CLAIMS

1. A combustor system, comprising:

a combustor having a first end, a second end, an outer shell, an inner shell, a secondary inner shell, and an annular volume formed between the outer shell and the inner shell extending from the first end to the second end;

a carbon dioxide inlet configured to introduce carbon dioxide to the combustor;

an oxygen inlet configured to introduce oxygen to the combustor;

a first mixing zone disposed within the combustor and configured to mix a first portion of any carbon dioxide introduced through the carbon dioxide inlet with at least a portion of any oxygen introduced through the oxygen inlet to produce a first mixture within the first mixing zone comprising oxygen and carbon dioxide, wherein:

the first portion of any carbon dioxide introduced through the carbon dioxide inlet flows through the annular volume of the combustor toward the first end of the combustor from the second end of the combustor,

the oxygen inlet is positioned in the annular volume and configured to promote mixing of the first portion of any carbon dioxide introduced through the carbon dioxide inlet and the oxygen introduced the oxygen inlet, and

the secondary inner shell is configured to prevent introduction of the oxygen introduced through the oxygen inlet through the inner shell;

a fuel inlet configured to introduce a fuel into the first end of the combustor;

a second mixing zone disposed within the combustor and configured to mix the first mixture and the fuel to produce a second mixture within the second mixing zone comprising oxygen, carbon dioxide, and fuel; and

a combustion zone configured to combust the second mixture to produce a combustion product, wherein a second portion of any carbon dioxide introduced through the carbon dioxide inlet flows through one or more apertures disposed through the inner shell and mixes with and cools the combustion product.

2. The system of claim 1, wherein:

the fuel is introduced into the first end of the combustor.

3. The system of claim 2, further comprising a secondary oxygen inlet configured to introduce oxygen to the second mixing zone.

4. The system of claim 1, further comprising at least one secondary oxygen inlet configured to spatially vary a ratio of oxygen-to-carbon dioxide in the first mixture.

5. The system of claim 4, further comprising a controller to actively control the spatial variation of the oxygen concentration by controlling the ratio of oxygen flow through the oxygen inlet and the at least one secondary oxygen inlet.

6. The system of claim 1, further comprising a variable geometry mixing device positioned in the first mixing zone configured to spatially vary a ratio of oxygen-to-carbon dioxide in the first mixture.

7. The system of claim 1, further comprising:

at least one cavity positioned in the second mixing zone configured to deliver at least a portion of the fuel to the combustion zone to produce a low-velocity region to enhance flame stability in the combustion zone, wherein the first portion of any carbon dioxide introduced through the carbon dioxide inlet flows through the annular volume of the combustor toward the first end of the combustor from the second end of the combustor to cool a wall of the at least one cavity, and wherein the first mixing zone is located near the first end of the combustor.

8. A combustion burner system, comprising:

a combustor having a first end, a second end, an outer shell, an inner shell, a secondary inner shell, an annular volume formed between the outer shell and the inner shell extending from the first end to the second end, a combustion burner comprising a burner face, and a combustion zone;

a carbon dioxide inlet, an oxygen inlet, and a fuel inlet; and

a mixing zone disposed within the combustor and configured to mix a first portion of any carbon dioxide introduced through the carbon dioxide inlet and at least a portion of any oxygen introduced through the oxygen inlet to produce a first mixture within the mixing zone comprising oxygen and carbon dioxide, wherein:

the first portion of any carbon dioxide introduced through the carbon dioxide inlet is configured to flow through the annular volume toward the first end of the combustor from the second end of the combustor,

the oxygen inlet is configured to deliver the oxygen introduced through the oxygen inlet to the first portion of any carbon dioxide introduced through the carbon dioxide inlet to produce the first mixture,

the oxygen inlet is positioned in the annular volume and configured to promote mixing of the first portion of any carbon dioxide introduced through the carbon dioxide inlet and the oxygen introduced through the oxygen inlet,

the oxygen inlet comprises a plurality of injection holes disposed through at least one of a wall of the combustor and a ring in the annular volume,

the secondary inner shell is configured to prevent introduction of the oxygen through the inner shell, and

the first mixture comprises a spatially varied ratio of oxygen-to-carbon dioxide across the burner face configured to generate a hot zone in a combustion zone to increase flame stability in the combustion zone.

9. The system of claim 8, further comprising at least one secondary oxygen inlet configured to spatially vary the ratio of oxygen-to-carbon dioxide in the first mixture.

10. The system of claim 8, further comprising a variable geometry mixing device in the first mixing zone configured to spatially vary the ratio of oxygen-to-carbon dioxide.

11. The system of claim 8, further comprising a gas injection device configured to provide an anchor flame upstream of the combustion zone, the anchor flame being adapted to increase flame stability in the combustion zone.

12. A combustion burner system, comprising:

a combustor having a first end, a second end, an outer shell, an inner shell, a combustion burner comprising a burner face, and a combustion zone;

a carbon dioxide inlet, an oxygen inlet, and a fuel inlet;

a mixing zone disposed within the combustor and configured to mix a first portion of any carbon dioxide introduced through the carbon dioxide inlet and at least a portion of any

oxygen introduced through the oxygen inlet to produce a first mixture within the mixing zone comprising oxygen and carbon dioxide, wherein the first mixture comprises a spatially varied ratio of oxygen-to-carbon dioxide across the burner face configured to generate a hot zone in a combustion zone to increase flame stability in the combustion zone;

a central burner body having a plurality of tubes in a bundled arrangement disposed therein, wherein a first portion of the plurality of tubes are configured to carry a fuel and a second portion of the plurality tubes are configured to carry the oxygen;

an opening disposed through at least a portion of a side of the central burner body configured to permit the passage of the first portion of any carbon dioxide into a volume disposed between the plurality of tubes; and

a controller configured to modulate at least a flow rate of the oxygen across the second portion of the tubes configured to carry the oxygen to spatially vary the ratio of oxygen-to-carbon dioxide across the burner face.