## CLAIMS

What is claimed is:

1. A method of using a natural gas storage facility to reduce the effect of diurnal demand on a natural gas source, the method comprising the steps of:

introducing a natural gas into the natural gas storage facility during a non-peak period of demand;

operating the natural gas storage facility during the non-peak period of demand such that

a guard bed system removes a natural gas impurity from the introduced natural gas, selectively separates the introduced natural gas into a heavy natural gas component and a light natural gas component, and retains the heavy natural gas component during the non-peak period of demand,

the light natural gas component passes from the guard bed system into an adsorbent bed system, and

the adsorbent bed system adsorbs the light natural gas component into a light natural gas adsorbent and retains the light natural gas component during the non-peak period of demand;

operating the natural gas storage facility during a period of peak demand such that

the guard bed system releases the heavy natural gas component,

the adsorbent bed system releases the light natural gas component from the light natural gas adsorbent, and

the released heavy natural gas component and the released light natural gas component mix to form a released natural gas product having a thermal value; and

introducing the released natural gas product into the natural gas source during the peak period of demand;

where the natural gas storage facility comprises the adsorption bed system that fluidly couples to the guard bed system,

where the natural gas source contains the natural gas, and

where the natural gas includes an impurity, a light natural gas component and a heavy natural gas component, and has a thermal value.

2. The method of claim 1 where the guard bed system includes a heavy natural gas adsorbent and is operable to retain the heavy natural gas component by adsorption.

3. The method of claim 2 where the heavy natural gas adsorbent is a microporous material.

4. The method of any one of claims 1 to 3 where the light natural gas component is substantially free of propane.

5. The method of claim 4 where the light natural gas component is substantially free of ethane.

6. The method of any one of claims 1 to 5 where the released natural gas product has a similar thermal value to the thermal value of the introduced natural gas.

7. The method of any one of claims 1 to 6 further comprising the steps of:

operating a temperature control system during the non-peak period of demand such that heat is removed from the guard bed system; and

operating the temperature control system during the peak period of demand such that heat is introduced into the guard bed system;

where the natural gas storage facility further comprises the temperature control system that is coupled to the guard bed system.

8. The method of any one of claims 1 to 7 further comprising the steps of:

operating a temperature control system during the non-peak period of demand such that heat is removed from the light natural gas adsorbent; and

operating the temperature controls system during the peak period of demand such that heat is introduced into the light natural gas adsorbent;

where the natural gas storage facility further comprises the temperature control system that is coupled to the adsorption bed system.

9. The method of any one of claims 1 to 8 further comprising the step of operating a storage facility compressor during the introduction of the natural gas into the natural gas

storage facility, where the natural gas storage facility further comprises the storage facility compressor that is coupled to the guard bed system.

10. The method of any one of claims 1 to 9 further comprising the step of operating a storage facility compressor during the period of peak demand such that a less than atmospheric condition forms in the guard bed system, where the natural gas storage facility further comprises the storage facility compressor that is coupled to the guard bed system.

11. The method of any one of claims 1 to 10 further comprising the step of operating a storage compressor during the period of peak demand such that a less than atmospheric pressure condition forms in the adsorbent bed system, where the natural gas storage facility further comprises the storage facility compressor that is coupled to the adsorbent bed system.

12. The method of any one of claims 1 to 11 further comprising the step of operating the natural gas storage facility during the period of peak demand such that the released light natural gas component assists in releasing the heavy natural gas component, forming the released natural gas product in the guard bed system, where the guard bed system fluidly couples to the adsorption bed system such that at least a portion of the released light natural gas component passes into the guard bed system.

13. The method of any one of claims 1 to 12 further comprising the steps of:

detecting a first condition associated with the start of the non-peak period of demand;

detecting a second condition associated with the end of the non-peak period of demand;

detecting a third condition associated with the start of the peak period of demand;

detecting a fourth condition associated with the end of the peak period of demand;

where detecting the first condition occurs before the introduction of the natural gas into the natural gas storage facility,

where detecting the second condition occurs during the operation of the natural gas storage facility during the non-peak period of demand,

where detecting the third condition occurs before the operation of the natural gas storage facility during the period of peak demand, and

where detecting the fourth condition occurs during the introduction of the released natural gas product into the natural gas source.

14. The method of claim 13 where the second condition and the third condition are the same.

15. The method of claim 13 or claim 14 where the first condition and the fourth condition are the same.

16. The method of any one of claims 13 to 15 where all of the conditions are associated with the pressure of the natural gas source.

17. A natural gas storage facility for reducing the effect of diurnal demand on a natural gas source, the natural gas facility comprising:

a guard bed system that has a heavy natural gas component storage capacity and that is operable to remove impurities from the introduced natural gas, to selectively separate the introduced natural gas into the heavy natural gas component and the light natural gas component, to retain the heavy natural gas component and to release the heavy natural gas component;

an adsorption bed system that fluidly couples to the guard bed system, that has a light natural gas component storage capacity, that contains a light natural gas adsorbent that is a microporous material, and that is operable to retain the light natural gas component using the light natural gas adsorbent and to release the light natural gas component from the light natural gas adsorbent;

optionally, a temperature control system that is separately coupled to both the guard bed system and the adsorption bed system and is operable to regulate the temperature of the guard bed system and the adsorbent bed system separately; and

optionally, a compressor system that is separately fluidly coupled to both the guard bed system and the adsorption bed system and is operable to regulate the pressure of the guard bed system and the adsorbent bed system separately;

where the natural gas storage facility couples to the natural gas storage facility such that introduced natural gas enters the guard bed system.

18. The natural gas storage facility of claim 17 where the guard bed system contains a heavy natural gas adsorbent material that is operable to remove impurities from the introduced natural gas, to selectively separate the introduced natural gas into the heavy natural gas component and the light natural gas component, to retain the heavy natural gas component by adsorption, and to release the heavy natural gas component by desorption.

19. The natural gas storage facility of claim 18 where the heavy natural gas adsorbent material is a microporous material.

20. The natural gas storage facility of any one of claims 17 to 19 where the microporous material has a BET Specific Surface Area value of at least 800 meters squared per gram ($m^2/g$) and a Micropore Volume value of at least 0.300 centimeters cubed per gram ($cm^3/g$) of microporous material as determined using nitrogen porosimetry at 77 °K.

21. The natural gas storage facility of any one of claims 17 to 20 where the microporous material is an activated carbon with slit-shaped micropores, has a bulk density is in a range of from 0.20 to 0.75 grams per cubic centimeter ($g/cm^3$), and has a BJH Average Pore Width in a range of from 10 to 30 Angstroms (Å) as determined using nitrogen porosimetry at 77 °K.

22. The natural gas storage facility of any one of claims 17 to 21 where the microporous material has an adsorbed amount ratio greater than 60 at 40 bars of system pressure and an adsorbed amount ratio greater than 65 at 50 bars of system pressure at 56 °C using methane.

23. The natural gas storage facility of any one of claims 17 to 22 where the microporous material has an adsorbed amount ratio greater than 100 at a pressure in a range of from 35 bars to 55 bars at 21 °C using methane.

24. The natural gas storage facility of any one of claims 17 to 23 where the microporous material has a stored amount ratio of greater than 115 at 50 bars of system pressure, greater than 110 at 45 bars of system pressure and greater than 100 at 40 bars system pressure, all using methane at 21 °C.

25. The natural gas storage facility of any one of claims 17 to 24 where the microporous material has a stored amount ratio greater than 100 at a pressure in a range of from 35 bars to 55 bars at 21 °C using methane.

## CLAIMS

1. A method of using a natural gas storage facility to reduce the effect of diurnal demand on a natural gas source, the method comprising the steps of:

introducing a natural gas into the natural gas storage facility during a non-peak period of demand;

operating the natural gas storage facility during the non-peak period of demand such that

a guard bed system removes a natural gas impurity from the introduced natural gas, selectively separates the introduced natural gas into a heavy natural gas component and a light natural gas component, and retains the heavy natural gas component during the non-peak period of demand,

the light natural gas component passes from the guard bed system into an adsorption bed system, and

the adsorption bed system adsorbs the light natural gas component into a light natural gas adsorbent and retains the light natural gas component during the non-peak period of demand;

operating the natural gas storage facility during a period of peak demand such that

the guard bed system releases the heavy natural gas component,

the adsorption bed system releases the light natural gas component from the light natural gas adsorbent, and

the released heavy natural gas component and the released light natural gas component mix to form a released natural gas product having a thermal value; and

introducing the released natural gas product into the natural gas source during the peak period of demand;

where the natural gas storage facility comprises the adsorption bed system that fluidly couples to the guard bed system,

where the natural gas source contains the natural gas, and

where the natural gas includes an impurity, a light natural gas component and a heavy natural gas component, and has a thermal value.

2. The method of claim 1 where the guard bed system includes a heavy natural gas adsorbent and is operable to retain the heavy natural gas component by adsorption.

3. The method of claim 2 where the heavy natural gas adsorbent is a microporous material.

4. The method of any one of claims 1 to 3 where the light natural gas component is substantially free of propane.

5. The method of claim 4 where the light natural gas component is substantially free of ethane.

6. The method of any one of claims 1 to 5 where the released natural gas product has a similar thermal value to the thermal value of the introduced natural gas.

7. The method of any one of claims 1 to 6 further comprising the steps of:

operating a temperature control system during the non-peak period of demand such that heat is removed from the guard bed system; and

operating the temperature control system during the peak period of demand such that heat is introduced into the guard bed system;

where the natural gas storage facility further comprises the temperature control system that is coupled to the guard bed system.

8. The method of any one of claims 1 to 7 further comprising the steps of:

operating a temperature control system during the non-peak period of demand such that heat is removed from the light natural gas adsorbent; and

operating the temperature controls system during the peak period of demand such that heat is introduced into the light natural gas adsorbent;

where the natural gas storage facility further comprises the temperature control system that is coupled to the adsorption bed system.

9. The method of any one of claims 1 to 8 further comprising the step of operating a storage facility compressor during the introduction of the natural gas into the natural gas storage facility, where the natural gas storage facility further comprises the storage facility compressor that is coupled to the guard bed system.

10. The method of any one of claims 1 to 9 further comprising the step of operating a storage facility compressor during the period of peak demand such that a less than atmospheric condition forms in the guard bed system, where the natural gas storage facility further comprises the storage facility compressor that is coupled to the guard bed system.

11. The method of any one of claims 1 to 10 further comprising the step of operating a storage facility compressor during the period of peak demand such that a less than atmospheric pressure condition forms in the adsorption bed system, where the natural gas storage facility further comprises the storage facility compressor that is coupled to the adsorption bed system.

12. The method of any one of claims 1 to 11 further comprising the step of operating the natural gas storage facility during the period of peak demand such that the released light natural gas component assists in releasing the heavy natural gas component, forming the released natural gas product in the guard bed system, where the guard bed system fluidly couples to the adsorption bed system such that at least a portion of the released light natural gas component passes into the guard bed system.

13. The method of any one of claims 1 to 12 further comprising the steps of:

detecting a first condition associated with the start of the non-peak period of demand;

detecting a second condition associated with the end of the non-peak period of demand;

detecting a third condition associated with the start of the peak period of demand;

detecting a fourth condition associated with the end of the peak period of demand;

where detecting the first condition occurs before the introduction of the natural gas into the natural gas storage facility,

where detecting the second condition occurs during the operation of the natural gas storage facility during the non-peak period of demand,

where detecting the third condition occurs before the operation of the natural gas storage facility during the period of peak demand, and

where detecting the fourth condition occurs during the introduction of the released natural gas product into the natural gas source.

14. The method of claim 13 where the second condition and the third condition are the same.

15. The method of claim 13 or claim 14 where the first condition and the fourth condition are the same.

16. The method of any one of claims 13 to 15 where all of the conditions are associated with the pressure of the natural gas source.

17. A natural gas storage facility for reducing the effect of diurnal demand on a natural gas source, the natural gas storage facility comprising:

a guard bed system that has a heavy natural gas component storage capacity and that is operable to remove impurities from the introduced natural gas, to selectively separate the introduced natural gas into a heavy natural gas component and a light natural gas component, to retain the heavy natural gas component and to release the heavy natural gas component;

an adsorption bed system that fluidly couples to the guard bed system, that has a light natural gas component storage capacity, that contains a light natural gas adsorbent that is a microporous material, and that is operable to retain the light natural gas component using the light natural gas adsorbent and to release the light natural gas component from the light natural gas adsorbent;

optionally, a temperature control system that is separately coupled to both the guard bed system and the adsorption bed system and is operable to regulate the temperature of the guard bed system and the adsorption bed system separately; and

optionally, a storage facility compressor that is separately fluidly coupled to both the guard bed system and the adsorption bed system and is operable to regulate the pressure of the guard bed system and the adsorption bed system separately;

where the natural gas storage facility couples to the natural gas source such that introduced natural gas enters the guard bed system.

18. The natural gas storage facility of claim 17 where the guard bed system contains a heavy natural gas adsorbent material that is operable to remove impurities from the introduced natural gas, to selectively separate the introduced natural gas into the heavy natural gas component and the light natural gas component, to retain the heavy natural gas component by adsorption, and to release the heavy natural gas component by desorption.

19. The natural gas storage facility of claim 18 where the heavy natural gas adsorbent material is a microporous material.

20. The natural gas storage facility of any one of claims 17 to 19 where the microporous material has a BET Specific Surface Area value of at least 800 meters squared per gram ($m^2/g$) and a Micropore Volume value of at least 0.300 centimeters cubed per gram ($cm^3/g$) of microporous material as determined using nitrogen porosimetry at 77 °K.

21. The natural gas storage facility of any one of claims 17 to 20 where the microporous material is an activated carbon with slit-shaped micropores, has a bulk density is in a range of from 0.20 to 0.75 grams per cubic centimeter ($g/cm^3$), and has a BJH Average Pore Width in a range of from 10 to 30 Angstroms (Å) as determined using nitrogen porosimetry at 77 °K.

22. The natural gas storage facility of any one of claims 17 to 21 where the microporous material has an adsorbed amount ratio greater than 60 at 40 bars of system pressure and an adsorbed amount ratio greater than 65 at 50 bars of system pressure at 56 °C using methane.

23. The natural gas storage facility of any one of claims 17 to 22 where the microporous material has an adsorbed amount ratio greater than 100 at a pressure in a range of from 35 bars to 55 bars at 21 °C using methane.

24. The natural gas storage facility of any one of claims 17 to 23 where the microporous material has a stored amount ratio of greater than 115 at 50 bars of system pressure, greater

than 110 at 45 bars of system pressure and greater than 100 at 40 bars system pressure, all using methane at 21 °C.

25. The natural gas storage facility of any one of claims 17 to 24 where the microporous material has a stored amount ratio greater than 100 at a pressure in a range of from 35 bars to 55 bars at 21 °C using methane.