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Nitrogen-doped porous activated carbon monolith derived from polymer for ultrahigh-CO_2 adsorption capacity and CO_2/N_2 selectivity

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Hierarchical porous carbon (HPC) monolithic with 3D network has received considerable attention due to their potentially technological application as candidates for electrochemical energy storage devices such as capacitors, lithium ion batteries, solar cells, sorbent for toxic gas separation and greenhouse gas capture for their well-defined pore dimensions and topologies. Synthetic polymer based hierarchical nanostructured carbons are particularly attractive for their consistent pore dimensions which can be adjustable on long length scales, so that diffusibility of guest species could be improved through its unique hierarchical pores. N-doped HPC monoliths exhibit multifaceted features such as tunable textural properties, excellent thermal and chemical stability, which are remarkable physicochemical properties that are answerable for micro/nanostructured porous carbons perfect candidates for emerging substrates in nanotechnology science. A two-step synthetic method has been developed to achieve functionalized nanoporous carbons via cross-linked polymer precursors, which are prepared by Friedel-craft alkylation and pyrolysis. Nitrogen-doping proves to be an effective method for reinforcing the CO_2 adsorption capacity of carbon-based adsorbents, although it remains a great challenge to reach a fit doping level of nitrogen (N) and a high porosity in a porous carbon simultaneously. Herein, a facile method that enables the fabrication of ordered microporous nitrogen-doped porous carbon monolith with a content of 4.6 wt% N, employs poly (H-BINAM) as precursor; through chemical activation, high microporosity is generated and gives birth to a monolithic structured porous nitrogen-doped carbon. This material exhibits a remarkable CO_2 adsorption capacity (6.74 mmol g-1 at 273 K and 4.27 mmol g-1 at 298 K under 1 bar), and an extraordinarily excellent CO_2/N_2 selectivity (153), which is calculated from the single-component adsorption isotherms based on Henry's Law. This value exceeds the CO_2/N_2 selectivity of thus mentioned for carbon-based adsorbents including diverse nitrogen doped ones, whose attributes are largely associated with the unusually high N-content as well as the partial graphitic framework.

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Experimental study of characterization of aged fluid in casing annulus

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In many cementing operations, the cement top does not reach to the surface. When this is the case, a cement-free casing annulus is formed between two casings, casing-head and cement-top. The fluid inside this confined space (annular fluid, AF) remains in place and ages. During a well's productive or abandoned life time, various operations concerning casing annulus may be required. If the condition of AF is unknown, applications may lead to ineffective results. Since the only access to any casing annulus is the top valve at the well-head, taking samples of the fluids from inside has not been practical. This paper aims to describe the final state of water-based AFs. Various AFs with different compositions were generated in the lab by changing the amounts of drilling mud, spacer and pre-flush; and a general formula of AF was determined. Then, long-term settling experiments were carried out by using a ten-foot PVC pipe. AFs were weighted up to 12.5 to 14.5 ppg and placed in the pipe; kept undisturbed for 3 to 11 weeks and densities of different levels were measured by taking samples. Lastly, mud column density distribution vs. time experiment was conducted in a twenty-foot physical model by recording pressure changes over time. As a result, the long-term settling experiments showed that the AF separates into three main zones: Compaction zone at the bottom, water zone at the top and a column of un-weighted mud in between. In majority of the experiments, compaction zone density varied between 19-20 ppg and was still able to transmit hydrostatic pressure. Based on the results, a mathematical barite bed height prediction model was derived. This study shows that the final condition of an AF column consists of three sections with different densities and any annular intervention attempt should be designed accordingly.

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