CLAIMS

1. A system for treating water comprising:

a primary actinic radiation reactor;

a source of a persulfate precursor compound disposed to introduce at least one persulfate precursor compound into the primary actinic radiation reactor;

a total organic carbon (TOC) concentration sensor located upstream of the primary actinic radiation reactor;

a persulfate concentration sensor located downstream of the primary actinic radiation reactor;

a source of actinic radiation having a continuously variable intensity disposed within the primary actinic radiation reactor; and

an electronic ballast circuit including a resonant tank circuit having a power output operatively coupled to the source of actinic radiation, the electronic ballast circuit operable to control the continuously variable intensity of the source of actinic radiation over a continuous range of power levels by continuously measuring the current supplied to the source of actinic radiation and adjusting a frequency of a drive voltage supplied to the resonant tank circuit responsive to at least one input signal from at least one of the TOC concentration sensor, the persulfate concentration sensor, and the measured current supplied to the source of actinic radiation.

2. The system of claim 1, further comprising a reverse osmosis unit located upstream of the primary actinic radiation reactor.

3. The system of claim 1, further comprising a secondary actinic radiation reactor located downstream of the primary actinic radiation reactor.

4. The system of claim 1, further comprising a particulate filter located downstream of the primary actinic radiation reactor.

5. The system of claim 1, further comprising an ultrafiltration apparatus located downstream of the primary actinic radiation reactor.

6. The system of claim 1, further comprising at least one unit operation selected from the group consisting of a heat exchanger, a degasifier, a particulate filter, an ion purification apparatus, and an ion-exchange column.

7. The system of claim 6, wherein the ion-exchange column is located upstream of the TOC concentration sensor.

8. The system of claim 1, further comprising a source of water located upstream of the primary actinic radiation reactor comprising one or more unit operations selected from the group consisting of a reverse osmosis filter, an electrodialysis device, an electrodeionization device, a distillation apparatus, an ion-exchange column, and combinations thereof.

9. The system of claim 8, wherein water from the source of water comprises less than about 25 ppb TOC.

10. The system of claim 1, further comprising a TOC concentration sensor located downstream of the primary actinic radiation reactor.

11. The system of claim 1, further comprising a source of reducing agent disposed downstream of the primary actinic radiation reactor.

12. The system of claim 11, wherein the reducing agent is sulfur dioxide.

13. The system of claim 1, wherein the primary actinic radiation reactor includes an ultraviolet lamp with includes a double sided electrical connection.

14. The system of claim 13, wherein the ultraviolet lamp with the double sided electrical connection includes a first electrical connection to a first electrode on a first end of the lamp, a second electrical connection to a second electrode on the first end of the lamp, and a third electrical connection to the second electrode on a second end of the lamp.

15. The system of claim 13, wherein the system further comprises a power control circuit for the ultraviolet lamp, the power control circuit comprising a component configured to continuously vary the power provided to the ultraviolet lamp in response to a frequency of a signal input into the power control circuit.

16. The system of claim 1, wherein the electronic ballast circuit is operable to control power provided to the source of actinic radiation by adjusting the frequency of the drive voltage supplied to the resonant tank circuit.

17. The system of claim 1, further comprising a controller configured to measure and regulate current supplied to the source of actinic radiation such that the source of actinic radiation runs at a desired power and intensity level.

18. The system of claim 17, wherein the controller is further operable to generate a control signal that regulates a rate at which the persulfate precursor compound is introduced into the primary actinic radiation reactor.

19. The system of claim 17, further comprising:

a source of a reducing agent disposed to introduce at least one reducing agent downstream from the primary actinic radiation reactor; and

a reducing agent concentration sensor located downstream of a point of addition of the at least one reducing agent;

wherein the controller is further configured to receive an input signal from the reducing agent concentration sensor and generate a control signal that regulates a continuously variable intensity of the actinic radiation in the primary actinic radiation reactor based at least in part on the input signal from the reducing agent concentration sensor.

20. The system of claim 19, wherein the controller is further operable to generate a control signal that regulates a rate at which the reducing agent is introduced to the system.

21. A system for treating water comprising:

a primary actinic radiation reactor;

a source of a persulfate precursor compound disposed to introduce at least one persulfate precursor compound into the primary actinic radiation reactor;

a total organic carbon (TOC) concentration sensor located upstream of the primary actinic radiation reactor;

a persulfate concentration sensor located downstream of the primary actinic radiation reactor;

a source of actinic radiation having a continuously variable intensity disposed within the primary actinic radiation reactor; and

an electronic ballast circuit including a resonant tank circuit having a power output operatively coupled to the source of actinic radiation, the electronic ballast circuit controlling the continuously variable intensity of the source of actinic radiation over a continuous range of power levels by continuously measuring the current of the source of actinic radiation and adjusting a frequency of a drive voltage supplied to the resonant tank circuit responsive to at least one input signal from at least one of the TOC concentration sensor, the persulfate concentration sensor, and the measured current supplied to the source of actinic radiation.

22. The system of claim 21, wherein the electronic ballast circuit controls the continuously variable intensity of the source of actinic radiation to provide sufficient power to the source of actinic radiation to remove a desired amount of TOC from fluid undergoing treatment in the system while not producing more ultraviolet radiation than is necessary to remove the desired amount of TOC.