CLAIMS

What is claimed is:

1. A method of forming a highly selective ultra-small pore amorphous adsorbent; the method comprising the steps of: introducing an ion-exchange material to a sodium aluminosilicate zeolite such that an ion-exchanged zeolite forms; calcinating the ion-exchanged zeolite at a calcination temperature such that the ion-exchanged zeolite collapses and forms a decationized amorphous adsorbent; and introducing a back ion-exchange material to the decationized amorphous adsorbent such that the highly selective ultra-small pore amorphous adsorbent forms, where the highly selective Ultra-small pore amorphous adsorbent has a pore aperture size operable to permit carbon dioxide to adsorb into the amorphous adsorbent and operable to deny methane from adsorbing into the amorphous adsorbent, and where the pore aperture size is in a range of from 0.33 nm to 0.38 nm.

2. The method of claim 1 where the sodium aluminosilicate zeolite is a Linde Type A zeolite.

3. The method of claim 1 where the positive ion of the ion-exchange material is an ammonium ion.

4. The method of claim 1 where the calcination temperature is in a range of from 473 °K to 773 °K.

5. The method of claim 1 where the positive ion of the back ion-exchange material is selected from the group consisting of an alkali metal cation or an alkaline earth metal cation.

6. The method of claim 5 where the positive ion is a sodium cation.

7. The method of claim 1 where the amorphous adsorbent has a carbon dioxide/methane selectivity factor in a range of from greater than 2.5 to 6.5 after 30 minutes at 8bar and

298 °K.

8. The method of claim 1 where the amorphous adsorbent has a carbon dioxide/methane selectivity factor in a range of from greater than 2.5 to 40 after 2 minutes at 8bar and 298 °K.

9. A highly selective ultra-small pore amorphous adsorbent comprising an aluminosilicate matrix of a collapsed cation exchanged aluminosilicate zeolite, where the amorphous adsorbent has a pore aperture size operable to permit carbon dioxide to adsorb into the amorphous adsorbent and operable to deny methane from adsorbing into the amorphous adsorbent and where the amorphous adsorbent has a carbon dioxide/methane selectivity factor, and where the amorphous adsorbent has a pore aperture size in a range of from 0.33 nm to 0.38 nm.

10. The composition of claim 9 where the aluminosilicate zeolite has a sodium Linde Type A structure.

11. The composition of claim 9 where the cation is selected from the group consisting of an alkali metal cation or an alkaline earth metal cation.

12. The composition of claim 11 where the alkali metal cation is a sodium cation.

13. The composition of claim 9 where the carbon dioxide/methane selectivity factor is in a range of from greater than 2.5 to 6,5 after 30 minutes at 8 bar and 298 °K.

14. The composition of claim 9 where the amorphous adsorbent has a carbon dioxide/methane selectivity factor in a range of from greater than 2.5 to 40 after 2 minutes at 8 bar and 298 °K.

15. A method for upgrading a natural gas stream comprises the steps of: introducing a natural

gas to a vessel containing the highly selective ultra-small pore amorphous adsorbent of claim 9, where the natural gas has a first mole percent of nitrogen and a first mole percent of carbon dioxide; and maintaining the natural gas in the vessel for a residence time such that the natural gas contacts the amorphous adsorbent and that an upgraded natural gas forms, where the upgraded natural gas has a second mole percent of nitrogen and a second mole percent of carbon dioxide, where the first mole percent of nitrogen is greater than the second mole percent of nitrogen, and where the first mole percent of carbon dioxide is greater than the second mole percent of carbon dioxide.

16. The method of claim 15 where the residence time is in a range of two minutes to 30 minutes.

17. The method of claim 15 where the amorphous adsorbent has a carbon dioxide/methane selectivity factor in a range of from greater than 2.5 to 40 after 2minutes at 8 bar and 298 °K.