CLAIMS:

What is claimed is:

1. An apparatus comprising a convection zone and a radiant zone, the convection zone comprising a steam superheater comprising:

a first heat exchanger in fluid communication with a first section of a line;

a first fluid source for injecting water coupled with the first section of the line downstream of the first heat exchanger;

a second heat exchanger in fluid communication with the first section of the line downstream of the first fluid source, wherein the second heat exchanger is in fluid communication with a second section of the line downstream of the first section of the line;

a second fluid source for injecting water coupled with the second section of the line downstream of the second heat exchanger; and

a third heat exchanger in fluid communication with the second section of the line downstream of the second fluid source;

wherein the apparatus also comprises a steam drum and a header, the first heat exchanger in communication with the steam drum for a supply of steam to the first heat exchanger, and the third heat exchanger is also in fluid communication with the header for export of steam to the header.

2. The apparatus of claim 1, wherein the first fluid source comprises a first flow control valve and the second fluid source comprises a second flow control valve.

3. The apparatus of claim 2, further comprising a control module communicatively coupled to the first flow control valve and the second flow control valve.

4. The apparatus of claim 1, further comprising:

a first temperature sensor coupled with the first section of the line between the first heat exchanger and the first fluid source;

a second temperature sensor coupled with the first section of the line between the first fluid source and the second heat exchanger;

a third temperature sensor coupled with the second section of the line between the second heat exchanger and the second fluid source; and

a fourth temperature sensor coupled with the second section of the line between the second fluid source and the third heat exchanger.

5. The apparatus of claim 4, further comprising:

a control module communicatively coupled to each temperature sensor and each of the first fluid source and the second fluid source.

6. The apparatus of claim 1, wherein the heat exchangers are metal tubes.

7. An apparatus comprising a convection zone and a radiant zone, the convection zone comprising a steam superheater comprising:

a first heat exchanger coupled with a first line;

a first fluid source for injecting water coupled with the first line downstream of the first heat exchanger;

a second line;

a second heat exchanger coupled with the first line downstream of the first fluid source and wherein the second heat exchanger is coupled with the second line;

a second fluid source for injecting water coupled with the second line downstream of the second heat exchanger; and

a third heat exchanger coupled with the second line downstream of the second fluid source;

wherein the apparatus also comprises a steam drum and a header, the first heat exchanger in communication with the steam drum for a supply of steam to the first heat exchanger, and the third heat exchanger is also in fluid communication with the header for export of steam to the header.

8. The apparatus of claim 7, further comprising:

a first temperature sensor coupled with the first line between the first heat exchanger and the first fluid source;

a second temperature sensor coupled with the first line between the first fluid source and the second heat exchanger;

a third temperature sensor coupled with the second line between the second heat exchanger and the second fluid source; and

a fourth temperature sensor coupled with the second line between the second fluid source and the third heat exchanger.

9. The apparatus of claim 8, further comprising:

an export temperature sensor coupled to an export line downstream of the third heat exchanger; and

a control module communicatively coupled to each temperature sensor and each of the first fluid source and the second fluid source.

10. The apparatus of claim 8, further comprising a control module communicatively coupled to each temperature sensor and each of the first fluid source and the second fluid source, wherein the first fluid source is a first flow control valve and the second fluid source is a second flow control valve.

11. A process for controlling a convection zone for a furnace, the process comprising:

heat exchanging steam with flue gas to provide heated steam;

injecting water through a first fluid source to the heated steam to provide a first reduced temperature steam;

heat exchanging the first reduced temperature steam with flue gas to provide an intermediate steam;

injecting water through a second fluid source to the intermediate steam to provide a second reduced temperature steam; and

heat exchanging the second reduced temperature steam with flue gas at an export temperature suitable for export to a header to provide an export steam.

12. The process of claim 11, wherein the first fluid source comprises a first flow control valve and the second fluid source comprises a second flow control valve.

13. The process of claim 12, wherein:

injecting water through the first fluid source comprises completely opening the first flow control valve, and

injecting water through the second fluid source comprises opening the second flow control valve after completely opening the first flow control valve.

14. The process of claim 12, further comprising opening the first flow control valve and the second flow concurrently.

15. The process of claim 11, further comprising:

measuring a first temperature of the heated steam with a first temperature sensor;

controlling a second temperature of the first reduced temperature steam by measuring the second temperature with a second temperature sensor and adjusting a first water flow rate of the first fluid source;

measuring a third temperature of the intermediate steam with a third temperature sensor; and

controlling a fourth temperature of the second reduced temperature steam by measuring the second reduced temperature steam with a fourth temperature sensor and adjusting a second water flow rate of the second fluid source.

16. The process of claim 15, wherein each of the first temperature and the third temperature is less than a design temperature of piping of the convection zone, and wherein each of the second temperature and fourth temperature is at least 50 °C above a saturation temperature of the steam.

17. The process of claim 15, further comprising managing a selective catalytic reduction system inlet temperature at 310 ºC to 400 ºC by adjusting the first water flow rate of the first fluid source and adjusting the second water flow rate of the second fluid source.

18. The process of claim 15, wherein each of the first temperature and the third temperature is less than 525 °C and each of the second temperature and the fourth temperature is greater than at least 20°C above a saturation temperature of the steam.

19. The process of claim 11, further comprising maintaining a stack temperature at least 150 °C by adjusting a total water flow rate of the first and second fluid source.

20. The process of claim 11, wherein the export temperature is a superheated temperature of the steam.

21. The process of claim 11, further comprising selecting an operating mode, the operating mode selected from the group consisting of a cracking mode, a decoking mode, and a combination thereof, the cracking mode comprising a first set of operating conditions comprising a cracking steam flow rate and a second set of operating conditions comprising a decoking steam flow rate, wherein a steam flow ratio of the cracking stream flow rate to decoking steam flow rate is 1.25:1 to 2.25:1.

22. The process of claim 21, wherein selecting the operating mode, further comprises selecting a feedstock mode, the feedstock mode selected from the group consisting of ethane feed, crude, naphtha, gas oil feed, and a combination thereof, wherein selecting the feedstock mode determines an amount of water to inject to the first fluid source and the second fluid source .

23. The process of claim 21, wherein the cracking mode further comprises a recycle gas cracking mode, a crude cracking mode, a liquid feed cracking mode, and a combination(s) thereof.

24. The process of claim 21, wherein the first set of operating conditions for the decoking mode further comprise a first total flow rate of water from the first fluid source and second fluid source, wherein the second set of operating conditions for the cracking mode further comprise a second total flow rate of water from the first fluid source and second fluid source, wherein a total flow rate ratio of the first total flow rate to the second total flow rate is 5:1 to 20:1.

25. A system programmed to perform a method, comprising:

an algorithm stored in a memory of the system, wherein the algorithm comprises a number of instructions which, when executed by a processor, causes a method to be performed, the method comprising:

heat exchanging steam with flue gas to provide heated steam;

injecting water through a first fluid source to provide a first reduced temperature steam;

heat exchanging the first reduced temperature steam with flue gas to provide

an intermediate steam;

injecting water through a second fluid source to provide a second reduced temperature steam; and

heat exchanging the second reduced temperature steam with flue gas at an export temperature suitable for export to a header.