DCE21 4th DOCTORAL CONGRESS IN ENGINEERING

U.PORTO FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

28 - 29 JUN 2021

PARTICIPANT CERTIFICATE

Mohsen Karimi

has submitted an abstract and presented an oral/poster communication in the

Symposium on Chemical and Biological Engineering

of DCE21-4th Doctoral Congress in Engineering, held online 28th and 29th of June, 2021.

DCE21 was promoted by the Faculty of Engineering of the University of Porto, Portugal.

Porto, June 29, 2021

Prof. João Pedro Pêgo
(DCE21 Organizing Committee)

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Fixed Bed Adsorption of Modified Activated Carbon for Gas Capture and Separation in Post-Combustion Conditions

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INTRODUCTION

Climate warming has become one of the main global environmental challenges and energy issues in the current. Among different greenhouse gases (GHGs) including CO_2, CH_4, N_2O and CFCCs, carbon dioxide is considered as main GHGs, which the sharply rising level of CO_2 resulting from the human activities, is one of the greatest concerns facing our civilization so far. On the other hand, beside the current percentage of CO_2 in the atmosphere, it is expected that the emission rate continuously increases in the future, due to economic growth and industrial development throughout the world, which are mainly originated from the combustion of coal, oil, and natural gas. In this way, the carbon capture and sequestration (CCS) strategy has been introduced as a benchmark plan to reduce the GHGs emissions and the overall mitigation costs.

Synthesis of samples:

The original commercial activated carbon PAC (Norit ROX 0.8) was grinding and sieving to particle sizes ranging from 0.106 to 0.250 mm and later was chemically modified by liquid phase, thermal and hydrothermal treatments as described elsewhere (PAPER SUBMETED IF POSSIBLE). Briefly, the sample was prepared by treated 25 g of the original PAC with 5 M of HNO_3 at room temperature (24 h), 150 ºC (3h) and 110 ºC (3 h). The sample was filtered and washed several times with distillate water until the neutrality of the ringing water. Later sample were dried at 110 ºC in an oven during 18 h. Then, the obtained sample was treated with 1 M of urea solution (50 mL per 2 g) at 200 ºC for 2h under its own vapor pressure in a stainless steel high pressure batch reactor. After that, the sample passed a gas phase thermal treatment of 1 g of the PACNAU sample under N2 flow (100 cm3•min−1) at 120 ºC, 400 ºC and 600 ºC for 1 h at each temperature and then at 800 ºC during 4 h, resulting in PACNAUT sample.

MATHEAMTICAL MODELING

The obtained breakthrough values for CO_2 adsorption, were modeled with mass and energy balances by considering the ideal gas law, neglecting the pressure drop, Langmuir's isotherm; also Linear Driving Forge model – LDF. Accordingly, the mass and energy balances results in

Global mass balance:

$$\frac{\partial F}{\partial z} + \varepsilon_b \frac{\partial C}{\partial t} + (1-\varepsilon_b)\sum_{i=1}^{n} \frac{\partial \bar{q}_i}{\partial t} = 0$$

Component mass balance (Adsorbate specie):

$$-\varepsilon_b D_{ax} \frac{\partial}{\partial z}\left(C \frac{\partial y_i}{\partial z}\right) + \frac{\partial (F y_i)}{\partial z} + \varepsilon_b \frac{\partial (C y_i)}{\partial t} + \rho_p (1-\varepsilon_b) \frac{\partial \bar{q}_i}{\partial t} = 0 \quad (2)$$

Mass transfer (LDF Model):

$$\frac{\partial \bar{q}_i}{\partial t} = k_{LDF}(q^* - \bar{q}_i)$$

Energy balance:

$$-K_{ax}\frac{\partial^2 T}{\partial z^2} + F C_{pg}\frac{\partial T}{\partial z} + \varepsilon_b C c_{pg}\frac{\partial T}{\partial t} + \\ +(1-\varepsilon_b)a_p h_p (T - T_s) + a_c h_w (T - T_w) = 0$$

Energy balance in the solid phase:

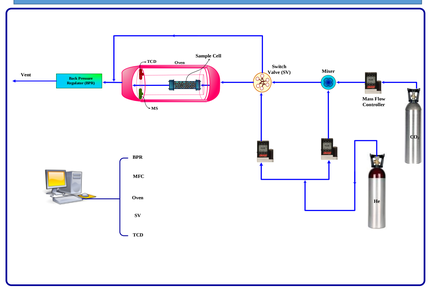
$$c_{ps}\frac{\partial T_s}{\partial t} = a_p h_p (T - T_s) + \sum_{i=1}^{n} (-\Delta H_i)\frac{\partial \bar{q}_i}{\partial t}$$

Here, L, and are the length of adsorption column, void fraction and the average adsorbed concentration, respectively. Also, is the Linear Driving Force (LDF). The developed model was solved via method of lines (MOL).

OBJECTIVES

In this study, the modified activated carbon considered as a solid sorbent for CO_2 capture. The sample has been chemically (hydrogen peroxide, sulphuric acid, nitric acid and urea) and thermally (at 800 ºC) modified, and the adsorption capacity was studied at different temperatures and pressures to evaluate the effects of various agents on prepared samples. Then, the CO_2 uptake capacity of prepared samples was measured through breakthrough adsorption experiments at the post combustion operating conditions to collect isotherm data. Thereafter, a mathematical model has been developed to simulate the fixed bed adsorption to determine the capacity and potential of the best prepared sample for CO_2 capture under representative conditions of the flue gas.

BREAKTHROUGH APPRATUS



The adsorption capacities for CO_2 adsorption of the prepared samples were measured using a fixed bed adsorption unit developed at LSRE-LCM. The experimental setup consists on several main parts. The first one is a Gas Chromatograph, which includes the adsorption column inserted in an oven to attain the required temperature. A Thermal Conductivity Detector (TCD) measures the outlet CO_2 composition. In this unit, a 6-way crossover valve (SV) is used to control the gas entrance flow to the Gas Chromatograph. Also, the gases feed flow rates are adjusted by three mass flow controllers (MFC). The pressure of the system is controlled by a Back Pressure Regulator (BPR). The helium gas is utilized as a carrier gas. Before each experiment, the available impurity and moisture are removed by passing the inert gas (Helium) in the bed of column at 473 K, for 12 h. Thereafter, the experiment is performed by passing a constant flow rate of the mixture (carrier gas and CO_2) in the column. During the adsorption runs, the CO_2 composition is continuously measured by the TCD at the outlet of the column as a function of time. In the last step, the desorption process is obtained by passing pure helium through the fixed bed.

It is a long established fact that a reader will be distracted by the readable content of a page when looking at its layout. The point of using Lorem Ipsum is that it has a more-or-less normal distribution of letters, as opposed to using 'Content here, content here', making it look likereadable English. Many desktop publishing packages and web page editors now use Lorem Ipsum as their default model text, and a search for 'lorem ipsum' will uncover many web sites still in their infancy. Various versions have evolved over the years, sometimes by accident, sometimes on purpose (injected humour and the like).

RESULTS AND DISCUSSION

Where does it come from?
Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage,The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum" by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.
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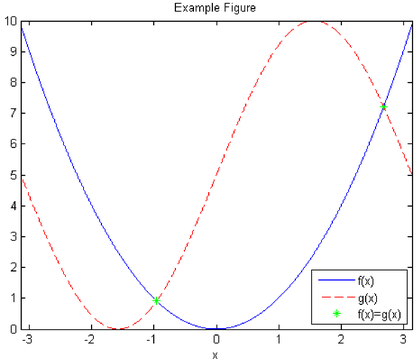

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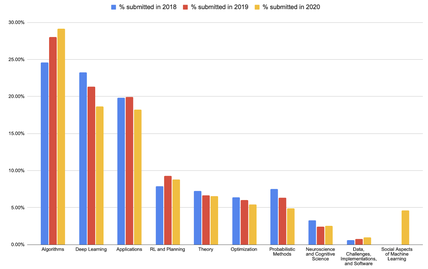

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CONCLUSION

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What is Lorem Ipsum?
Lorem Ipsum is simply dummy text of the printing and typesetting industry. Lorem Ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book. It has survived not only five centuries, but also the leap into electronic typesetting, remaining essentially unchanged. It was popularised in the 1960s with the release of Letraset sheets containing Lorem Ipsum passages, and more recently with desktop publishing software like Aldus PageMaker including versions of Lorem Ipsum.
Why do we use it?
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