CLAIMS

1. A method of improving efficiency of a combustion system utilizing a high viscosity heavy oil residue fuel, the method comprising:

   a. providing a source of CO_2 or a CO_2-rich gaseous mixture;
   b. bringing the CO_2 or CO_2-rich gaseous mixture into intimate contact with the heavy oil residue under predetermined conditions of temperature and a pressure below about 73 bar, to maintain CO_2 below supercritical pressure conditions;
   c. maintaining the contact of the CO_2 or CO_2-rich mixture with the heavy oil residue below about 73 bar until a predetermined concentration of dissolved CO_2 is attained and the viscosity of the heavy oil residue is reduced;
   d. pumping and atomizing the reduced-viscosity heavy oil residue for combustion in a combustion chamber.

2. The method of claim 1, further comprising, after step (c), transporting the reduced-viscosity heavy oil residue via a pipeline to the combustion system.

3. The method of claim 1 , further comprising introducing the reduced-viscosity heavy oil residue with dissolved CO_2 into a pressurized heated storage vessel under predetermined conditions of temperature and pressure to maintain the viscosity of the heavy oil residue within a prescribed viscosity range, and passing the reduced-viscosity heavy oil residue from the storage vessel and atomizing it for combustion in a combustion chamber.

4. The method of claim 1wherein the CO_2 or CO_2-rich mixture and heavy oil residue are contacted in an agitated mixing vessel under an atmosphere of pressurized gaseous CO_2.

5. The method of claim 1 wherein the CO_2 or CO_2-rich mixture is introduced into a moving stream of the heavy oil residue and passed through a static or dynamic in-line mixing device to dissolve the CO_2 in the heavy oil residue.

6. The method of claim 1, wherein the atomization of the reduced-viscosity heavy oil residue is accomplished by an atomizing media including steam and/or CO_2.

7. The method of claim 1, wherein the atomization of the reduced-viscosity heavy oil residue is accomplished by one or more mechanical atomization injectors.

8. The method of claim 1, wherein the source of CO_2 or a CO_2-rich gaseous mixture is provided from an integrated CO_2 capture and processing unit.

9. The method of claim 1, wherein the source of CO_2 or a CO_2-rich gaseous mixture is provided from at least a two-stage CO_2 capture and processing unit, each stage delivering CO_2 or a CO_2-rich gaseous mixture at different pressures.

10. The method of claim 1, wherein combustion occurs in the presence of air, oxygen or oxygen-enriched air.

11. The method of claim 1, further comprising

e. passing flue gases from the combustion chamber to one or more flue gas treatment units;

f. passing effluent flue gases from the one or more flue gas treatment units to a CO_2 capture unit; and

g. passing at least a portion of CO_2 from the CO_2 capture unit to step (b).

12. The method of claim 1, wherein the mixture of CO_2 (or CO_2-rich mixture) and heavy oil is maintained in a storage tank prior to pumping to the combustion chamber.