Zeolite and Active Carbon as Contacting Media for CO_2 Removal: Case study - CO_2 Removal of Produced Gas at PT Pertamina EP Asset XY

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ABSTRACT
The carbon dioxide is a common impurity to the natural gas production which causing equipment failures due to corrosion and natural gas calorific content decreased. Gathering Station of PT Pertamina EP Asset XY has significant carbon dioxide concentration on its natural gas production. However, installing an amine unit is not an option due to low operating pressures and cost of compression process. This study investigates stripping process of CO2 gas saturated on a gas well stream production through absorbent contacting mechanism with a laboratory-scale of contacting column tower that contains zeolite and activated carbon under ambient condition. In this study, carbon dioxide filtering process was carried out with three prototype models. Horizontally layered column, vertically inserted tubing column and horizontally layered column packed with active carbon. The first model is a Poly Vinyl Chloride (PVC) column tower with four stratified trays where each level has packed 250 grams of zeolite. The second model is a tubular PVC column contains 8 inserted small tubing where each of tubing was poured with a zeolite 250 grams capacity. Meanwhile, the third model is similar with first model, however, each tray level contains as much as 250 grams of activated carbon. The effluent gas from diesel and gasoline combustion engines were used as samples due to global pandemic condition. The result as follows: CO2 level decreased 0.9- 1.0 percent for prototype model I and 0.8 - 0.9% for the model II. The third model has significance impact reduces smoke concentration on effluent gas from diesel combustion engine. The study shows significance role of zeolite to be determined as CO2 removal in sour gas on oil and gas production.

Keywords: *Carbon Dioxide, Natural Gas, Contacting Tower, Zeolite, Stripping.*

1. INTRODUCTION

Natural gas as associated gas or non-associated gas may contain some impurities on its composition when being produced from subsurface. Carbon dioxide, Hydrogen supplied dan Nitrogen are commonly found in the natural gas reduces calorific content and obviously lowering its natural gas price. Furthermore, those impurities may causing processing equipment failures, such as material brittlement and corrosion [1].

Amine unit contacting column tower has been well known as absorbing method to remove gas impurities out from sour gas. Mono Ethyl Amine or diethyl Amine DEA reduces CO2 concentration in sour natural gas by adsorb the impurity on a contact tray surface area. The rich amine contains Carbon dioxide and will be deliberated at reboiler column [2].

Some studies have been developed toward zeolite and active carbon roles reducing CO2 gas concentration on effluent gas. Zeolite and active carbon have been widely used as additives to purify and maintained the performance of water or soil. Zeolite has been studied in order reduces CO2 concentration zeolite as much 28,94% on effluent gas of motorcycle combustion engine [3]. This material is also had been studied as molecular sieve material on bioethanol dehydration [4]. In the other side, activated carbon has performance as absorbance which its sources are from agricultural waste, sugarcane waste, waste of sawn timber, lives stock waste and coal processing waste [5].

However, Zeolite and active carbon performance in order to decrease carbon dioxide concentration in natural gas is unknown. This study proposes an alternative method as solution to lowering carbon dioxide

concentration of natural sour gas at PT Pertamina EP Asset XY with granular zeolite and active carbon as absorbance. Three different typical contacting column tower with zeolite have been developed and studied.

PT Pertamina EP Asset XY has been gathered crude with main gathering station which separating associated gas that been produced from several oil gas wells. Unfortunately, those produced gas contain significance carbon dioxide concentration. Amine unit is not an option to this field due to its low operating pressure and budget optimization, therefore, it needs an alternative method to strip Carbon dioxide from the produced natural gas.

2. METHOD

The study proposes an alternative method lowering Carbon dioxide concentration from natural gas through laboratory setup scale observation. As absorbance, zeolite and active carbon has been used and set in the contacting trays tower with different setting position and quantities. The contacting column tower models are:

1. Model I (single Zeolite column and four contacting trays)
2. Model II (single Zeolite column with vertical stages)
3. Model III (single active carbon and four contacting trays)

Model I as seen at Figure 1, uses a 4-inch PVC as column tower with 16 cm height and four contacting trays. The tray is a sieve steel grade holds granular zeolite which distributed evenly on the top of the tray. The zeolite has 5 cm thickness and 250 grams on each tray with approximately 2 mm uniform grain distribution.

Model II is shown at Figure 2 has single contacting column tower with 4 inch in diameter and 60 cm in depth. The sieve steel tray holds zeolites stacks. The 1-inch PVC column holds zeolites and there are 8 columns filled the bigger PVC pipe. The zeolite has masses 250 grams on each column with approximately 2 mm uniform grain distribution.

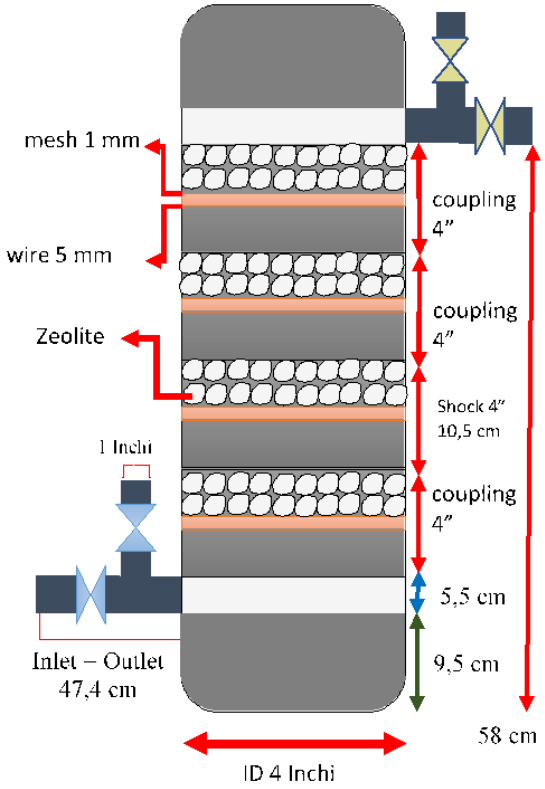

Figure 1 Model I (Horizontally layered Zeolite column with four contacting trays)

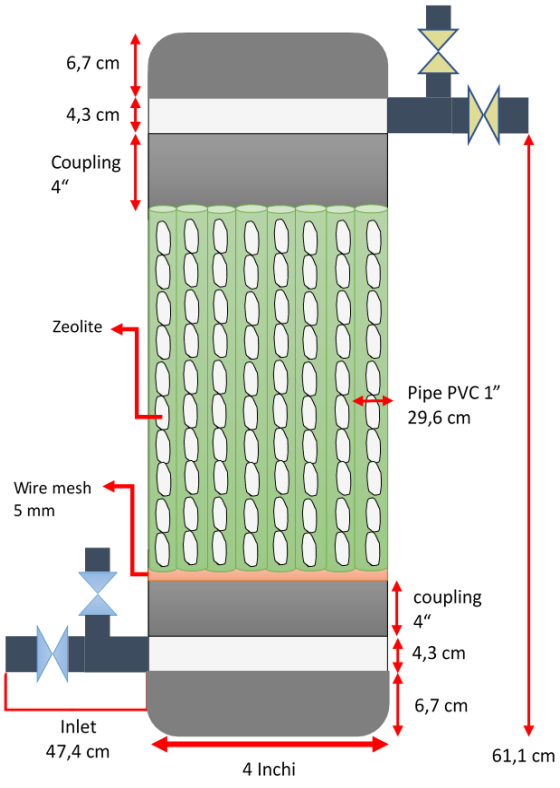

Figure 2 Model II (PVC column with inserted small tubing)

Model III has similar column and trays with Model I and packed with active carbon instead of using granular zeolites. The carbon masses and grain diameter similar with Model I, which is 250 grams of masses and 2 mm of grain diameter.

Effluent gas of diesel and gasoline combustion engines have been used as gas feed instead of natural sour gas due to pandemic condition. Effluent gas flows into inlet valve which positioned at the base of column tower and experiencing contacted with dry granular zeolites packed on each tray while moving toward up to outlet valve. The carbon dioxide concentration of flue gas before and after contacted with zeolites stack has been measured and analyzed using portable CO2 emission analyzer. The experiments have been carried out to those three different contacting models.

3. RESULT AND DISCUSSION

The flue gas emission of diesel engines which passes through zeolite contacting towers has been measured and analyzed with CO2 emission analyzer. The measurement process was observed at the Transportation Agency City of Blora. The effluent gas was produced by gasoline 2500 cc and diesel 1500 cc combustion engines.

For Model I, initial CO2 concentration in the flue gas before contacting process was 13.3%. however, the CO2 concentration decreased when it been passed through zeolite contacting areas, with recorded concentration was 12.8%. The exposure or contacting times of flue gas with zeolite was 5 minutes and opacity number is 9.5%. These results show the performance of zeolites decreases Carbon dioxide concentration in the flue gas emission.

In the other hand, for Model II, the results show similar trend with Model I. The CO2 concentration before experiencing zeolite contacted zeolite is 13.8 % and decreases into 12.9 % after contacted onto zeolites. However, the opacity number for Model II much greater than Model I, which is 49.6 %.

Model III uses active carbon as media to decrease CO2 impurity in the flue gas. It has decreased CO2 concentration by 0.5% of initial concentration. However, this model has opacity number of 8.1 %, much less low than Model II and Model I. Opacity is the quality of effluent gas which determined by its smoke appearances. The effluent gas of diesel engine will be in good condition if it has low opacity number.

4. CONCLUSION

The contacting towers have been developed and analyzed. Zeolites and active carbon give different experimental data results. Model I decrease CO2 content from 13.3 % initial concentration into 12.8 % final concentration and opacity number is 9.5%. Model II initial CO2 concentration is 13.8 % and decreased up to 12.9 %. However, the opacity number is much greater, which is 49.6%. Therefore, Model II les effective to strip CO2 from the flue gas.

Model III has lower performance than Model I with 0.5% decreases CO2 content from the flue gas. However, it has better opacity number which is more effective to reduce CO2 concentration. Much more, the arrangement of horizontal trays shows more effective than vertically stack trays to sieve and reduces CO2 concentration in the flue gas. Finally, according to opacity number from the study, active carbon is more effective to filter CO2 concentration than zeolites at the same contacting tower.

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REFERENCES

[1] W. D. McCain Jr, *Properties of petroleum fluids*. PennWell Corporation, 2017.

[2] M. Stewart and K. Arnold, *Gas sweetening and processing field manual*. Gulf Professional Publishing, 2011.

[3] A. R. Ramli, “ADSORPSI GAS CO2 MENGGUNAKAN KAPUR TOHOR ARANG AKTIF DAN ZEOLIT PADA KENDARAAN BERMOTOR RODA DUA.” Universitas Muslim Indonesia, 2018.

[4] K. Khaidir, D. Setyaningsih, and H. Haerudin, “Modification of natural zeolite as molecular sieve material on bioethanol dehydration,” *J. Zeolit Indones.*, vol. 8, no. 2, pp. 97–105, 2009.

[5] E. Arsad, “Teknologi pengolahan dan pemanfaatan karbon aktif untuk industri,” *J. Ris. Ind. Has. Hutan*, vol. 2, no. 2, pp. 43–51, 2010.