Moroccan Journal of Chemistry
ISSN: 2351-812X
http://revues.imist.ma/?journal=morjchem&page=login
Irawan & al. / Mor. J. Chem. 8 S1 (2020) 001-011

Improvement of Reaction Selectivity Performance with Alkali Charge and Reaction Time on Oxygen Delignification Process

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Received 22 Dec 2019,
Revised 02 Jan 2020,
Accepted 09 Jan 2020

Abstract

The chemicals of NaOH is highly related to the quality of the pulp in the *medium consistency oxygen* process. This research used *Acacia mangium* and *Eucalyptus* pulp with KaNo 18. The condition of the *medium consistency oxygen* process, the temperature of 80^{o}C, oxygen pressure of 1 bar. Reaction time was 20 to 100 minutes at intervals of 20 minutes. NaOH charges 5 to 25 kg /t at intervals of 5 kg/t. The analysis parameters used are KaNo and viscosity. The higher value of NaOH charge and reaction time, the higher value of the delignification degree. The higher value of NaOH charge and the reaction time, the higher the value of chain scission number. The variation of NaOH charge in the same reaction time indicated that the higher NaOH charge value, the lower value of the polymerization degree. The variation in reaction time indicated the longer the reaction time, the lower the polymerization degree. The reaction selectivity value was not affected by the high value of NaOH charge. The longer the reaction time used, the lower the reaction selectivity.

Keywords: *Medium consistency oxygen; delignification degree; polymerization degree; chain scission number; reaction selectivity*

1. Introduction

The fiber degradation and delignification can be found in the pre bleaching process dominantly. The pre bleaching process is a medium consistency oxygen process delignification system. This process is in part considered as a continuation of the pulping alkaline processes and, somehow, as the first step in the bleaching process. Oxygen delignification in the pre bleaching stage decrease the kappa number prior to chlorination and provides the bleaching plant with a pulp that has a considerably reduced kappa number [1]. The oxygen delignification is the removal of part of the residual lignin of kraft cooking through the pulp reaction with oxygen and sodium hydroxide, using the temperature as an activating element [2]. Oxygen delignification is a substitute for both chlorine and chlorine dioxide delignifaction which has technical and economic benefits [3]. Carbohydrate degradation occurs in particular during the initial and continues towards the end of kraft cook. The oxygen-alkali process (O-delignification) is known to be more selective (Carbohydrates yield/delignification) than the final phase of kraft cooking [4]. The medium consistency oxygen process consists of a centrifugal pump, a steam medium pressure injection system, a gas mixer with high turbulence, a distribution reactor and a pressurized reactor [5]. One of the medium consistency oxygen system is a single reactor system. This system can improve the delignification selectivity which can be seen from the viscosity value of the pulp produced. The variables of the medium consistency oxygen process are pressure in the process, temperature, pH, reaction time, and consistency. Complete variation of process conditions as shown in Table 1 [2].

Table 1. Typical conditions in the oxygen delignification for industrial.

Operational Conditions	Average Consistency (%)	High Consistency (%)
Pulp consistency, %	10 – 14	25 – 34
Reaction time, min	50 – 60	30 – 45
Reaction temperature, oC	70 – 105	400 – 115
Alkaline charge, kg.t-1	18 -28	18 – 23
Oxygen load, kg.t-1	20 – 24	15 – 24

Oxygen gas is then added to the pulp ahead of an oxygen mixer, which reduces the size of the oxygen gas bubbles and produces intimate contact between the pulp and oxygen [1]. Oxygen delignification is the dissolution of some of the lignin remaining in the kraft pulping process with oxygen and sodium hydroxide and using temperature as an activating element. The result of this process is a decrease in KaNo, so the use of bleaching chemicals will decrease[2]. The degree of delignification at the same sodium hydroxide charge was dependent on initial kappa number. The target of cooking softwood kraft for unbleached pulp is above the kappa range 25−30 and further delignification is using an alkaline oxygen process to the kappa level 15-20 [3]. Process scheme of *Medium consistency oxygen* process can be seen in Figure 1. The delignification process occurs in the medium *consistency oxygen* stage. The delignification reflected on the reduction of Kappa numbers. Kappa number reduction in the medium system consistency oxygen depending on classification and wood species [4]. For softwood species, Kappa Number reduction can reach 75% while hardwood Kappa Number reduction can reach 45% to 50%. At the stage of the *medium consistency oxygen* process beside use thermal applications also applied the injection of alkaline chemicals. The oxygen delignification process is a flexible process and best done between the cooking process and the bleaching process [5]. Using oxygen delignification before bleaching to reduce the amount of chlorinated organic compounds in the bleach plant effluent [6]. The chemical used in the *medium consistency oxygen* process is soda (NaOH). Alkaline chemicals are very important in the process of cellulose degradation. The process of degradation of fiber in alkaline media is initially characterized by swelling of the cell wall. The reactions between oxygen and the

degradation products in the process liquor reduce the amount and effectiveness of oxygen available for delignification reactions during the OD process [7]. Oxygen shows relatively lower selectivity between delignification power and carbohydrate degradation. Delignification is generally limited to no more than 50% to prevent over degradation of carbohydrates [8]. The degree of polymerization (DP) was calculated from the value of intrinsic viscosity using the relationship proposed by Inmergut, Shurtz, and Mark

$DP^{0.905} = 0.75\ [\eta]$

Where the values of 0.905 and 0.75 are constants characteristic of the polymer-solvent system and [η] is the intrinsic viscosity ($mL.g^{-1}$) [9]. The degree of polymerization indicates the level of cellulosic degradation during the cooking process. The higher the polymerization degree value, the stronger the cellulose (fiber) in cellulose degradation events. The solubility of cellulose in soda decreases as the degree of polymerization increases [10].

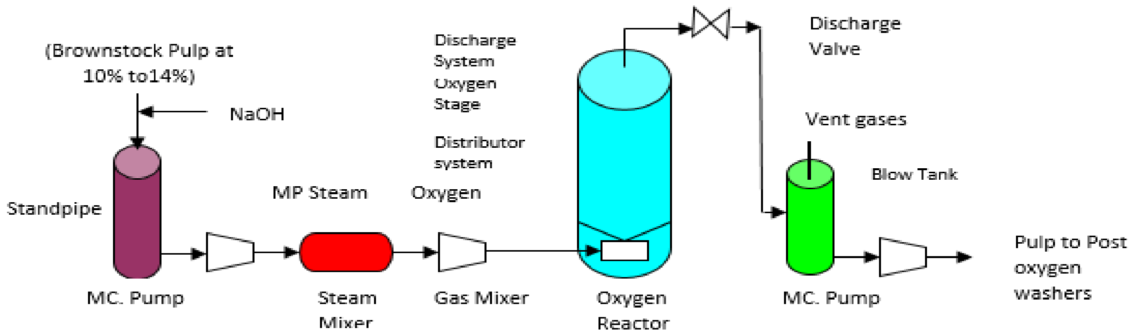


Figure 1. Scheme of *Medium consistency oxygen* single-stage system [4].

The Polymerization degree is calculated from the intrinsic viscosity [η] of the pulp in ml g^{-1}, and the weight fractions of hemicelluloses (H) and cellulose (G) in the pulp according to Equation 1[11].

$$DP = \left[\frac{(1.65[\eta]-116H)}{G} \right]^{1.111}$$

The negative aspect of oxygen delignification is its poor selectivity (i.e., delignification/cellulose degradation), especially at a high degree of delignification and high initial kappa numbers [11]. The selectivity of the O stage on was improved by offered a greater effect on kappa number reduction but induced more serious cellulose degradation [12]. Selectivity is commonly calculated as the ratio of the change in kappa number to the change in viscosity of the pulp. The selectivity coefficient (α) is defined as the slope of a curve when (1/DPt – 1/DP0) is plotted versus the change in kappa number (ΔK). The value (1/DPt – 1/DP0) represents the number of chain scissions per polymer unit of cellulose. Selectivity is defined as the reduction in kappa number is divided by a number of chain scissions of cellulose (1/DPt – 1/DP0) [13].

$$Selectivity = \frac{(\Delta K)}{(1/DPt - 1/DP0)}$$

2. Experimental

2.1. Materials

In this research used *Acacia mangium* and *Eucalyptus* pulp with KaNo standard 17 -18. In each trial using a sample weight of 4 gram OD (oven dry). Chemicals used NaOH (lab grade), oxygen gas (pure).

2.2. Method

Unbleached pulp samples of *Acacia mangium* and *Eucalyptus* with KaNo standard 17-18 were used in the treatment of medium consistency oxygen process. The test tubes used 6 pieces with a capacity of 270 cm^3 each. The pulp sample used each 4 g OD. The consumption of NaOH variation used 5 kg/t, 10 kg/t, 15 kg/t, 20 kg/t and 25 kg /t based on the sample OD weight. The variation of reaction time used 20, 40, 60, 80 and 100 minutes. The reaction temperature was 80ºC with an oxygen pressure of 1 bar. The mixing of material consistency was 10%. Stir the mixture sample and NaOH until smooth and tightly close the test tube. After the test tube closed, inject O_2 gas into the test tube until a pressure of 1 bar is reached. Placed each test tube into the rotator with a temperature of 80ºC. Turn on the test tube rotating motor. Controlled the condition of the tool until the reaction time was completed in accordance with the variations available. After the treatment finished, lift the test tube from the heater. Open the test tube and remove the pulp sample, wash with 2000 mL of water and strain with Whatman filter paper No.41 use a vacuum. Then the pulp was ready to be analyzed for KaNo and viscosity. The KaNo parameter analysis used the TAPPI T 236 CM-94 method [14] and the viscosity parameter the TAPPI T 230 method [15].

2.3. Instrumentation

The equipment used for this research were water bath with a temperature setting of 80ºC, six reactor tubes with a capacity of 270 cm^3 with valve for oxygen filling and two chambers rotate to place the reactor tube.

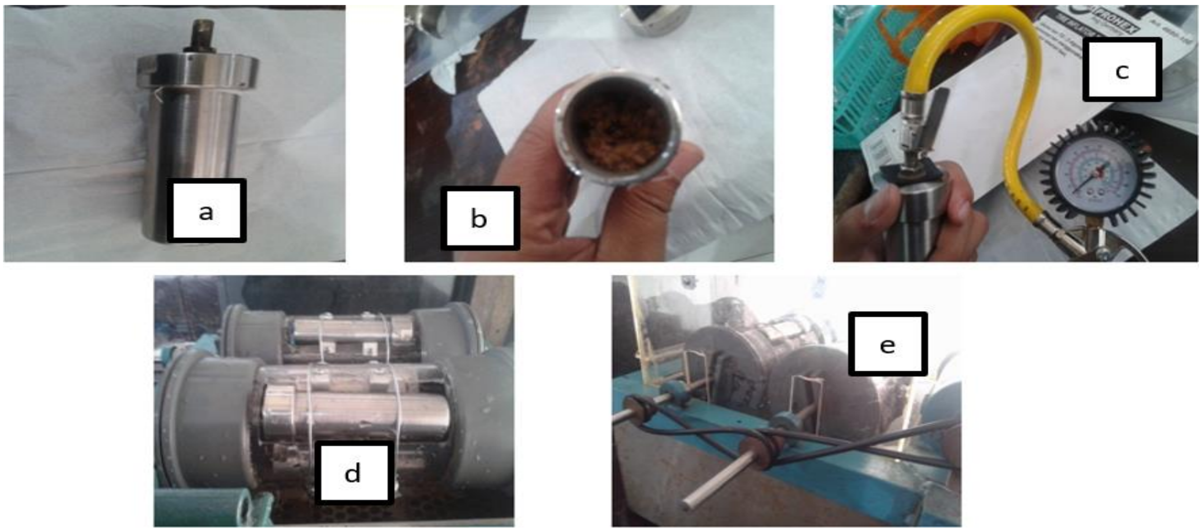


Figure 2. (a) Test tube for Medium consistency oxygen process, the capacity of 270 cm^3; (b) Position of pulp sample in the reaction tube; (c) Inject oxygen into the test tube; (d) Position the test tube in the rotary chamber; (e) Test tube rotation system in a water bath

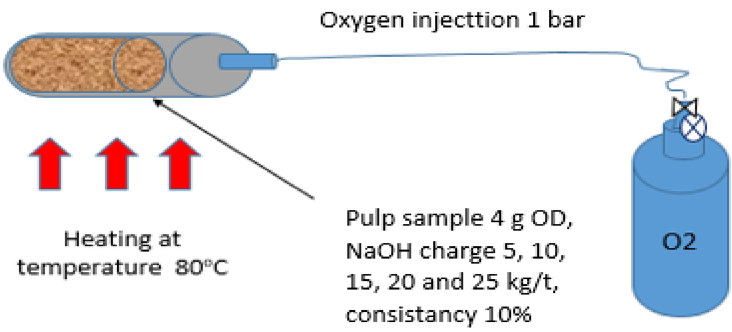


Figure 3. Medium consistency oxygen test tube with oxygen supply

3. Results and discussion

Medium consistency oxygen process was carried out with a variety of process parameters, among others, NaOH charge, reaction time, reaction temperature and O_2 pressure. The NaOH charges used were 5, 10, 15, 20 and 25 kg/t. The reaction times used were 20, 40, 60, 80 and 100 minutes. The reaction temperature used was 80°C. The oxygen pressure used was 1 bar. The quality of the pulp produced was influenced by the type of pulp, NaOH charge, reaction time and temperature of the reaction on the *medium consistency oxygen* process.

Table 2. Results of pulp quality analysis in *medium consistency oxygen* process

No	Time (min)	NaOH Charge (kg/t)	*Acacia mangium*		*Eucalyptus*	
			KaNo	**Viscosity (cm^3/g)**	**KaNo**	**Viscosity (cm^3/g)**
1	Pre *Medium consistancy oxygen*	-	18.00	808	17.69	679
2	20 min	5	11.88	785	13.66	670
3		10	11.87	768	12.10	667
4		15	11.19	727	11.13	659
5		20	11.40	713	11.40	668
6		25	11.02	759	10.90	632
7	40 min	5	11.75	771	11.75	659
8		10	11.60	794	11.60	664
9		15	10.84	692	10.83	636
10		20	10.70	699	10.70	624
11		25	10.47	683	10.46	620
12	60 min	5	11.66	757	11.62	647
13		10	11.36	793	11.36	653
14		15	10.68	677	10.68	599
15		20	10.27	624	10.27	569
16		25	10.20	613	10.20	565
42	80 min	5	11.62	741	11.46	637
43		10	11.33	784	11.13	634
44		15	10.51	586	10.53	571
45		20	10.04	599	10.04	535
46		25	9.95	493	10.03	532
47	100 min	5	11.58	734	11.40	630
48		10	11.22	784	11.00	627
49		15	10.42	573	10.24	568
50		20	9.84	565	9.84	509
51		25	9.80	460	9.90	506

The analysis parameter of pulp quality produced from the *medium consistency oxygen* process was Kappa number and viscosity. The KaNo value indicates the delignification process in the pulp and the degree of delignification value. The

lower the KaNo value the higher the solubility of lignin in the *medium consistency oxygen* process. The higher the solubility of lignin, the higher the value of delignification degree in the *medium consistency oxygen* process. The viscosity value indicates the value of cellulose degradation or degree of polymerization. The lower the viscosity value, the higher the cellulose degradation. The results of pulp analysis based on NaOH charge and reaction time variations in the oxygen consistency medium process can be seen in Table 2. Based on the KaNo and Viscosity values can be calculated by several other parameters. namely the delignification and polymerization degree. The reaction selectivity value was calculated based on the difference in Kappa number (dK) and the difference in the polymerization degree value (1/DPt – 1/DP0) in each treatment [16]. The selectivity value in treatment indicates the effectiveness of a *medium consistency oxygen* process.

3.1. The effect of NaOH charge on the degree of delignification at a temperature of 80°C

The degree of delignification is the percentage decrease in lignin content before and after the *medium consistency oxygen* process. The lignin content calculated based on the value of KaNo. Where L (%) = 0.147 x KaNo [16]. While the formula delignification degree (%) is [17]:

$$DD\ (\%) = \frac{(Lo(\%) - Lt(\%))}{Lo(\%)} \times 100\%$$

Where:

DD is the Degree of Delignification

Lo (%) is the content of lignin before the medium consistency oxygen process

Lt (%) is the content of lignin after the medium consistency oxygen process

Delignification degree values from *Acacia mangium* and *Eucalyptus* samples were calculated based on the KaNo value and viscosity in the medium consistency oxygen process The effect of NaOH charge on delignification degree values in *Acacia mangium* and *Eucalyptus* can be seen in Figures 4 (a) and (b).

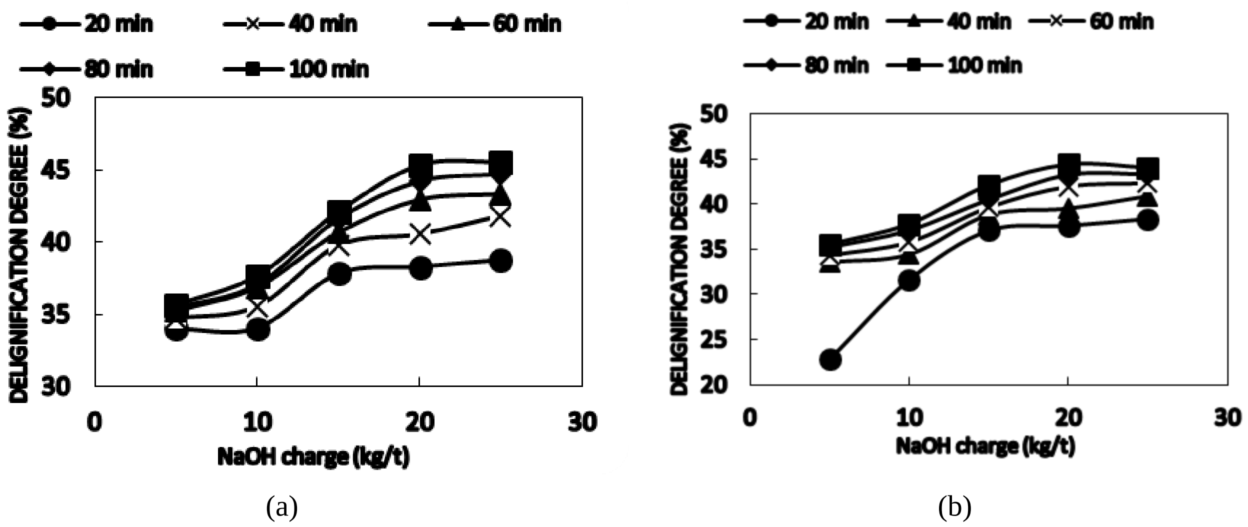


Figure 4. Effect of NaOH charge and reaction time on delignification degree value (%) of: (a) *Acacia mangium* and (b) *Eucalyptus*, in medium consistency oxygen process

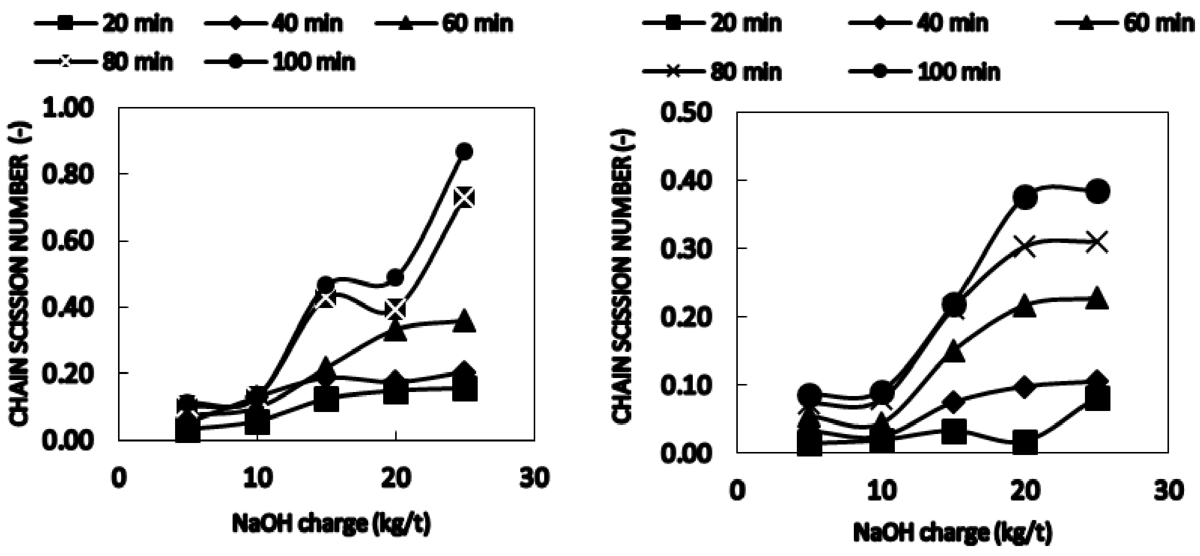
In Figure 4(a) and (b) show the phenomenon that the higher the value of NaOH charge on the *medium consistency oxygen* process, shows the value of delignification degree increases. It means the lignin dissolved was increase due to the increase in NaOH in the *medium consistency oxygen* process. The reaction time was also very influential on the degree of delignification. The longer the reaction time used shows the higher the degree of delignification. In *Acacia mangium*, the highest degree of delignification was 35.7% to 45.6% achieved at a process temperature of 80^{o}C, the reaction time of 100 minutes, oxygen pressure of 1 bar and NaOH charge 5, 10, 15, 20 and 25 kg/t.

While the reaction time of 20 minutes produced the lowest delignification level of 34.00% to 38.87%. Every increase in NaOH charge of 5 kg/t and reaction times of 20, 40, 60, 80 and 100 minutes affected the increasing of the delignification degree were 1.2%, 1.8%, 2.0%, 2.3% and 2.5% respectively. In *Eucalyptus*, the highest degree of delignification was 35.6% to 44.0%. Achieved at a process temperature of 80^{o}C, the reaction time of 100 minutes, oxygen pressure of 1 bar and NaOH charge 5, 10, 15, 20 and 25 kg / t. While the reaction time of 20 minutes produced the lowest delignification level of 22.8% to 38.4%. Every increase in NaOH charge of 5 kg/t and reaction times of 20, 40, 60, 80 and 100 minutes affected the increasing of the delignification degree were 3.9%, 1.8%, 2.0%, 2.0% and 2.1% respectively.

3.2. Effect of NaOH charge on changes of chain scission number

Cellulose degradation was always related to the termination of a number of C chains in the cellulose structure. The chain scission number in degradation can be formulated with. chain scission number = (1/DPt - 1/DPo) x DPo [16].

The number of C chains interrupted during the medium consistency oxygen process between *Acacia mangium* and *Eucalyptus* can be seen in Figure 5 (a) and (b).



(a) (b)

Figure 5. Effect of NaOH charge and reaction time on chain scission number value (%) of: (a) *Acacia mangium* and (b) *Eucalyptus* in medium consistency oxygen process

Figures 5 (a) and (b) show that the higher NaOH charge and reaction time, higher chain scission number values in the samples of *Acacia mangium* and *Eucalyptus*. Every increase reaction time 20 minutes indicated the longer the reaction time, the higher the level of chain scission number value according to the NaOH charge used. This means the cellulose degradation in the medium consistency process of oxygen was affected by NaOH charge and reaction time. In *Acaccia mangium*, the highest chain scission number value was 0.1126 to 0.8700 achieved at a process temperature of 80^{o}C,

the reaction time of 100 minutes, oxygen pressure of 1 bar and NaOH charge 5, 10, 15, 20 and 25 kg/t. While the reaction time of 20 minutes produced the lowest chain scission number value were 0.0326 to 0.1563. Every increase in NaOH charge of 5 kg/t at reaction times 20, 40, 60, 80 and 100 minutes affects the increase in chain scission number values of 0.031, 0.038, 0.071, 0.158 and 0.189 respectively. In *Eucalyptus*, the highest chain scission number value was 0.0869 to 0.3857 achieved at a process temperature of 80oC, the reaction time of 100 minutes, oxygen pressure of 1 bar and NaOH charge 5, 10, 15, 20 and 25 kg/t. While the reaction time of 20 minutes produced the lowest chain scission number value were 0.0149 to 0.0830. Every increase in NaOH charge of 5 kg/t at reaction times 20, 40, 60, 80 and 100 minutes affected the increase in chain scission number values of 0.0170, 0.0180, 0.0431, 0.0593 and 0.0747 respectively.

3.3. Effect of NaOH charge on the value of polymerization degrees

The degree of polymerization is closely related to the intrinsic viscosity value of the pulp. The higher polymerization degree values. the longer the carbon chain length contained in cellulose. It means illustrated the more resistant to cellulose degradation events. While the remaining carbon chains can be explained by the degree of polymerization. The degree of polymerization of *Acacia mangium* and *Eucalyptus* in the process of Medium consistency oxygen with variations in NaOH charge and reaction time can be seen in Figures 6 (a) and (b).

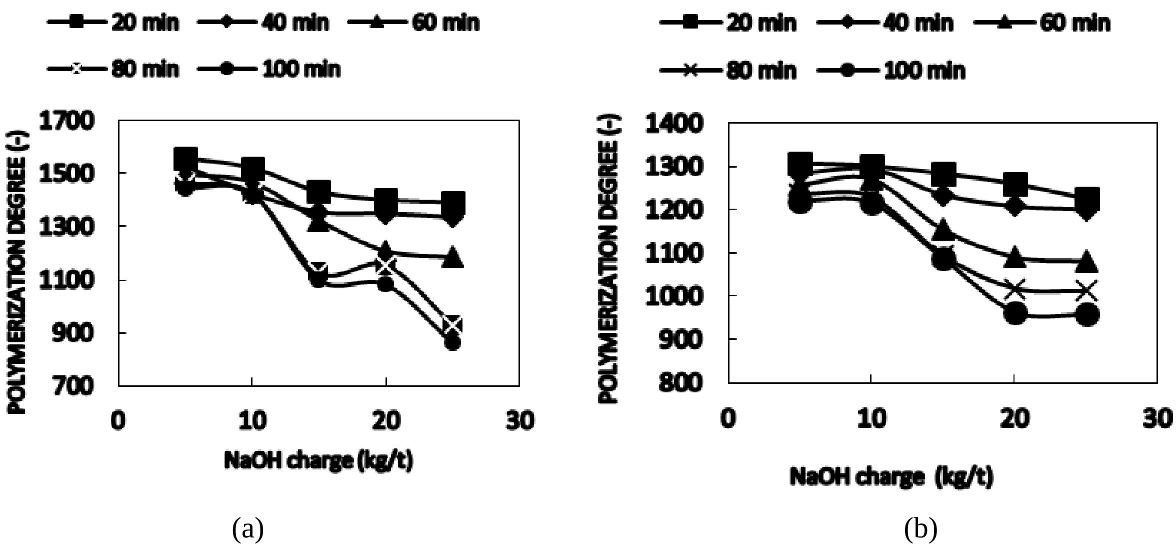


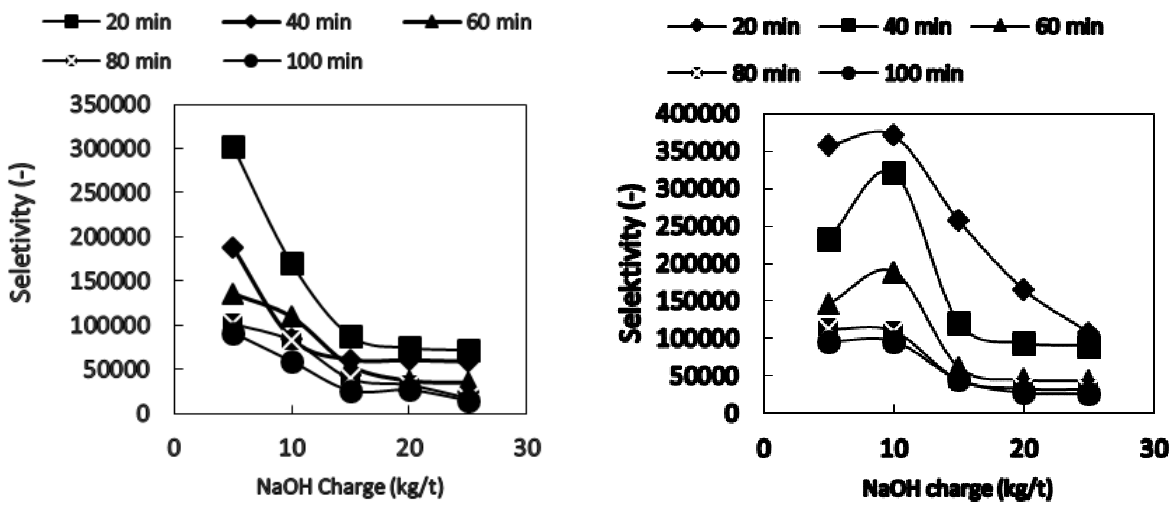
Figure 6. The effect of NaOH charge on the polymerization degree value (-) of: (a) *Acacia mangium* and (b) *Eucalyptus* in the medium consistency oxygen process with variations in reaction time

In Figures 6 (a) and (b), shown that the higher NaOH charge and reaction time, lower polymerization degree values in the samples of *Acacia mangium* and *Eucalyptus*. The longer reaction time used with a variation of 20 minutes, greater the rate of reduction in the polymerization degree. In *Acacia mangium*, the highest polymerization degree value was 1392 to 1559 achieved at a process temperature of 80°C, the reaction time of 20 minutes, oxygen pressure of 1 bar and NaOH charge 5, 10, 15, 20 and 25 kg/t. While the reaction time of 100 minutes produced the lowest polymerization degree value were 861 to 1447. Every increase in NaOH charge of 5 kg/t at reaction times 20, 40, 60, 80 and 100 minutes affects the decrease in polymerization degree values of 41.7, 48.1, 78.2, 133.1 and 146.5 respectively. In *Eucalyptus*, the highest polymerization degree value was 1225 to 1307 achieved at a process temperature of 80oC, the reaction time of 20 minutes, oxygen pressure of 1 bar and NaOH charge 5, 10, 15, 20 and 25 kg/t. While the reaction time of 100 minutes produced the lowest polymerization degree value were 957 to 1221. Every increase in NaOH

charge of 5 kg/t at reaction times 20, 40, 60, 80 and 100 minutes affects the decrease in polymerization degree values of 20.5, 20.9, 44.2, 55.9 and 65.8 respectively.

3.4. Effect of NaOH charge on changes of reaction selectivity value

The parameters of reaction selectivity were indicated pulp quality in the medium consistency oxygen process. The higher the value of reaction selectivity the more efficient the medium consistency oxygen process. The reactions selectivity values of *Acacia mangium* and *Eucalyptus* can be seen in Figures 7(a) and (b).



(a) (b)

Figure 7. Effect of NaOH charge and reaction time on reaction selectivity values of: (a) *Acacia mangium* and (b) *Eucalyptus* in *medium consistency oxygen* process

Based on Figures 7(a) and (b) show the value of NaOH charge is not affected in the value of reaction selectivity in the medium consistency oxygen process. Variable reaction time in the process of medium oxygen constancy is very influenced in increasing the value of selectivity. The longer the reaction time, the reaction selectivity value will increase. For *Acacia mangium*, the highest reaction selectivity can be achieved with NaOH charge of 5 kg/t. The selectivity reaction at the reaction time of 20, 40, 60, 80 and 100 minutes were 3.02 x 10^5, 1.88 x 10^5, 1.36 x 10^5, 1.02 x 10^5 and 0.92 x10^5 respectively. While the lowest reaction selectivity value occurred at NaOH charge 25 kg/t. The reaction selectivity at the reaction time of 20, 40, 60, 80 and 100 minutes were 7.19 x 10^4, 5.90 x 10^4, 3.49 x 10^4, 1.77 x 10^4 and 1.52 x 10^4 respectively. Based on the variation in reaction time. the longer the reaction time. the lower reaction selectivity. At the reaction time of 20 minutes produced the reaction selectivity were 7.19 x 10^4 to 30.21 x 10^4. The reaction time of 40 minutes produced reaction selectivity were 5.90 x 10^4 to 18.81 x 10^4. The reaction time of 60 minutes produced reaction selectivity were 3.49 x 10^4 to 13.58 x 10^4. The reaction time of 80 minutes produced reaction selectivity were 1.77 x 10^4 to 10.17 x 10^4. The reaction time of 100 minutes produced the selectivity of the reaction were 1.52 x 10^4 to 9.18 x 10^4. In *Eucalyptus*. the highest reaction selectivity can be achieved on NaOH charge of 10 kg/t. The reaction selectivity at reaction time of 20, 40, 60, 80 and 100 minutes were 3.71 x 10^5, 3.21 x 10^5, 1.89 x 10^5, 1.10 x 10^5 and 0.97 x 10^5 respectively. While the lowest reaction selectivity value occurred at NaOH charge 25 kg/t. The reaction selectivity at the reaction time 20, 40, 60, 80 and 100 minutes were 10.85 x 10^4, 9.07 x 10^4, 4.36 x 10^4, 3.27 x 10^4 and 2.68 x 10^4 respectively. Based on the variation in reaction time. the longer the reaction time. the lower reaction selectivity. At the reaction time of 20 minutes produced the reaction selectivity were 10.85 x 10^4 to 35.80 x 10^4. The reaction time of 40 minutes produced the reaction selectivity were 9.07 x 10^4 to 23.33 x 10^4. The

reaction time of 60 minutes produced the reaction selectivity were 4.36 x 10^4 to 14.62 x 10^4. The reaction time of 80 minutes produced the reaction selectivity were 3.27 x 10^4 to 11.24 x 10^4. The reaction time of 100 minutes produced the reaction selectivity were 2.68 x 10^4 to 9.60 x 10^4.

4. Conclusion

In the medium consistency oxygen process. the most important analysis parameters are KaNo and viscosity. The KaNo value presents the value of the delignification degree. The viscosity value presents the polymerization degree and the C chain broken value. The value of reaction selectivity is calculated base on the comparison of the KaNo with the polymerization degree value changes. This study shows the phenomenon that the higher value of NaOH charge. the higher value of delignification degree. It means the higher lignin dissolved due to an increase in NaOH charge. The longer reaction time used results in increasing of delignification degrees.

In *Acacia mangium*, the highest degree of delignification was achieved at 100 minutes reaction time. process temperature of 80°C. 1 bar oxygen pressure and NaOH charge 5, 10, 15, 20 and 25 kg/t. The lowest degree of delignification was achieved at 20 minutes reaction time. Every increase in NaOH charge of 5 kg/t at reaction times of 20, 40, 60, 80 and 100 minutes affects the increase of the delignification degrees were 1.2%, 1.8%, 2.0%, 2.3% and 2.5% respectively.

In *Eucalyptus*. it shows that the reaction time of 100 minutes produced the highest delignification degree and the lowest delignification degree was achieved at the reaction time of 20 minutes. Every increase in NaOH charge of 5 kg/t at the reaction times of 20, 40, 60, 80 and 100 minutes affects the increase of the delignification degree was 3.9%, 1.8%, 2.0%, 2.0%, and 2.1% respectively. The higher NaOH charge and reaction time, the increase in chain scission number value. Every increase in reaction time of 20 minutes affects the increase of chain scission number value in the NaOH charge sequence used.

In *Acacia mangium*, shows that the reaction time of 100 minutes produced the highest chain scission number value of 0.1126 to 0.8700, while the reaction time of 20 minutes produced the lowest chain scission number value of 0.0326 to 0.1563. Every increase in NaOH charge of 5 kg/t at reaction times 20, 40, 60, 80 and 100 minutes affects the increase in chain scission number values were 0.031, 0.038, 0.071, 0.158 and 0.189 respectively.

In *Eucalyptus*, the reaction time of 100 minutes produced the highest chain scission number value of 0.0869 to 0.3857, while the reaction time of 20 minutes produces the lowest chain scission number value of 0.0149 to 0.0830.

The NaOH charge value and reaction time effected on the polymerization degree. The higher NaOH charge value, the lower the value of the polymerization degree. The longer the reaction time, the lower the polymerization degree value.

In *Acacia mangium*, it was shown that the reaction time of 20 minutes produced the highest polymerization degree and the reaction time of 100 minutes produced the lowest polymerization degree. Every increase in NaOH charge of 5 kg/t at reaction times 20, 40, 60, 80 and 100 minutes affects the decrease in polymerization degrees were 41.7, 48.1, 78.2, 133.1 and 146.5 respectively.

In *Eucalyptus*, it was shown that the reaction time of 20 minutes produced in the highest degree of polymerization and the reaction time of 100 minutes produced the lowest of polymerization degrees. Every increase in NaOH charge of 5 kg/t at reaction times of 20, 40, 60, 80 and 100 minutes affected the reduction in polymerization degrees were 20.5, 20.9, 44.2, 55.9 and 65.8 respectively.

In the medium consistency oxygen process, the reaction selectivity value was not affected by the NaOH charge. Variable reaction time was very influenced in the increasing of reaction selectivity value. The longer the reaction time used, the reaction selectivity value will increase in various variations of NaOH charge. The highest reaction selectivity of *Acacia mangium* can be achieved with NaOH charge of 5 kg/t from various reaction time variations. The lowest

reaction selectivity at NaOH charges 25 kg/t, at a variety of reaction times. In Eucalyptus, the highest reaction selectivity can be achieved with NaOH charge of 10 kg/t from various reaction times. The lowest reaction selectivity occurred at NaOH charge 25 kg/t, at a variety of reaction times. The longer the reaction time, the lower the reaction selectivity.

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