IOP Conf. Series: Journal of Physics: Conf. Series **846** (2017) 012014 doi:10.1088/1742-6596/846/1/012014

Air Pollutants Minimalization of Pollutant Absorber with Condensation System

Yayat Ruhiat*, Firmanul Catur Wibowo, Yuvita Oktarisa

Dept. of Physics Education, Faculty of Teacher Trainings and Education
University of Sultan Ageng Tirtayasa

Email: yruhiat@untirta.ac.id

Abstract. Industrial development has implications for pollution, one of it is air pollution. The amount of air pollutants emitted from industrial depend on several factors which are capacity of its fuel, high chimneys and atmospheric stability. To minimize pollutants emitted from industries is created a tool called Pollutant Absorber (PA) with a condensing system. Research & Development with the approach of Design for Production was used as methodology in making PA. To test the function of PA, the simulation had been done by using the data on industrial emissions Cilegon industrial area. The simulation results in 15 years period showed that the PA was able to minimize the pollutant emissions of SO2 by 38% NOx by 37% and dust by 64%. Differences in the absorption of pollutants shows the weakness of particle separation process in the separator. This condition happen because the condensation process is less optimal during the absorption and separation in the separator.

1. Introduction

The development of industrial gives implication to several aspects, which are the speed of air pollution, odor, vibration, noise, and water pollution. Based on the result studies in some industry areas, air pollutant increase significantly. In 1960-2010 the concentration of Corbon Dioxide pollutant rised from 320-390 ppm, along this period the rate of CO_2's concentartion increased 20,5 % . By this situatiion the emition of CO_2 from industrial will be increased 0,4 % every year. The kind of air pollutants which are produced by industry depend on the category of fuel used. The bigger capacity of fuel, the higher chimney used [1]. The height of the chimney used by industry affect to the separation's distance of its emission [2]. The higher of the chimney used, the further distance of separation of pollutant, which emitted by industry [3]. Meanwhile, the capacity of pollutants emitted depends on the stability of atmosphere condition on that area. Area with unstable atmosphere condition (A), the concentration of pollutant emitted is high, otherwise if the area is on stable atmosphere (E), the concentration of pollutant emitted is low [4]. The large size of air pollutants emitted by industry in various stabilities of atmosphere forces an effort to minimize the emission; one way, which can be done is by doing modification of chimney.

Decreasing polution by modification of chimney was used by adding Electricity Cataly Oxidation (ECO) SO_2 and electricity coagulation. Some research about pollutant absorbing have been done, for instance Pollutant detection by absorbption using mie scattering and topographic targets as retroreflectors [5], Effects on air pollutant removal by plant absortion and absortion [6], Environmental Samples Analysis by atomic absortion spectometry and inductively couple plasma-optical emission spectroscopy [7], and Light with AERONET measuremnets [8]. Most of the previous

reseach focus on reaction, the speed of component's disolacement from gas to liquid (absortion), and efficiency of gas control (absortion) which have been done by using tools for contaminent in the form of gas (absorber). Furthermore, model-related absorption of pollutants insome atmospheric conditions have been conducted by several researchers, including: the effect on the recovery model of the flow of CO_2 in the absorption of CO_2 by K_2CO_3 solution in a packed column with a non-isothermal conditions [9]. Furthermore, research regarding on apsortion pollutant model have been done by several researcher, for example the effect of flowing model on CO_2 recovery on the absortion of CO_2 in the methyldiethanolamine which promotor piperazine in coloumn packed [10]. After that, a new approach to estimating surface facility costs for shale gas development [11. Based on several work system tools, which already exist, Pollutant Absorber (PA) with condensation system was made to reduce air pollutant. PA is one of control technic used to absorb the pollutant before flow out from the chimney, to maximum the efficiency, this technic working based on condensation system. The different between PA with previous tools can be seen from the function of its, PA can absorb and separate pollutant based on different fuel. All of the pollutant are absorbed and after that separated by using separator, and finally these pollutants absorbed.

2. Material and Method

The methodology of this research is Research & Development technique with Design For Production (DFP) approach. The research methodology using a DFP approach using stratified system perspective of manufacturing activities to guide the product development process [12]. Tools used in this research are *softwarae screen3* dan *WrPlot*. To get information about the concentrate of the pollutant which emitted, data about industrial emition is needed, meanwhile to get information about the distance of pollutant separation, climate's data is needed. The process of working reseach can be seen from Figure 1.

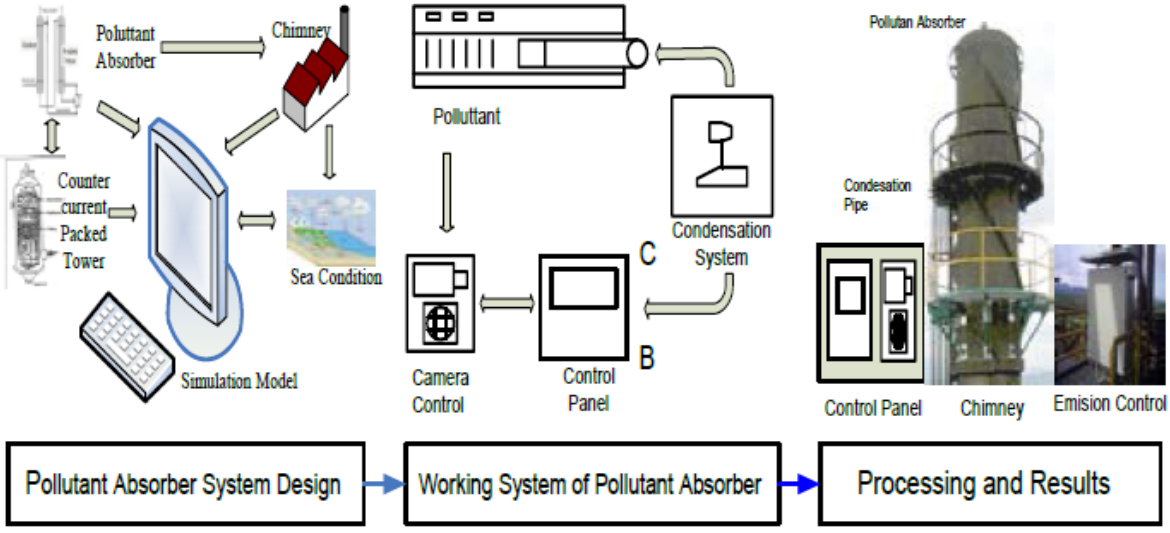


Figure 1. Design and control of minimization of air pollutant

Based on Fig. 1 above, the design and simulation tool based on the study of industrial chimneys and pollutant absorber mounted on the chimney. Based on the research approach, the treatment of the pollutants carried out in several stages, as shown in Figure 2. Based on these images, pollutants coming out of the chimney is absorbed by the filter accommodated on chamber1, then these pollutants are separated on chamber2, then any kind of pollutants are stored in chamber3, The flow of pollutants in each sub appliance, detected using an instrument of control. To keep the flow of particles in each pipe is made by condensing system. PA working system absorbs all kinds of pollutants coming out of the chimney. Pollutants were arrested filter absorber accommodated in the chamber through a capillary tube. To maintain, modify, and change the smoke particles to separate into charged ions created by the condensing system to maintain the energy through the process enthalpy.

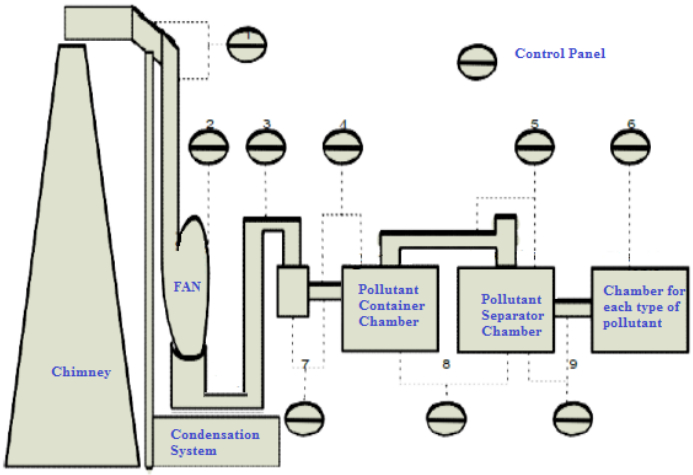
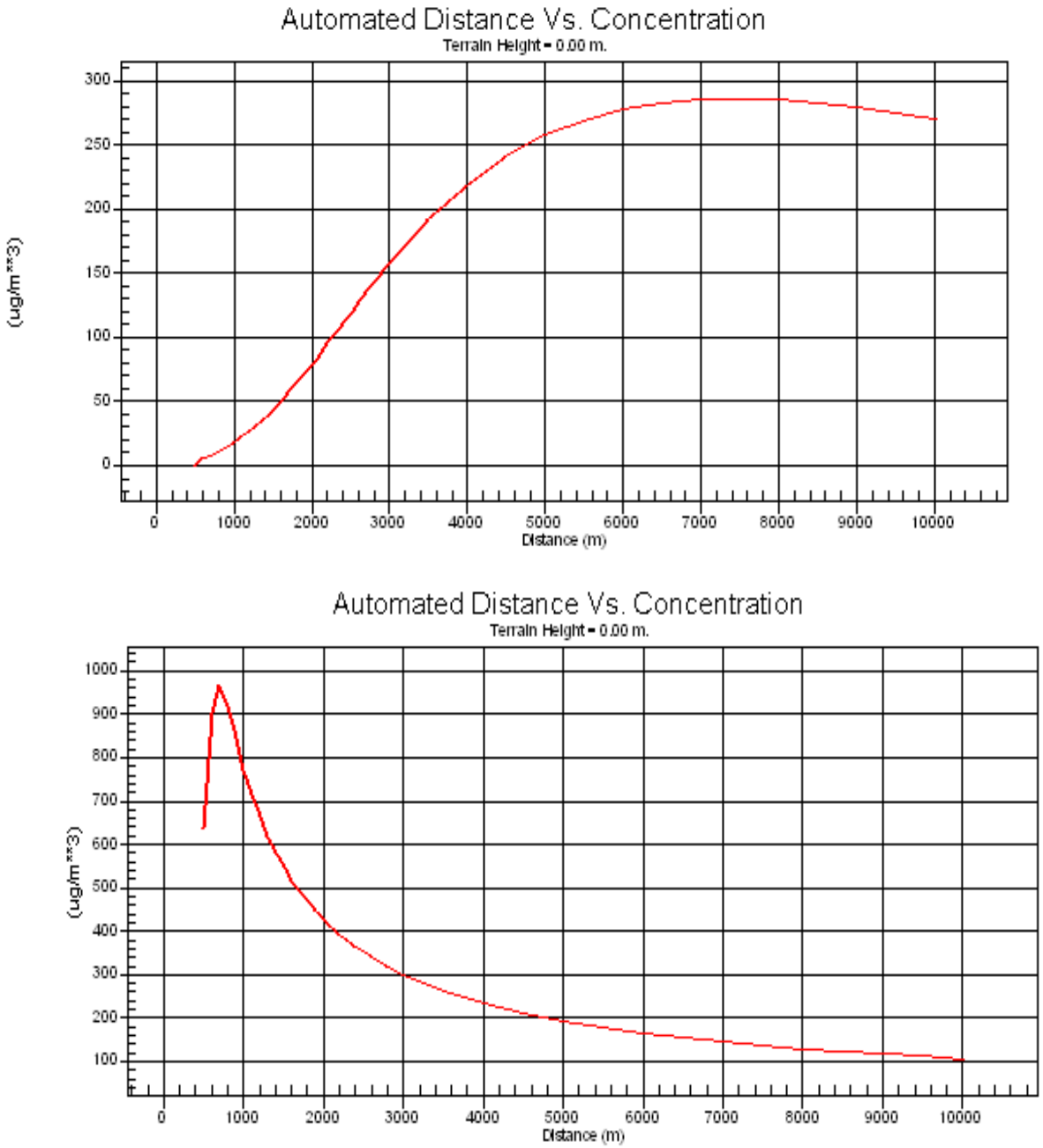


Figure 2. Reduction of air pollutants control design

3. Results and Discussion

PA is a tool that serves to absorb all kinds of pollutants emitted from industrial chimneys. In absorbing pollutants emitted, this tool works with the absorption process. The absorption process is the process of absorption of chemical pollutants. The process of absorption in a packed column is controlled by diffusion with fast chemical reaction in the liquid film, while the in tray columns controlled by physical absorption [13]. Pollutants from chimney absorbed by using absorber, the tool works by three processes namely Absorption, Separation and Adsorption (ASA). To test the function of the tool, simulation using data on industrial emissions industrial estate in Cilegon and climate data started Year 2005-2015 of Meteorology and Geophysics (BMKG) Serang.

To analyze the concentration of pollutants emitted every industry use SCREEN3 software. On the software required input data on climate, namely: atmospheric stability and wind speed. Based on climate data from BMKG Serang over a period of 10 years atmospheric stability obtained in Cilegon is currently on the stability of the A to E with an average wind speed of 2.4 m / sec. Using data from industrial emissions in Cilegon industrial area, as well as the climatic conditions in the region, obtained by the difference between the industry by using a control technique of absorption with no control of the absorption of pollutants. Results SCREEN3 software running distance and pollutant concentrations in two different situations that shown in Figure 3 below. Based on the picture, it appears there is a big difference between the air pollutant concentrations of industries that use control techniques by using techniques that do not control. Using data from atmospheric stability and wind speed are the same, obtained by two different patterns. Industries that do not use a control technique of absorption (Figure 3A) the concentration of air pollutants at first small, but the concentration is on the rise. The maximum pollutant concentrations occur at a distance of 7000 meters, then decomposed by the wind pollutant concentrations resulting in decreased concentration. Meanwhile, for industries that use control techniques absorption of air pollutants (Figure 3B) concentrations of air pollutants emitted steadily declining. However, at a distance of 0-500 meters there is increased concentration of air pollutants, it is possible PA mounted on a chimney is not working optimally. Another thing that happened from the look of the picture above, running SCREEN3 done with the assumption of new industry operates. Furthermore, the distribution range of pollutants, but depending on atmospheric stability also depends on wind speed and height of the chimney. The greater the wind speed, the concentration of pollutants around the chimney increases. This is because polluters will more quickly reach certain locations because of the wind. Additionally, strong winds will be faster deflect the current polluters moved up so that the trajectory of the movement of pollutants will be closer to the ground surface [4, 14].



(a) Without control (upper) (b) Using the techniques of control (bottom)

Figure 3. Comparison between the distance and the concentration air pollutants

To test the reliability of the control apparatus functions pollutant PA validated by using the location as a case study of PT Chandra Asri in Cilegon industrial area. The industry is used as an indicator of measurement, because the industry is already using a chimney with absorption control techniques. The results of the analysis of pollutant concentrations emitted by the PA was then compared with the results of the measurement. This was done to test the reliability of the control techniques PA absorb air pollutants, the results of the comparison between models and measurements, is shown in Figure 4. Based on these images, pollutants emitted from industries first large concentration, but after going through the process of ASA pollutant concentrations to be reduced , the high concentration of pollutants in the beginning of the simulation, because the use of environmental boundary conditions assuming an open chimney.

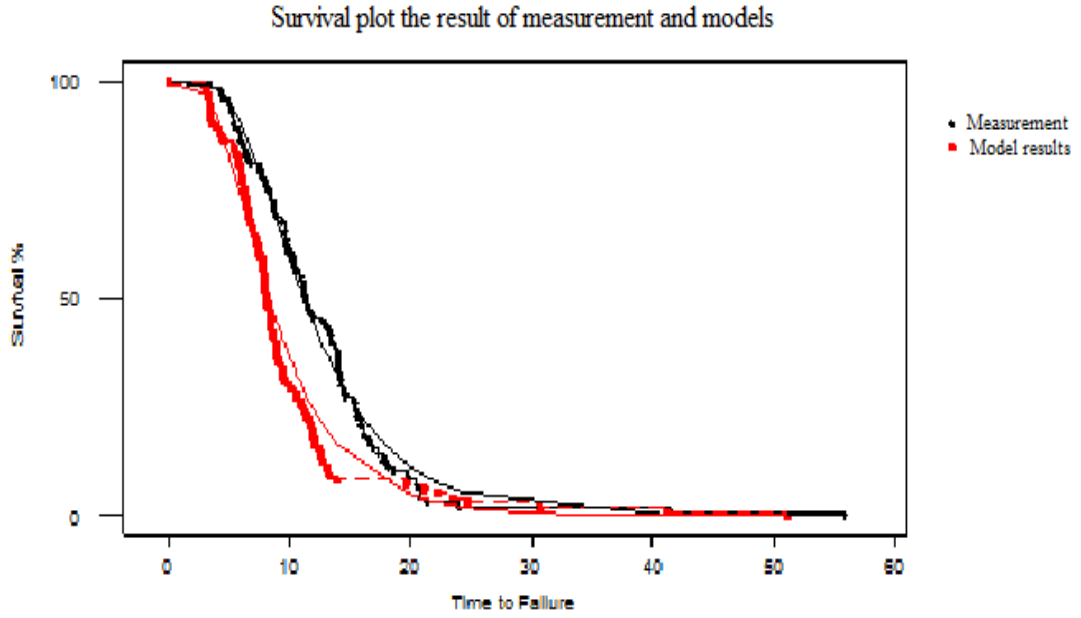


Figure 4. Model results once there absorbent

Furthermore, to determine the function of the PA to absorb pollutants, simulations conducted with data input discharge emission measurement results in Cilegon Industrial Zone in the period from January to July 2014. The simulation was conducted to determine the effectiveness of PA installation in minimizing the emissions of air pollutants. Additional information on thesesimulations, will predict the concentration of air pollutants emitted from industries. The type of air pollutant simulated using PA namely: sulfur dioxide (SO2), sodium oxide (NOx) and dust. These pollutants, would have predicted concentration in a span of 30 years, from 2014 to 2043 year. The prediction of pollutant emission is shown in Figure 5.

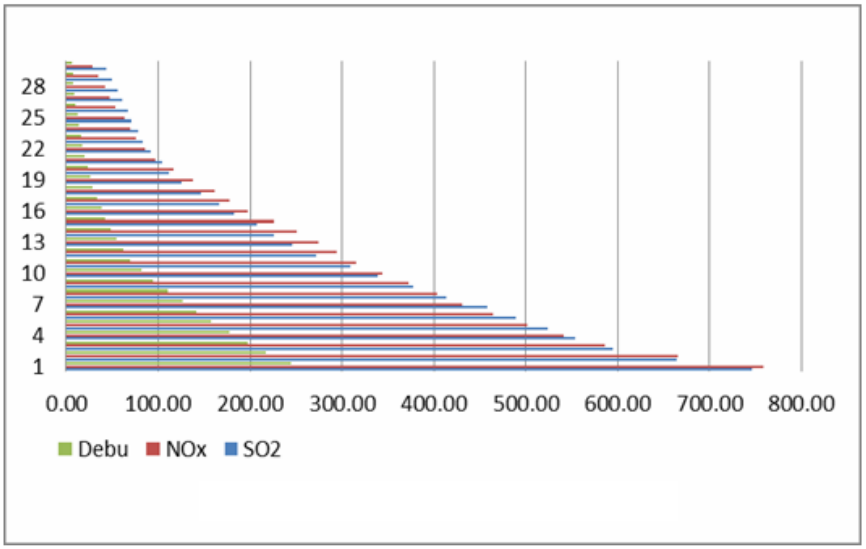


Figure 5. Expects lower concentration

Based on these images, simulation minimization using PA pollutants SO_2, NOx and dust every year cuts. SO_2 pollutant emissions at the time of measurement of 2014 amounted to 747.00 ug / m3 in a span of 15 years PA is able memnimalisasi pollutant emissions of SO_2 by 38%. Meanwhile, when the NOx pollutant emissions measurements in the same year amounted to 758.73 ug / m3 during that time, the PA is able to minimize NOx by 37%. However, for the pollutant emissions of dust initially at 244.44 ug / m3 in the same time frame, the PA is able to minimize by 64%. Based on simulation results, it appears that the pollutant concentrations which do not react with other elements, more rapidly absorbed by the PA. PA tool mounted on the chimney industry would

be effective if it is used to absorb the dust compared to other pollutants. PA has not optimlanya work function in absorbing all kinds of air pollutants, shows the ineffectiveness of the separator functions to separate the types of pollutants. Weak particle separation process, one possible cause less optimal condensation process on the separator.

The simulation results PA installation in the chimney industry showed a reduction in pollutant emissions. Their means of PA be the solution to minimize pollutant emissions from industry, it will encourage the industry to an area. Every year all industries increased, for industrial goods metals and base metals rose between 15.40 to 15.67% [15]. By successfully and installation of PA on every chimney industry, assumed the environment inside and outside the industry to be clean.

4. Conclusion

PA to the condensing system is a tool to absorb all kinds of pollutants that emitted from industrial chimneys. The tool works by three processes namely Absorption, Separation and Adsorption (ASA). In absorbing pollutants emitted, this tool works with the absorption process. The results of the simulation work function tool, PA is able to minimize the pollutants emitted from industries. In the period of 15 years, PA able to minimize the pollutants SO_2 by 38%, NOx by 37% and dust by 64%. The difference in minimizing pollutant concentrations showed the weakness of the process of particle separation in the separator. This condition happen because the condensation process is less optimal during the absorption and separation in the separator.
Therefore, condensation system for the absorption and separation of contaminants need to continue to be detected by the instrument controls.

Acknowledgments
The work was financially supported by Reseacrh and Comuunity servise of Sultan Ageng Tirtayasa University

References

1. Frooqnia, A., Verdín, C. T., & Sepehrnoori, K. (2016). Inference of Rock Pressure- Production Properties from Gas-Oil Production Logs. *Journal of Natural Gas Science and Engineering*, 124-143, Volume 36, Part A.
2. Hajra, B. (2014). A Review of Some Recent Studies on Buoyancy Driven Flows in an Urban Environment. *International Journal of Atmospheric Sciences*, 1-15, Volume 2014.
3. Park, Y. K., & Chang Wu, S. (2012). Two-dimension Numerical Simulation of Stack Flue Gas Dispersion. *Journal of the Korean Oil Chemists' Society*, 33-39, Volume 29.
4. Ruhiat, Y. (2009). *Model Prediksi Distribusi Laju Penyebaran Pencemar SO2 dan Debu dari Kawasan Industri Cilegon.* Bogor: IPB.
5. Byer, R., & Garbuny, M. (1973). Pollutant Detection by Absorption Using Mie Scattering and Topographic Targets as Retroreflectors. *Applied Optics* , 1-10, Volume 12 No 7.
6. Fujii, S., Cha, H., Kagi, N., Miyamura, H., & Kim, Y. S. (2004). Effects on air pollutant removal by plant absorption and adsorption. *Building and Environment*, 105-112, Volume 40.
7. Popescu, I., Stihi, C., Cimpoca, G., Dima, G., Vlaicu, G., Gheboianu, A., et al. (2009). Environmental Samples Analysis by Atomic Absorption Spectrometry (AAS) and Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-AES). *Romamnia Journal Physic*, 1-6, Volume 54.
8. Chin, M., Diehl, T., Dubovik, O., Eck, T., Holben, B., Sinyuk, A., et al. (2009). Light absorption by pollution, dust, and biomass burning aerosols: a global model study and evaluation with AERONET measurements. *Annales Geophysicae*, 3439-3464.
9. Kusnarjo, Kuswandi, Susianto, & Altway, A. (2009). Pengaruh Model Aliran terhadap Recovery CO2 pada Absoprsi Gas CO2 oleh Larutan K2CO3 Didalam Packed Column dengan Kondisi Non-Isothermal. *Reaktor*, 154-160, Volume 12 No3.
10. Wiguna, G. A., Nazaruddin, N., Susianto, & Altway, A. (2014). Model Simulasi Absorpsi Gas CO2 dalam Larutan Methyldiethanolamine (MDEA) berpromotor Piperazine (PZ) dalam Packed Column. *Jurnal Teknik Pomits* , 1-6, Volume 2 No. 1.
11. Zhu, L., & Yuan, J. (2016). A new approach to estimating surface facility costs for shale gas development. *Journal of Natural Gas Science and Engineering*, 202-212, Volume 36.

12. Herman, J., & Chincholkar, M. (2002). Reducing Throughput Time During Product Design. *Journal of Manufacturing System*, 1-8, Volume 20 No. 6.
13. Gary, Rochele, T., & Dang, H. (2003). *Carbon Dioxide Absorption Rate and Solubility in Monoethanolamine/Piperazine/Water*. Austin: University of Texas .
14. Ruhiat, Y., Wibowo, F. C., Hasani, A., Kuswantoro, M., & Fahrizal, R. (2016). Spatial and Temporal Model Development for Analysis the Impact of Concentration of Pollutant and Emission to the Air Quality. *Advance Science Letters*, 1-4, Volume 22 No 12.
15. Badan Pusat Statistik. (2016). *Badan Pusat Statistik Indonesia*. Jakarta: BPS.