The maximum conversion of ethanol in the RMS was 70.2%. The H_2 gas yield obtained was 15.2%. The result of every stage can be seen:

1) Stage 1: The result of mass balance at the operating condition and design process on the stage 1 show in the Tabel 3.

TABLE III
THE RESULT OF STAGE 1 CALCULATION

Component	F1	F2	F3
C_2H_5OH	0.0079	0.002354	-
H_2O	0.0237	0.01267	-
CO	-	0.005608	-
CO2	-	0.005484	-
H_2	-	0.015851	0.011888
P	-	-	-
T	-	-	-
Yield H_2	-	-	-
H_2 Recovery	-	-	-

2) Stage 2: The result of mass balance at the operating condition and design process on the stage 2 show in the Tabel 4.

TABLE IV
THE RESULT OF STAGE 2 CALCULATION

Component	**F1**	**F2**	**F3**
C_2H_5OH	0.0079	0.002147	-
H_2O	0.0237	0.012084	-
CO	-	0.005643	-
CO2	-	0.005864	-
H_2	-	0.01082	0.018153
P	-	-	-
T	-	-	-
Yield H_2	-	-	-
H_2 Recovery	-	-	-

3) Stage 3: The result of mass balance at the operating condition and design process on the stage 3 show in the Tabel 5.

TABLE V
THE RESULT OF STAGE 3 CALCULATION

Component	**F1**	**F2**	**F3**
C_2H_5OH	0.0079	0.000593	-
H_2O	0.0237	0.006754	-
CO	-	0.004974	-
CO2	-	0.009639	-
H_2	-	0.002802	0.0361
P	-	-	-
T	-	-	-
Yield H_2	-	-	-
H_2 Recovery	-	-	-

The results of each step were compared to the optimisation measures to get the operating conditions and parameters of the best design for the reactor and separator in combination. Table 6 shows a comparison of H_2 and H_2 recovery yield for each step of optimisation.

TABLE VI
COMPARISON OF YIELD OF H_2 AND H_2 RECOVERY FOR EACH OPTIMIZATION STAGE

No	**Parameter**	**Stage 1**	**Stage 2**	**Stage 3**
1	Yield of H_2	15.20%	15.90%	21.40%
2	H_2 Recovery	42.80%	62.6	92.8
3	Flow rate of H_2	0.011888	0.018153	0.0361

From the table above it can be stated that step 3 is the best option for hydrogen production and membrane reactors in combination. The results of the design for the production of bio-hydrogen gas using a combination of reactor and separator membrane can be seen in Table 7.

TABLE VII
THE RESULT OF DESIGN REACTOR MEMBRANE SEPARATOR FOR BIO-HYDROGEN PRODUCTION FROM BIO-ETHANOL

No	**Keterangan**	**Nilai**
1	Yield of H_2	21.40%
2	H_2 recovery	92.80%
3	Flow rate of H_2 (mol/s)	0.0361
4	Design Parameter :	
	a. Diameter of Reactor	0.0508 m
	b. Lenght of Reactor	RMS = 10 cm
5	Operating Parameter :	
	a. Pressure	20 bar
	b. Temperature	973 K
	c. Pressure shell in membrane separation	Vakum 2 bar

IV. CONCLUSIONS

The conclusions on the implementation of this research are: (1) To produce bio-ethanol from oil palm empty fruit bunch, optimal conditions for a pre-treatment process occur when using a concentration of 0.5 N NaOH for 75 minutes. The hydrolysis process was carried out using sulphuric acid at a concentration of 6% for 60 minutes. The fermentation process was carried out for 3 days. (2) To produce hydrogen from the conversion of bio-ethanol made from empty oil palm bunch using a combination of reactor and separator membrane in optimal conditions for generating maximum hydrogen yield, the design of the data obtained was as follows: Hydrogen Yield (H2) of 21.4%, H_2 Recovery of 92.8%, flow rate of Pure H_2 gas of 0.0362 mol / sec, Diameter reactor of 0.0508 m, Reactor (RMS) length of 10 cm, Operating Pressure of 20 bar, Operating temperature of 973 K, Shell in membrane separation pressure of 2 bar vacuum.

ACKNOWLEDGMENT

We thank the Indonesian Directorate General of Higher Education (DP_2M DIKTI) for financial support of this work through the research Grant for lecturer "National Strategic Research Grant 2009". We are grateful to all participants of the Sultan Ageng Tirtayasa University, Cilegon Banten for all their support of this work.

REFERENCES

[1] FAOSTAT. Food and Agriculture Organization of the United Nations.2012

[2] Y. Peryoga, M.D. Solikhah, A. A. Raksodewato. Production Cost Assessment of Palm Empty Fruit Bunch Coversion to Bio-Oil via Fast Pyrolysis. Ijaseit, 4(6) (2014)443

[3] Isroi, Peningkatan Digestibilitas Dan Perubahan Struktur tandan kosong kelapa sawit Oleh Pretreatment pleurotus Floridanus Dan Asam Fosfat. 2013

[4] Eka-Sari, S. Syamsiah, H. Sulistyo, M. Hidayat. The Kinetic of Biodegradation Lignin in Water Hyacinth (Eichhornia Crassipes) by Phanerochaete Chrysosporium using Solid State Fermentation (SSF) Method for Bioethanol Production, Internasional Journal of World Academy of Science, Engineering and Technology, 4 (2011) 182-185.

[5] E. I. Evstigneev. Factors affecting lignin solubility. Russian Journal of Applied Chemistry, 84(6) (2011,) 1040-1045.

[6] P. D. Kumar, M.J. Barret, Dlwiche, P. Stroeve. Methods for Pretreatment of lignocellulosic Biomass for Efficient Hydrolysis and Biofuel Production, Ind. Eng. Chem. Res. 48 (8)(2009) 3713–3729.

[7] M.J. Taherzadeh, K. Karimi. Pretreatment of Lignocellulosic Waste to Improve Ethanol and Biogas Production : A Review, Internasional Journal of Molecular Science. 9 (2008) 1621-1651.

[8] A.K. Wardani, F.N.E. Pertiwi. Produksi Etanol dari Tetes Tebu oleh Saccharomyces cerevisiae pembentuk Flok (NRRLv-Y 265). J. Agritech., 33(2) (2013) 131-139.

[9] C.Tengborg, M. Galbe, G. Zacchi. Influence Of Enzyme Loading And Physical Parameters On The Enzymatic Hydrolysis Of Steam-Pretreated Softwood . Biotechnol. 17(1) (2001) 110-117.

[10] E. Triwahyuni, Y. Muryanto., Y. Sudiyani, H. Abimanyu. The Effect of Substrate Loading on Simultaneous Saccharification and Fermentation Process for Bioethanol Production From Oil Palm Empty Fruit Bunches. Energy Procedia. 68 (2015) 138-146

[11] V.A.D. Rana, Eckard, B. K. Ahring. Comparison of SHF and SSF of Wet Exploded Corn Stover And Loblolly Pine Using In-House Enzymes Produced From T. reesei RUT C30 and A. saccharolyticus. SpringerPlus, 3 (1) (2014) 516.

[12] E.Y. Garcia, M.A. Laborde. Hydrogen Production by the Steam Reforming of Ethanol: Thermodynamic Analysis. Int. J. Hydrogen Energy;16(5) (2012) 307-312.

[13] J.G. Highfield, F. Geiger, E.Uenala, T.H. Schucan. Hydrogen Release by Steam-Reforming of Ethanol for Efficient, Clean Fuel Applications. Hydrogen EnergyProgress X, Proceedings of the 10th World Hydrogen Energy Conference, (2) (1991) 1039-1049.

[14] K. Vasudeva. K. Mitra, N. Umasankar, S.C.Dhingra. Steam Reforming of Ethanol for Hydrogen Production: Thermodynamic Analysis. Int. J. Hydrogen Energy; 21(1) (1996) 13-18.

[15] I. Fishtik, A. Alexander, R. Datta, D.A. Geana. Thermodynamic Analysis of Hydrogen Production by Steam Reforming of Ethanol via Response Reactions. International Journal of Hydrogen Energy, 2 (5) (2000) 31-45.

[16] Ioannides, T. Thermodynamic Analysis of Ethanol Processors for Fuel Cell Applications.Journal of Power Sources, 9 (2) (2001) 17-25.

[17] Brian James & Jeff Kalinoski, Analysis of Ethanol Reforming System Configurations, DOE Hydrogen Program, Directed Technologies Inc, 2008.