value of Kenaf fibre will increase and optimize to produce high quality fluff pulp. In order to utilize Kenaf fibre as raw material for fluff pulp, there are some problems that have to be solved. They are sustainable harvesting for industrial scale, fibre handling, storage and transportation to avoid fibre defect, good variety plant, and guarantee for the farmers's harvests to be bought by the industry. If those problems are solved, the fluff pulp investments will grow up in the future.

4. MATERIALS AND METHODS

I. MATERIALS

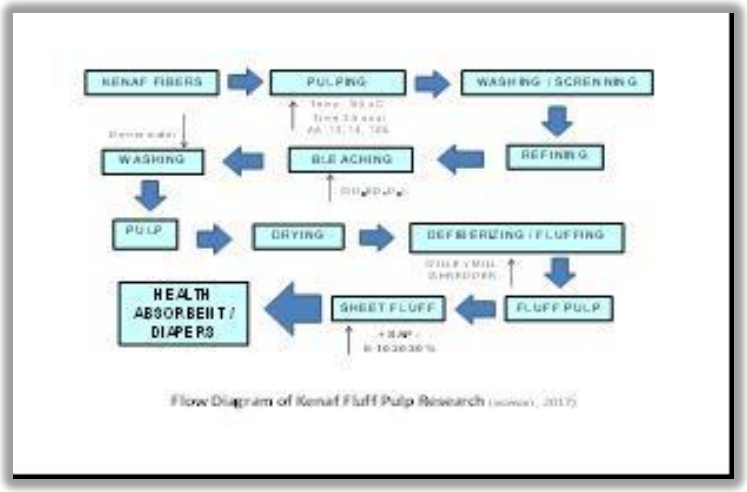
Fibre materials are Kenaf stalk low quality from Malang, East Java, whereas chemicals are caustic (sodium hydroxide/ NaOH) for cooking, oxygen (O) for pre-bleaching, chlorine dioxide (ClO_2) for bleaching, and additives of s*uper absorbent polymer* (SAP) or Acrylic acid-sodium acrylate copolymer–crosslink for liquid absorbent. Trade marks of SAP are: *Aqualic CA-W3, Aquamate Aq-2008, Kolan GS-3000, Drytech 535 LD, Aridal Asap 1100, etcs.*

Equipment

The equipments are: rotary digester, Jonhson screen, Refiner, Oxygen bleaching apparatus, Willey mill, Shredder, chemical and physical pulp analysis, absorbency and specific volume testing equipment.

Methods

Kenaf fluff pulp production for diapers research flow diagram is shown in Figure 1.



Flow Diagram of Kenaf Fluff Pulp Research

Raw materials preparation :

Kenaf fiber is chipped into dimension of 3-5 cm followed by moisture content measurement before pulping.

Pulping Condition:

Pulping of Kenaf chips is carried out in a Rotary Digester with capacity of 1600 gr oven dry (OD), using of soda process, with three active alkali (AA) charges: 12% AA (PK-12),14% AA (PK-14) and 16% AA (PK-16). Liquid to solid Ratio=1:4, Temperature= 165 °C, and Cooking Time= 3.5 hours (1.5 hrs + 2 hrs). Cooking is followed by washing prior to bleaching.

Bleaching Condition:

Kenaf pulp is bleached into $OD_oED_1D_2$ sequences toward ECF bleaching as shown in Table 2.

Table 1 : Bleaching process for pulp fluff Kenaf

Pameter	Stages of bleaching				
	O	**D_0**	**E**	**D_1**	**D_2**
Time, minutes	60	60	60	180	180
Temperature, ^oC	100	70	70	75	75
Pressure O_2, psi	87	-	-	-	-
Consistency, %	10	10	10	10	10
ClO_2 , % Active	-	0.22 KN	-	-	-
ClO_2 , %	-	-	-	1	0.5
NaOH, %	1	-	2	-	-
$MgSO_4$, $7H_2O$, %	0,5	-	-	-	-

Notes : O = Oxygen bleaching
D_o = Initial ClO_2 bleaching
E = Alkaline extraction with NaOH
D_1 = Second ClO_2 bleaching
D_2 = Third ClO_2 bleaching

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Chemical analysis of fluff pulp

Fluff pulp chemical testing is carried out using the Indonesian National Standard (SNI) testing methods for extractive and cellulose content, pulp viscosity, AOX, and pH.

Fluffing

Fluff pulp fiberization is carried out on the dried pulp sheet by using of 2 mechanical fiberizer equipment: Willey mill and Shredder in order to obtain individually separated fibres cotton like.

Fluff morphology

Measuring of fluff pulp fibre length is carried out using the SNI: pulp fibre length measurement.

Absorbency and specific volume

The testing of absorbency capacity and specific volume analysis is carried out with Scan-C:33-80 standard for *Specific Volume and Absorption Properties*. Specific Volume is carried out by putting the pulp pad on a plane plate followed by 30 second pressure of 500 gram weigh then measure the height. Calculation of the Specific Volume is using the following formula (Scan-C 33:80,1980):

$$X = (19.64h / 10w)$$

where : X = specific volume (cm^3/gr)

h = pad height (mm)

w = pad weight OD (gr).

The absorbency capacity is measured by putting the pad into a testing equipment containing of 0.9% salt solution (9 g/l) for 30 seconds and calculated the result using formula below (Scan-C 33:80,1980)

$$Y = (b - w) / w$$

where : Y = absorbency capacity (g/g)

b = weight of pad (wet)

w = Weight of pad (OD)

Testing equipment for Specific Volume and Absorption Properties is shown in Figure 2a and 2b.

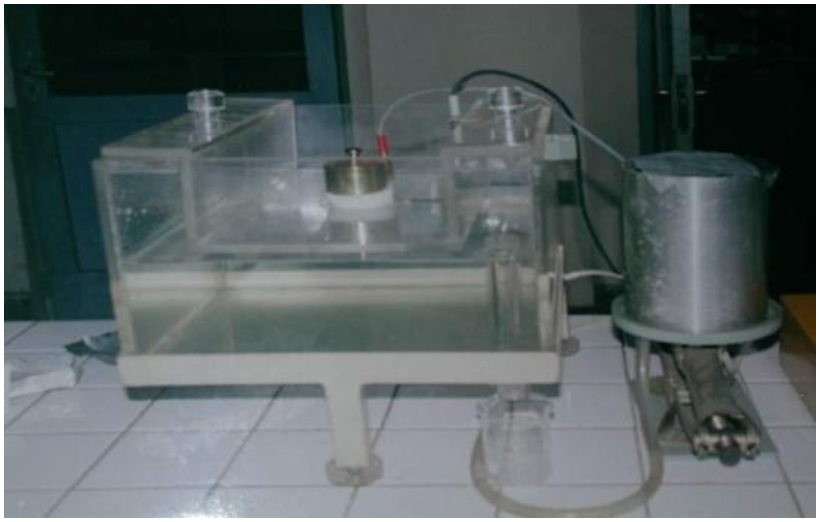

Figure 2a. Absorption fluff equipment test

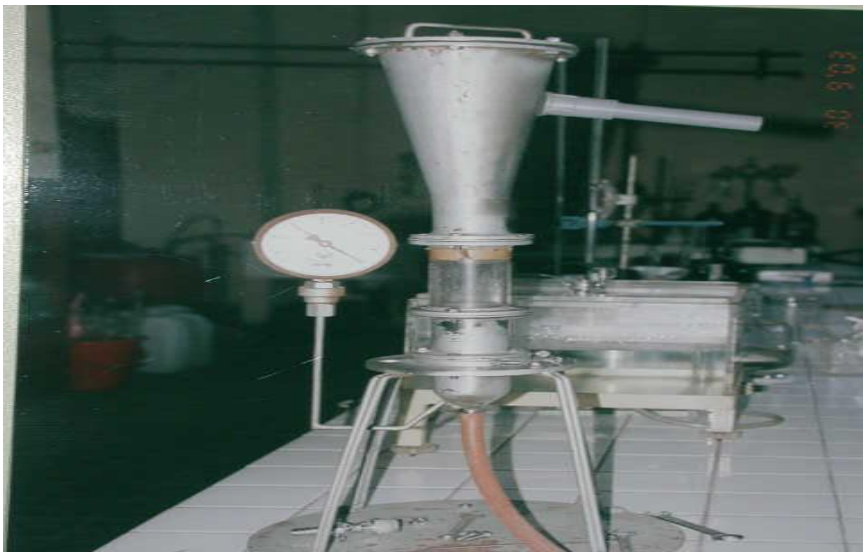

Figure 2b. Specific volume equipment test

5. RESULTS AND DISCUSSION

Pulping method of fluff pulp

Soda pulping is one of the chemical pulping method using of *sodium hydroxide* (NaOH) in the process reacts with lignin and other components in the Kenaf fibres (Mimms et al, 1993). Kenaf pulp is bleached in the $OD_0ED_1D_2$ sequences known as ECF (*Elementally Chlorine Free*) bleaching using chlorine dioxide (ClO_2) instead of chlorine gas (Cl_2) as in conventional bleaching. The ECF process is using small amount of organic chlorine compound, therefore it is environmentally friendly process while the pulp brightness and physical strength are high (Nakamata, 2004). The bleached pulp is then made into pad fluff pulp followed by packing like commercial diapers as ahown in Figure 3a, 3b, and 3c respectively.

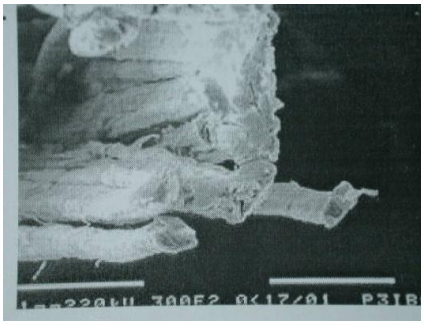

Figure 3a. Fiber fluff Kenaf

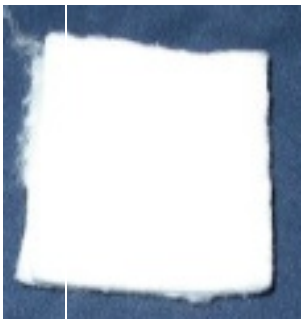

Figure 3b. Pad of fluff

Figure 3c. Commercial diapers

Kenaf pulp yield of AA charge 14% and 16% are 63.10% and 61.83% with Kappa Number (KN) 10.96 and 9.08 consecutively. The higher AA will decrease pulp yield and KN as shown in Figure 3d. Active alkali tend to break down the lignin, cellulose, or hemicellulose in line with AA charge and reaction time. The more delignification process, the lower the Kappa Number which will lessen the pulp yield and reject. Reject is a group of fibres or other

materials that is hard to break down in the cooking, too much reject indicates that the material is hard to disintegrate.

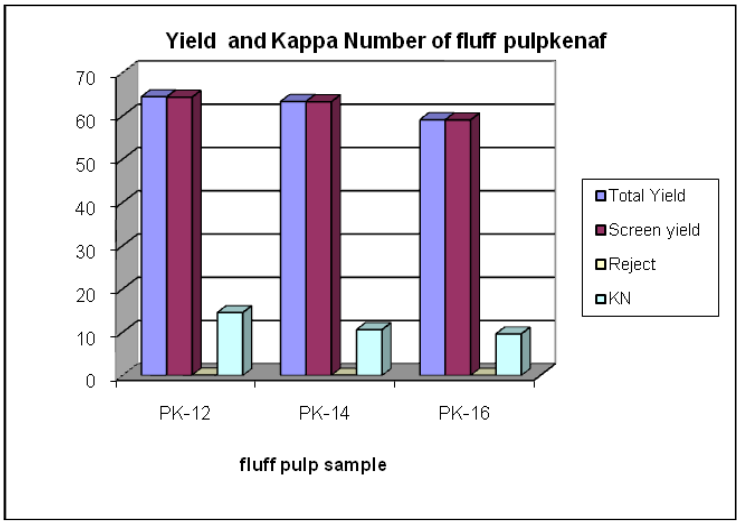

Figure 3d. Pulping Kenaf fiber for fluff pulp

Kappa number (KN) can specify pulping level, the high KN indicates the high residual lignin in the pulp (Casey, 1980). The lignin will consume more bleaching chemicals in bleaching phase. The condition is in accordance with the AA consumption of cooking, the more AA causes more delignification and the lower the KN. Pulp yield and KN pulp observation in the 14% and 16% AA cooking shows insignificant result, but for 12 AA shows significant result and lower fluff pulp quality.The optimum cooking condition for high yield fluff pulp, low KN, and less chemical consumption are obtained when using of 14% AA. The result can be obtained in the Kenaf-14 which consume less chemical and energy so that it is more economist while the fluff pulp quality is in compliance with the standard.

Residual black liquor of fluff pulp cooking

Total solids, pH, residual total alkali, active alkali, organic, and anorganic content of the residual black liquor are analyzed as shown in Table 2.

Table 2 : Black liquor Properties of Kenaf pulping

Sample	Solids %	Residual		Organic	norganic	pH
		Total Alkali	Active Alkali			
Fluff 12%	13.26	7.04	10.21	3.14	96.86	12.10
Fluff 14%	14.54	8.25	9.20	3.68	96.32	12.12
Fluff 16%	16.17	12.47	5.99	4.29	95.71	12.22

Total solids will increase with the increasing of AA charge as shown on the AA 14% to 16% which gives total solids of 14.54% to 16.17% respectively. These total solids are quite high which is normally 9% in non-wood cooking, whereas the residual AA during the cooking is indicated in the black liquor pH as shown Table 2.

R esidual of total alkali and active alkali indicate the chemical cooking liquor efficiency. In a large mill, the residuals are recovered for they still contain anorganic 95.71-96.86% which can be used in the next cooking, whereas the organic is used as energy source (Mimms et al,1993).

II. BLEACHING OF FLUFF

Lignin in the fluff pulp needs to be removed to increase the absorbency of the fibres. This is related with lignin properties as hydro phobic and stiff, which can decrease the absorbency while darken the pulp for its chromophoric functional group. Bleaching is a process that lightens, whitens, or brightens the cellulose fibers in the pulp through chemical actions. This is important because there have never been found unbleached fluff pulp diapers in the market. Besides unhygienic image, it also gives impression of unclean to users.

Table 3. Chemical properties of fluff

Component	Sample		Commercial Diapers
	Fluff Kenaf	Stora Fluff	
Extractives, %	0.01- 0.07	0.15 - 0.30	0.1
α-celulose, %	80.54 - 90.11	82.67- 86.87	85 - 90
Viscosity, cp	4.76	6.78- 6.87	-
Brightness, % ISO	89,46	85-86	86
pH	6.5	6.0	-
Moisture content,%	9.2	8.0	-
AOX, kg/ton	0.05	< 0.1	-
Knot, %	5	3- 8	-

Bleaching of fluff pulp is carried out in O-D_0-E-D_1-D_2 sequences, which is economist because of its lower KN after cooking that causes less bleaching chemicals consumption. Bleaching of Kenaf fluff pulp can reach brightness to above 89 %GE, which exceeds the Stora fluff and commercial diapers brightness standard of 85–86 %GE as shown in Table 3.

Chemical of fluff

Some requirements for fluff pulp are low extractive content, high brightness and cellulose content above 80% (Field, 1982). In fact, Kenaf fluff pulp has low extractives in the ranges of 0.01-0.07%, which is lower than the commercial diapers of 0.1 – 0.3% as shown in Table 3. This condition makes clear that Kenaf fluff pulp has the same quality as the fluff pulp commercial. The α cellulose content of Kenaf fluff pulp is above 80–90% which means that the cellulose content is high enough to function as absorbence material or properly bonding the liquid.

This property can give positive effect which is optimal quality for fluff pulp diapers. Residual of chlorine in the pulp should be low which revealed the AOX content <0.1 so that during exposed with the skin will not irritate or allergic to users.

Morphology of fluff fiber

According to Klemm's length fibres classification in Casey (1980), Kenaf fluff pulp fibres length are in the range of 1.95-5.00 with average of 2.98 mm which is categorized into long fibre group (>1.96 mm). This fibre length value is in accordance with the imported Stora fluff fibre length and the commercial diapers as shown in Figure 4.

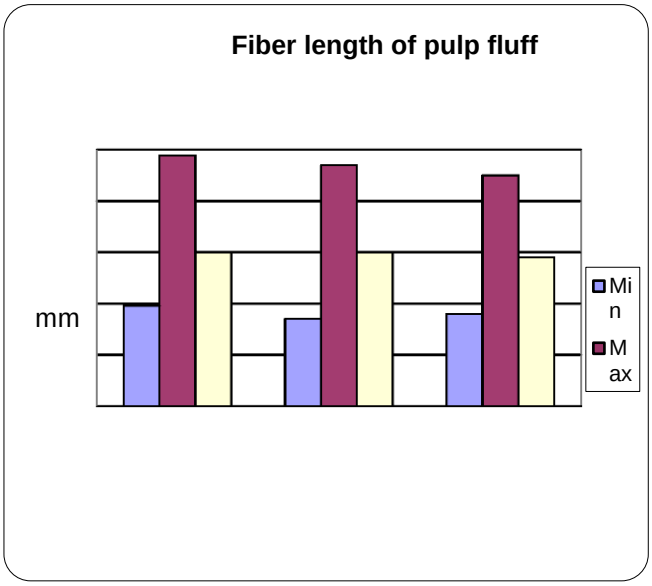

Figure 4 : Fiber length of fluff pulp

From the fibre length point of view which is one of the requirement for fluff pulp, Kenaf has a good prospective to substitute imported fluff material. Its length fibre like cotton is the primary choice for diapers' absorbent material to retain water. The length of fibre **± 2,98 mm (>1.96 mm)** can provide wide surface area, strong fibre bonding, and high absorbency.

Fluff absorbency

The most important output of the fluff pulp production is its high liquid absorbency that can substitute imported fluff. Normally, dry cellulose fibre are hygroscopic that can absorb water from any source. However, it is hard to obtain 100% of dry cellulose. Getting rid of 1% moisture content from cellulose fibre will harm the cellulose molecule structure (Gallary, 1973). Water absorption in the fluff pulp can be categorized into three ways, i.e.: water adsorption, water absorption, and capillary water (Gallary, 1973).

The adsorption and absorption of 30% water weigh in the fibre is called fibre saturation. Kenaf fluff pulp has a limit of water absorbency, starting from the interaction amongst hydrogen bonds with cellulose hydroxide groups,

and water molecule, which traps a certain amount of water in the **cellulose tube**. The amount of water trapped in the cellulose tube is the maximum absorbent capacity of the cellulose (Field, 1982 ; Liva , 1979;).Based on the liquid absorbent capacity observation, Kenaf fluff pulp is categorized having almost similar absorbency with the imported fluff pulp especially with sample Kenaf-14. The absorbency are varies depends on the defiberizing handling either by willeymill or shredder.Shredded fluff has higher absorbency than the willey mill fluff since the fibre is more exposed than the willey mill fluff which has more fines and cuts. Absorbency range is between 7.03–9.20 g/g, which is closed with 8.0–9.5 g/g of the imported Stora fluff as shown in Table 5.

Table 4 : Kenaf fluff pulp Liquid Absorbent Capacity

Fluff Sample	Absorption capacity (g/g) for 30 seconds							
	Willeymill Defiberzing				Shredder Defiberizing			
	+ SAP, %				+ SAP , %			
	0	10	20	30	0	10	20	30
Fluff-12	7.03	10.76	11.98	13.78	9.05	12.17	13.08	14.90
Fluff-14	9.12	12.10	14.62	15.49	9.20	14.10	16.62	17.99
Fluff-16	9.11	13.63	15.07	16.42	9.03	14.63	16.47	18.78
Stora fluff	8.0 - 9.5							
Commercial Diapers	8.6 - 15.9							
SAP 100%	25 - 30							

The addition of 10%, 20% and 30% of *Super Polymer Absorbent* (SAP) into fluff pulp based on dry weight has shown positive effect increasing of the liquid absorbency properties. Exampel of SAP can be seen in Figure 5.

Figure 5. Sample of Super Polymer Absorbent (SAP)

The increasing of absorbency is correlated closely with the amount of SAP added, since SAP can improve the liquid absorbency (Jasper,182). The higher the addition of SAP percentage the higher the absorbency increasing even up to 75%. Sample Kenaf fluff-12 shows that it initially has the lowest 7.03 g/g absorbency but after being added 10% SAP the absorbency is increasing into 10.76 g/g or increasing 53.05%. An addition of 30% SAP on weight can increase the absorbency up to 95.54 %. The value of Kenaf fluff pulp absorbency before and after the

SAP addition indicate its prospective and speciality in increasing of diapers quality to compete with the imported market diapers. Important thing to bear in mind on the addition of SAP is the appraisal of the minimum and economist SAP quantity since SAP is quite costly (Branon,1990 ; Visoli, 1997).

Fluff Specific Volume

Specific volume of fluff pulp is the quantity of fibres in a volume unit divide weight unit. The higher the specific volume value the more fluffy is the pulp. Kenaf fluff's specific volume produced by willey mill or shredder give specific volume value between 5.80-7.84 cm^3/g. These values depend more on the fluff pulp fiberization process than on the cooking or bleaching as shown in Table 5. Willey mill fiberization shows lower value than the shredded fluff pulp. This is because the willey mill fluff pulp has more fines and soft so that the specific volume value is lower. Whereas the shredded fluff has coarse and voluminous fibres which gives higher specific volume value. Specific volume value will affect the forming of tubes amongst the fluff fibres. The more interfibre tubes forming will increase the liquid absorbent capacity (Stora Enso, 1994).

Table 5 : Specific volume value of Kenaf fluff pulp

Fluff Sample	Specific volume (cm^3/g)							
	Willeymill Defiberzing				Shredder Defiberizing			
	+ SAP, %				+ SAP, %			
	0	10	20	30	0	10	20	**30**
Fluff-12	5.80	6.20	6.82	6.97	7.24	7.58	7.69	7.73
Fluff-14	5.85	6.22	6.87	7.01	7.28	7.66	7.72	7.84
Kenaf-16	5.80	6.27	6.85	6.98	7.27	7.64	7.74	7.81
Stora Fluff	6 – 19 cm^3/g							
Commercial Diapers	7.3 - 21.2 cm^3/g							

Techno-economy of Kenaf fluff pulp production

Techno-economy analysis of Kenaf fluff pulp production is carried out through makloon approach in a 30 ton/ day with some assumptions as follows :

- Kenaf fibre low quality/ discard = Rp 850/ kg
- Kenaf fluff pulp Production = 30 ton/ day
- 1 Year Production = 300 days
- US $ Exchange rate Kurs = Rp 9.500
- Fluff pulp market price $ 1000/ ton = Rp 9.500.000/ ton

First stage calculation is by estimating the required Kenaf plantation area to supply the production of 30 ton/ day fluff pulp continuously with the assumption Kenaf Production/ ha = 2.5 ton (OD), and bleached fluff pulp yield = 50% as shown in Table 6.

Table 6: Kenaf Plantation Land Use Analysis

1	Consumption of Kenaf fiber /day	30 ton/ day x 100/ 50	60 ton /day
2	Consumption of Kenaf fiber/ year	300 days/ yr x 60 ton/day =	18,000 ton/year
3	Land area for Kenaf plantation to produce fluff pulp (OD) 30 ton/ day	100/ 50 x 30 ton/ day : 2.5 ton/ ha	24 ha/day
4	Minimum land area required to produce 1 ton fluff pulp	24 ha/ day : 30 ton/ day	0.8 ha/day
5	Required land area for 1 year production (2 times harvest/ year)	24 ha/day x 300 day/ year : 2	3,600 ha/year

Supplying of Kenaf raw material continuously from the farmers to the pulp mill producing 30 ton pulp/ day, which is equal to 9,000 ton/ year, there should a land preparation of minimum 3,600 ha/ year. The analysis and target achievement will be better if there is control on Kenaf plant type and plantation management. To put those above effort on right track requires 15% additional land area from the minimum area demand. Other alternative is through reinciting of intensive or extensive Kenaf plantation program in Java or outside Java Island.

Table 7 : Cost Benefit Analysis for Kenaf fluff pulp production

No	Cost Component	Value	Cost (Rp)
1	Kenaf fiber	23%	1,700,000
2	Chemicals	22%	1,626,087
3	Utility	24%	1,773,913
4	Overhead cost	14%	1,034,783
5	Administration	**1%**	73,913
6	Bank Interest	16%	1,182,609
7	Production Cost of fluff pulp/ ton (**macloon**)	100%	7,391,305
8	Production Cost of fluff pulp 30 ton/ day		221,739,150
9	Cost production of fluff / year (1 year = 300 days production)		66,521,745,000
10	Gross Sales (before tax / year)		85,500,000,000
11	Value Added Tax 11.5%		9,832,500,000
12	Net Sales (after tax/ year)		75,667,500,000
13	Benefit/ year		9,145,755,000
			(13.75%)
If the investment is deposited in Indonesian Bank with 6%/ year Interest of deposit bank before tax 15%, it will give profit of Rp 3,392,608,995			

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Table 8 shows the cost of 1 ton Kenaf fluff pulp production is Rp 7,391,305. Mill operational cost is Rp 5,691,305 (excluding raw Kenaf fibre cost). If compared with the current 6% Indonesian Bank deposit interest, the profit of selling Kenaf fluff pulp is three times higher. Therefore, the investment of Kenaf fluff pulp production or business in Indonesia is quite feasible and promising.

Table 8 : Calculated Indonesian Consumption of Fluff for diapers per year

1	Population of Indonesia year 2005		220 milion
2	Children under 5 years old 15%	15% x 220 million	33 milion
3	Children under 5 years old used diapers 10%	10% x 33 milion	3.3 milion
4	Weight of fluff in diapers/ child = 20gr	20/ 1 milion/ day x 3.3 milion	66 Ton/ day
5	Using of diapers/day = 4 times/child	4 x 66 ton/ day	264 ton/ day
6	Consumption of fluff/year (300days)	300 day/year x 264 ton/day	79.200 ton/ year
7	Conversion to fluff pulp mills (Cap. 9.000 ton/year), equals to mills		9 mills
8	Saving for national income revenue (1 ton = $ 1000)	79.200 ton/year x $ 1000/ton	$ 79.2 milion/ year
		Rp 9.500 x $ 79.2 milion/th	Rp 752.4 bilion/ year

Kenaf Fluff SWOT Analysis

Setting up of new business requires some careful considerations and judgements, therefore mapping of the obstacles and prospects are carried out thoroughly on the strength, weakness, opportunity, and threat (SWOT) analysis. The SWOT analysis studies all aspects of the technical, quality, social, and economy of the Kenap fluff pulp production so that it can raise the opportunity of replacing the imported softwood long fibre for diapers. Moreover, reducing the imported fluff pulp by producing of Kenaf fluff pulp locally will save the Indonesian national revenue. In fact, there are some discovered strategies that can be used to develop Kenaf fluff pulp as raw material for diapers as shown in Table 9. From the users health risk point of view, since Kenaf fluff pulp chemical content analyzed as residual chlorine is relatively small below 0.1% which is alike as in the commercial fluff pulp, therefore it will not give negative effect. Another risk such as Kenaf fluff pulp compete with other products of Kenaf will not happen since Kenaf fluff pulp raw materials are the low quality of Kenaf or the reject, which is not in use any longer.

Table 9 : Matrix of Kenaf Fluff SWOT Analysis

	STRENGTHS (S)	**WEAKNESSES (W)**
	1. Kenaf is locally available 2. Product quality = Import quality 3. Technology & human resources is available 4. High local market demand	1. Kenaf fluff pulp mill is not available 2. Kenaf fiber costly 3. Discontinue Kenaf fiber supply

OPPORTUNITIES (O)	*SO - STRATEGIES*	*WO - STRATEGIES*
1. Market for fluff Kenaf 2. Duty free 3. Optimation for Kenaf farmer	*1. Profitable business development (S1, S2 , O1)* *2. New product development (S1, O2)*	*1. Seeking for investment to set up Kenaf fluff pulp mill (W1, O2)* *2. Extensive and intensive Kenaf plantation (W2, W3, O3)*
THREATS (T)	***ST - STRATEGIES***	***WT - STRATEGIES***
1. High additives and production cost 2. Continuous fluff pulp import 3. Diapers import minded	*1. Promote to fluff pulp (S1, S2, T1)* *2. Elimination for import pulp fluff (S4, T3)*	*Synergic cooperation in setting up fluff pulp mill (W1 , W3, T1)*

6. CONCLUSION

Kenaf fluff pulp or fibres technically and economically are prospective to be developed as raw material for fluff pulp diapers since it has specialty qualities such as its physical properties which are almost similar with the imported fluff pulp qualities.

Optimum condition of fluff pulp production with soda pulping are Active alkali 14%, cooking temperature 165^{o} C for 3.5 hours which will produce 61.83 – 63.10% pulp yield and Kappa Number of 9.08 – 10.96. Bleaching is done with the $OD_0ED_1D_2$ sequences producing of 89 % GE brightness and the extractives < 0.01% and knot content 5%. Shredded fluff pulp has the absorbency capacity above 9.12 g/g, which will be able to increase up to 90% with the additional of SAP 10–30% treatment of dry fluff weight. Kenaf fluff pulp quality is as good as the current market fluff pulp. Operational cost of Kenaf fluff pulp production with makloon system in the pulp industry is Rp 7,391,305/ ton. With the selling price of $ 1000/ ton and $1 = Rp 9,500, the techno-economy net profit is Rp 9,145,755,000/ year or 13.75 % of the capital. Kenaf fluff pulp needs 24 ha/day or 3,600 ha/ year to produce 30 ton/ day with the assumption that the harvesting is once in 5 months or twice in a year, and the fluff pulp yield is minimum 50%.

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