ADVANCES in NATURAL and APPLIED SCIENCES

ISSN: 1995-0772
EISSN: 1998-1090
2017 November 11(13): pages 27-34

Published BYAENSI Publication
http://www.aensiweb.com/ANAS
Open Access Journal

Development Buck Boos Converter, Capacity 100-200 Watt Base PI & PI-Fuzzy Logic Control As Support Wind Turbine Power Plant

[1]Ali Musyafa, [2]Ya'Umar, [3]Muhammad Khamim Asy'ari, [4]Alex Taufiqurrohman Zain, [5]Ronny D.Noriyati, [6]Andi Rahmadiansah

[1]*Ass. Professor, Department of Engineering Physics, Faculty of Industrial Engineering, Institut Teknologi Sepuluh Nopember, Box. ITS Surabaya, Surabaya, Indonesia.*
[2]*Ass. Professor, Department of Engineering Physics, Faculty of Industrial Enginering, Institut Teknologi Sepuluh Nopember, Box. ITS Surabaya, Surabaya, Indonesia.*
[3]*Student, Department of Engineering Physics, Faculty of Industrial Engineering, Institut Teknologi Sepuluh Nopember, Box. ITS Surabaya, Surabaya, Indonesia.*
[4]*Student, Department of Engineering Physics, Faculty of Industrial Enginering, Institut Teknologi Sepuluh Nopember, Box. ITS Surabaya, Surabaya, Indonesia.*
[5]*Ass. Professor, Department of Engineering Physics, Faculty of Industrial Enginering, Institut Teknologi Sepuluh Nopember, Box. ITS Surabaya, Surabaya, Indonesia.*
[6]Lecturer, *Department of Engineering Physics, Faculty of Industrial Enginering, Institut Teknologi Sepuluh Nopember, Box. ITS Surabaya, Surabaya, Indonesia.*

Received 25 September 2017; Accepted 28 November 2017; Available online 5 December 2017

Address For Correspondence:
Ali Musyafa, Department of Engineering Physics, Faculty of Industrial Enginering. Institut TEeknologi Sepuluh Nopember, Surabaya, Indonesia.
Tel: 62-31-594-7188; E-mail: musyafa@ep.its.ac.id.
Jl. Teknik Sipil Blok V-11, Perum ITS Surabaya, Indonesia 60111,

ABSTRACT

Background: Buck boos conventional is a electronics converter That convert DC voltage at. a certain level input to DC voltage at certain level output. Control system is needed to keep the output voltage according to the set point. Buck boost converter system is implemented control mode PI and PI-Fuzzy. Performance of PI-fuzzy controller for buck boost converter is conform than conventional PI controller when both controller are subjective to the same operation. The optimization the performance control system (. PI-FLC control system performance with 40 V set 10 V input has the best stability performance with maximum overshoot (Mp) = 0 V, settling time (Ts) = 0.09 seconds, peak time (Tp) = 0.017 seconds, rise time (Tr) = 0.01 sec and steady state error (Ess) = 0.1 V) , the wind energy capture to electricity conversion are optimization.

KEYWORDS: Keyword 1 : Buck Boss Converter, Keyword 2 : PI, Keyword 3 : PI-Fuzzy, Keyword 4 : FLC Keyword 5 : DC

INTRODUCTION

Power electronics are device use to guide the casement of high energy efficiency from a power generator from a new renewable energy-base power plant include wind turbine. The research here integrates power

ToCite ThisArticle: Ali Musyafa, Ya'Umar, Muhammad Khamim Asy'ari, Alex Taufiqurrohman Zain, Ronny D.Noriyati, Andi Rahmadiansah., Development Buck Boos Converter, Capacity 100-200 Watt Base PI & PI-Fuzzy Logic Control As Support Wind Turbine Power Plant. **Advances in Natural and Applied Sciences**. 11(13) Pages 27-34

electronics divisions for the purpose of changing the system of electricity and the storage of electricity in the battery. This research is focused on the development of power electronics technology used in wind turbine systems. Electrical power plant equipment is shown in Fig. 1. The DC-DC power converter (DC-DC converter) consists of a transition type, also known as DC Chopper, utilized primarily for supplying DC voltage outputs of varying magnitudes according to demand at load. The input power of the DC-DC process is derived from a DC power source which usually has a fixed input voltage.

Basically, the result of the DC output voltage is achieved by adjusting the length of connection time between the output side and the input side of the same circuit. The components used to perform the connection functions are none other than switches (solid state electronic switches) such as Thrystor, MOSFET, IGBT, GTO [1].

Methodology:

Basically, the mechanical energy obtained from the speed of the turbine rotation is strongly influenced by the wind velocity that blow varied. Because the wind speeds come in varying accuracy, the mechanical energy generated by turbine rotation is also relatively unstable. To keep the output from the wind turbine so that its value is stable then it needs a buck converter which is supported by control system. In this study, the controller to be implemented is a conventional control system and intelligent control system (PI-Fuzzy). From this research is expected to give the best control action, so that buck converter control system can produce the best efficiency and stability.

The modeling of buck boost converter is shown in Figure 1.[2,3].

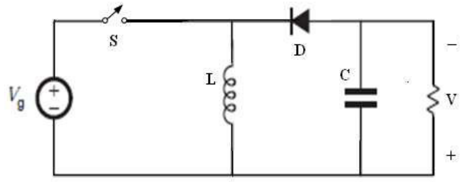

Fig. 1: Buck boost converter circuit

The Procedure of the research refer to flowchart shown in Figure 2.

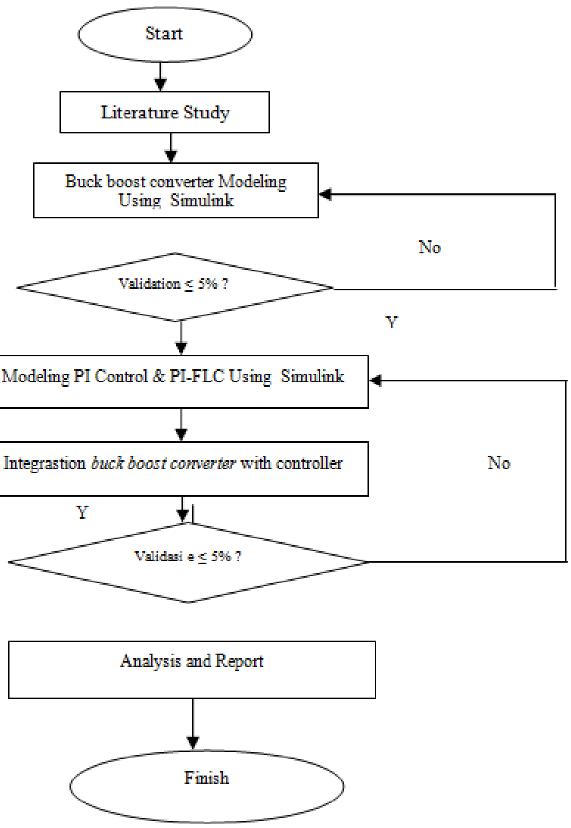

Fig. 2. Flowchart of the research [4] Diagram blok of Converter system

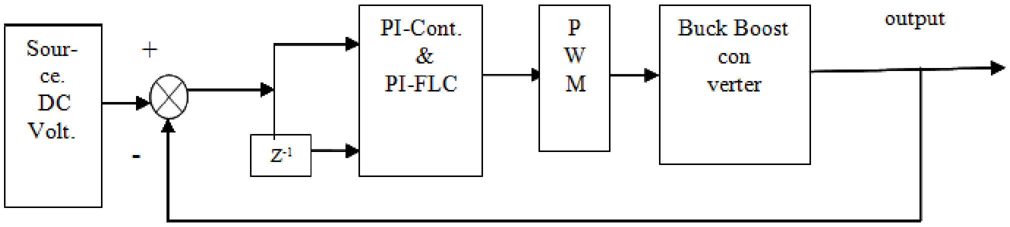

Fig. 3. Blok Diagram of Converter Seestem. [5,6]

For the value of the voltage produced by the installed wind turbine, if the voltage value is in the arrange (10 – 34.9) V and the current is 2,9 A, with the set point 29 V setting, the desired 10% ripple value, the voltage tolerance which is allowed at 3% the converter efficiency built at least 85% and the switching frequency is 31372.6 Hz [3] (the use of this switching frequency using the frequency approach on the microcontroller) then the RLC values are determined by the following calculation; Determination of duty cycle value [8], by calculating duty cycle using equation (1).

$$\frac{V}{Vg_{\text{minimal}}} = \frac{D}{1-D} \quad (1)$$

$$\frac{28}{10} = \frac{D}{1-D} \rightarrow D = 0{,}74$$

Resistor value is calculated using equation (2)

$$R = \frac{Vo}{Io} \quad (2)$$

$$R = \frac{28}{2{,}9} \rightarrow R = 9{,}655\Omega$$

Inductor value is calculated using equation (3),

$$L\min = (1-D) \times R \quad (3)$$

$$L\min = \left(\frac{(1-0{,}74)^2}{2 \times 31372{,}6}\right) \times 9{,}655$$

$$L\min = \left(\frac{0{,}0676}{62745{,}2}\right) \times 9{,}655$$

$$L\min = \frac{0{,}653}{62745{,}2}$$

With:

$$L\min = 1{,}041 \times 10^{-5} \rightarrow L\min = 10{,}41\ \mu H$$

The value of the capacitor is calculated using equation (4) ;

$$C = \frac{28 \times 0{,}78}{9{,}655 \times 0{,}03 \times 31372{,}6} \quad (4)$$

$$C = 2{,}28016 \times 10^{-3}\ ,\ C = 2280{,}16\ \mu F$$

The transfer function of the buck boost converter model is as follows [4]

$$G_{(s)} = \frac{V\left(1 - \dfrac{sDL}{D'^{2}R}\right)}{D\left(D'^{2} + \dfrac{sL}{R} + s^{2}LC\right)} \quad (5)$$

If the values of R, L, C, and D are included in equation (5), then they are obtained:

$$G_{(s)} = \frac{1{,}751\left(10^{-4}\right)s + 28}{1{,}757\left(10^{-8}\right)s^{2} + 7{,}977\left(10^{-7}\right)s + 0{,}0944}$$

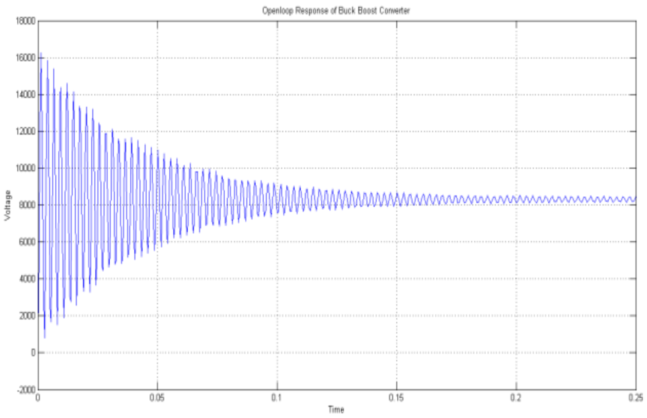

Fig. 4: Open loop response buck boss converter

Based on determination of PI parameter by ziegler-nichols method, proportional gain value is 0,00205005711 and gain integral value is 0,137219351 [7,8].

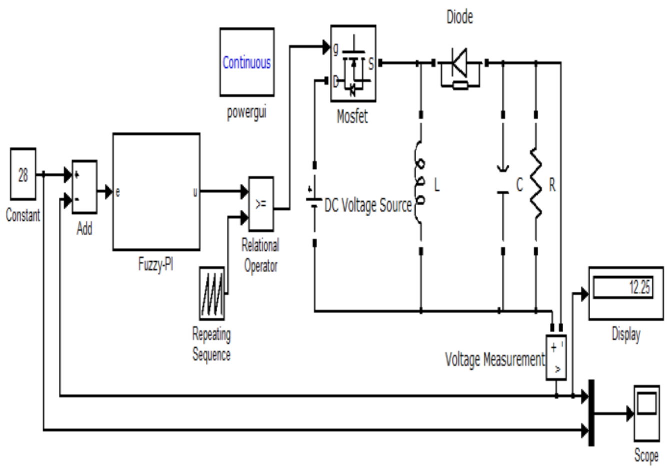

Fig. 5: Semolina model for PI- fuzzy controller for buck boost converter

Type of fuzzy logic is surgeon. fuzzy logic type surgeon is suitable for linear plant as wind turbine plant.

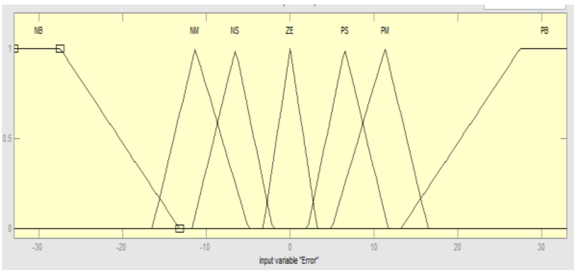

Fig. 6: Membership plot function for error input

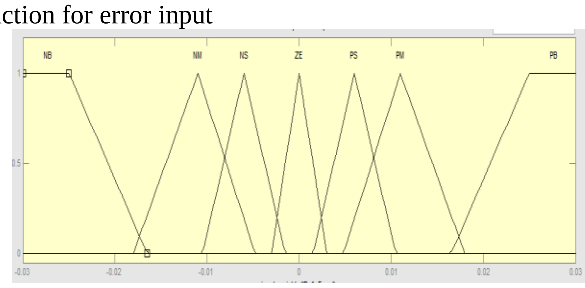

Fig. 7: Membership plot function for delta error input

Membership function for gain proportional (Kp) output and gain integral (Ki) output Gain proportional (Kp) Gain integral (Ki) show in Table 1, and FLC in Table 2.

Table 1: Membership function for gain

St	0,00053	B	0,00397
T	0,00131	M	0,00912
Ide	0,00205	Ide	0,13722
NA1	0,00355	S	0,01659
NA2	0,00541		
NA3	0,00725		

Table 2: Fuzzy logic rules

Error							
De	NB	NM	NS	ZE	PS	PM	PB
NB	St/S	St/S	St/S	T/S	NA1/M	NA2/M	NA3/B
NM	St/S	St/S	T/S	Ide/Ide	Ide/M	Ide/Ide	NA1/B
NS	St/S	T/S	Ide/S	Ide/Ide	Ide/Ide	NA1/M	NA2/B
ZE	T/S	T/S	Ide/Ide	Ide/Ide	NA1/Ide	NA1/M	NA2/M
PS	St/B	T/S	Ide/Ide	Ide/Ide	NA1/M	NA2/M	NA3/B
PM	St/B	Ide/Ide	Ide/Ide	NA1/M	NA2/M	NA3/B	NA3/B
PB	St/M	St/S	St/S	Ide/Ide	NA3/B	NA3/B	NA3/ B

RESULTS AND DISCUSSION

Simulation PI-Control system shown in figure 8.

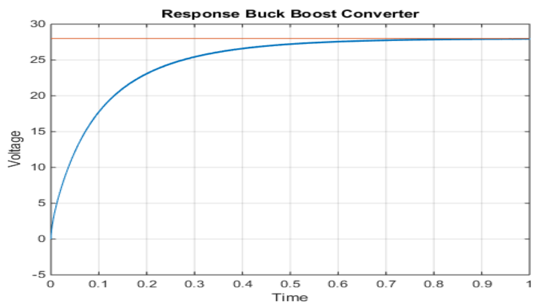

Fig. 8: Response of PI controller for buck boost converter with input 10 V.

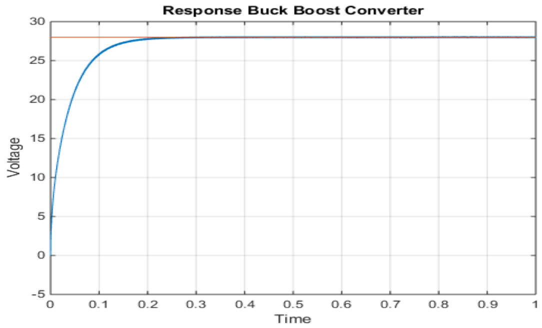

Fig. 9: Response of PI controller for buck boost converter with input 25 V

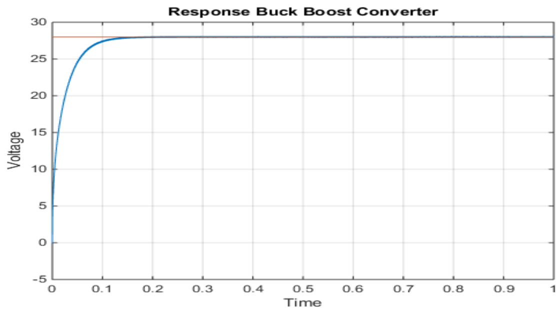

Fig. 10: Response of PI controller for buck boost converter with input 40 V.

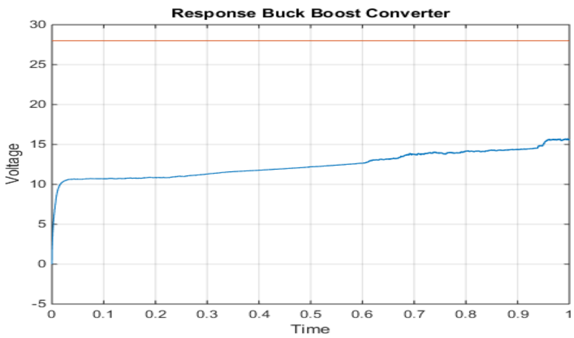

Fig. 11: Response of fuzzy-PI controller for buck boost converter with input 10 V

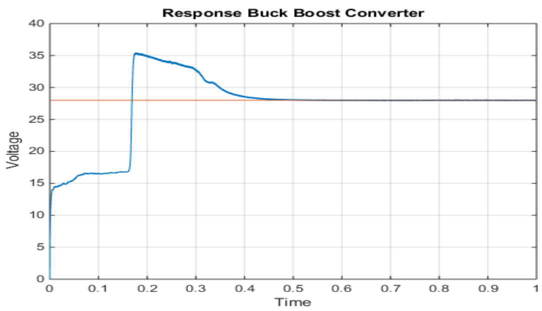

Fig. 12: Response of fuzzy-PI controller for buck boost converter with input 25 V

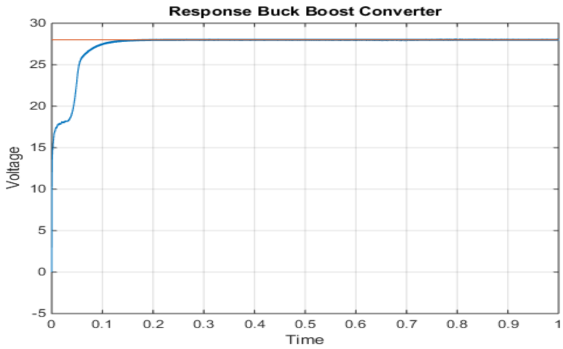

Fig. 13: Response of fuzzy-PI controller for buck boost converter with input 40 V.

Table 3: Performance indicator of fuzzy-PI controller for buck boost converter

Performance indicator	PI Controller			PI-Fuzzy Controller		
	Vin= 10 V	Vin = 25 V	Vin = 40 V	Vin= 10 V	Vin = 25 V	Vin = 40 V
maximum overshoot	0	0	0		21,5%	0
rise time	0,278	0,088	0,058	0,0	0,167	0,054
delay time	0,064	0,020	0,010		0,009	0,001
settling time	0,530	0,160	0,098		0,398	0,094
error steady state	0,046	0,109	0,109		0,206	0,109

Conclusion:

Design of buck boost converter system with control and Fussy Logic Control, it can be concluded that buck boost converter system using PI tuning control Ziegler Nichols got value Kp = 0,002050 and Ti = 0,001494. The performance of a PI-FLCl system with a set of 25 V, and input = 10 V, has the best stability with maximum overshoot (Mp) = 0, settling time (Ts) = 0.22 seconds, peak time (Tp) = 0, rise time (Tr) = 0.167 sec. and steady state error (Ess) = 0.12 V. PI-FLC control system performance with 40 V set 10 V input has the best stability performance with maximum overshoot (Mp) = 0 V, settling time (Ts) = 0.09 seconds, peak time (Tp) = 0.017 seconds, rise time (Tr) = 0.01 sec and steady state error (Ess) = 0.1 V. Performance of PI-FLC for buck boost converter is better than conventional PI controller when both controllers are subjected to the same operating conditions. Performance indicator are rise time, delay time, settling time, and error steady state.

ACKNOWLEDGEMENT

The authors would like to thank the Institute for Research and Community Service (LPPM ITS), Institut Technologi Sepuluh Nopember, Surabaya. With supporting financing, the research. Also, the authors would like to thank the anonymous referees for their comments on the eelier version of this work.

REFERENCES

1. Badr, Munaf, 2016. *Employing Open Loop Control Model of DC-DC Buck Converter to Supply a Solenoid Coil* . F. 9, s.l. : International Journal of Engineering and Applied Sciences, 3. ISSN.
2. Choudhary, Dhananjay dan Saxena, Anmol Ratna, 2012. *" DC-DC Buck-Converter for MPPT of PV System..* 7,Dept. of Electrical Engineering, Madhav Institute of Technology & Science, Gwalior, India.
3. Hidayat Mochamad, Suryo, 2010. "Rancang Bangun Buck Boost Konverter," Universitas Indonesia.
4. Kamala, J., 2010. "Enabled Smart Control Architectures and Their Application to Dc-Dc Converter," University Chennai
5. Myrzik, J.M.A. and M. Calais, Member, IEEE, 2003. "String and module integrated inverters for single phase grid connected photovoltaic systems – A review", Paper accepted for presentation at IEEE Bologna PowerTech Conference, June 23-26, Bologna, Italy
6. Kazimierczuk, Marian, 2008. "Pulse-width Modulated DC-DC Power Converters," Wright state University Dayton, Ohio, USA.
7. Hansen, L.H. et al., 2001. " Conceptual survey of generators and power electronics for wind turbines", Riso National Laboratory, Roskilde, Denmark, December.
8. Musyafa, A., I.M.Y. Negara, Imam Robndi, 2011. " Design Optimal of Adaptive Control and Fuzzy Logic Control on Torque-Shaft Small Scale Wind Turbine", Canadian Journal on Electrical and Electronics Engineering, CJEEE 2(6): 202-208.

9. Musyafa, A.A., Harika, I.M.Y.Negara, Imam Robandi, 2010. Pitch AngleControl of Variable Low Rated Speed Wind Turbine Using Fuzzy Logic Control. International Journal Of Engineering & Technology IJET-IJENS,; 10(5): 21-24.
10. Musyafa, A., I.M.Y. Negara, Imam Robndi, 2011. " Design Optimal in Pitch Controlled Variable speed under rated wind speed WECS Using Fuzzy LogicControl" Australian Journal Of Basic and Applied Science (AJBAS) August, pp: 781-788.
11. Musyafa, A., I.M.Y. Negara, Imam Robndi, 2011. "A wind Turbine for low rated wind speed region in East Java" (IJAR, Azerbaijan), September, pp: 353-358.
12. Musyafa, A. et al., 2017. "Development of Power Electronics ,Buck Boost Converter, Based PI-PID Control On Horizontal Wind Turbine Generation, For Low Rate Wind speed, Australian Journal of Basic and Applied Sciences, 11(11) August 2017, Pages: 79-87
13. Control On Horizontal Wind Turbine Generation, For Low Rate Wind speed" Australian Journal of Basic and Applied Sciences, 11(11) August 2017, Pages: 79-87 , ISSN:1991-8178 EISSN: 2309-8414
14. Journal home page: www.ajbasweb.com
15. Manias Stefanos, 2000. "Power Electronics", Professorof National University of Athens, Simeon press-Coryright
16. Mahesh Gowda, M., N. Kiran, Yadu dan Parthasarthy, 2014. "*Modelling of Buck DC-DC Converter Using Simulink".*, Department of Electronics & Communication, PES College of Engineering, Mandya, Karnataka, India : International Journal of Innovative Research in Science, Engineering and Technology, 3.
17. Mohan, et al., 2013. *Power Electronics: Converters, Applications, and Design.* s.l. : John Wiley & Son.
18. Muhammad H. Rashid, 2001. "Power Electronics Handbook," Ph.D., Fellow IEE, Fellow IEEE, Academic press, Copyright.
19. Mohan, Undeland, Robbins, 1995. "Power Electronics" 2ndedtion, A.Tziolas A.E.
20. Sulaiman R Diary, 2010. "Desaign of High Efficiency DC-DC Converter for Photovoltaic Solar Home Application," University of Salahaddin- Hawler.
21. Skvarenina, Timothy L. 2002. "The Power Electronics Handbook Industrial Electronics Series," Indiana : Crc press.-208
22. Silvana.D.Costa. et al., 2015. Evaluation Safety Integrity Level Using Layer of Protection Analysis in Recycle Gas First Stage Cycle Compressor at PT. Pertamina Persero**.,** Australian Journal of Basic and Applied Science.