# Adsorption of Nitrogen, Carbon Dioxide and Methane at Cryogenic Temperatures and High Pressures. Part 2: Kinetic Measurements with a Dynamic Apparatus

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Natural gas is the most environmentally friendly of the fossil fuels and, in contrast to many other clean fuels, the infrastructure necessary for its widespread use already exists in many parts of the world. However, before a natural gas field can be developed it must be processed to remove impurities, and the cost of the required processing can be critical to the field's economic viability. Conventionally, $CO_2$ removal requires the use of a water-based amine solution and large absorber and regeneration towers, while $N_2$ separation requires distillation towers operating at cryogenic temperatures. Furthermore, the conventional $CO_2$ removal process saturates the gas with water vapour, which can lead to the duplication of expensive gas dehydration equipment. If the feed gas contains $CO_2$ and $N_2$ at combined levels in excess of 10 % by mole, then the cost of such processes can make development of the gas field unviable. Many workers are investigating the use of alternative gas separation technologies such as membranes and adsorption to address this general problem. However, very little work has been done studying the efficacy of adsorption processes at cryogenic temperatures. Furthermore, almost all kinetic adsorption studies made by inverse gas chromatography are conducted at pressures close to 1 atmosphere. We have constructed an inverse gas chromatography apparatus capable of measuring adsorption kinetics, specific retention volumes and isosteric enthalpies of adsorption at temperatures between 190 and 298 K, pressures to 1 MPa and at flow rates between 5 and 40 sccm. This system was used to study the dynamic adsorption of $N_2$, $CO_2$ and $CH_4$ on carbon molecular sieves and zeolites. This presentation will describe the measurement results and the challenges that were overcome as well as future plans to construct a larger scale apparatus.