CLAIMS

1. A system, comprising:

an underwater assembly, comprising:

a flow control device: and

an actuator coupled to the flow control device, wherein the actuator is configured to actuate the flow control device;

an insulated housing surrounding the flow control device and the actuator, wherein the insulated housing is configured to retain heat; and

a thermal control system comprising a heat exchanger coupled to the actuator, wherein the thermal control system is configured to control a temperature of the actuator.

2. The system of claim 1, wherein the heat exchanger comprises a heat exchanger volume isolated from an interior of the insulated housing, and the thermal control system is configured to circulate a fluid through the heat exchanger volume.

3. The system of claim 2, wherein the thermal control system comprises an inlet passage extending from an exterior through a wall of the insulated housing, through the interior of the insulated housing, and to an inlet of the heat exchanger.

4. The system of claim 3, wherein the thermal control system comprises an outlet passage extending from an outlet of the heat exchanger, through the interior of the insulated housing, and through the wall to the exterior of the insulated housing.

5. The system of claim 4, comprising a valve coupled to the outlet passage, wherein the thermal control system is configured to open or close the valve in response to at least one temperature threshold.

6. The system of claim 5, wherein the valve comprises a thermally actuated valve unit having a thermal actuator coupled to a valve mechanism, and the thermal actuator is configured to open or close the valve mechanism in response to the at least one temperature threshold.

7. The system of claim 5, wherein the thermal control system comprises an actuation system configured to open or close the valve in response to the at least one temperature threshold, wherein the actuation system comprises a temperature sensor, a controller, and an actuator.

8. The system of claim 2, wherein the heat exchanger comprises a coil disposed about the actuator, and the coil is configured to circulate the fluid.

9. The system of claim 2, wherein the heat exchanger comprises a plurality of fins coupled to the actuator and a conduit coupled to the plurality of fins, and the conduit is configured to circulate the fluid.

10. The system of claim 2, wherein the heat exchanger comprises a jacket disposed about and coupled to the actuator, and the jacket defines a volume configured to circulate the fluid.

11. The system of claim 2, wherein the thermal control system comprises a pump configured to force circulation of the fluid through the heat exchanger volume.

12. The system of claim 2, wherein the fluid comprises sea water that enters the heat exchanger volume from an exterior of the insulated housing.

13. A system, comprising:

an underwater thermal control system, comprising:

a heat exchanger configured to control a temperature of an actuator disposed in an insulated housing;

an inlet passage configured to pass a water flow from an exterior of the insulated housing into the heat exchanger;

an outlet passage configured to pass the water flow from the heat exchanger to the exterior of the insulated housing;

a valve coupled to the outlet passage, wherein the valve is configured to open and close to control circulation of the water flow through the inlet passage, the heat exchanger, and the outlet passage; and

a controller configured to open the valve when a temperature of the actuator is at or above an upper threshold temperature and configured to close the valve when the temperature of the actuator is at or below a lower threshold temperature.

14. The system of claim 13, comprising a thermostat configured to measure the temperature of the actuator.

15. The system of claim 14, wherein the thermostat comprises a temperature sensor, the controller, and a valve actuator coupled to the valve.

16. The system of claim 15, wherein the thermostat is configured to operate a pump to force the water flow through the heat exchanger.

17. The system of claim 13, comprising a mineral extraction component having the actuator.

18. A method, comprising:

sensing a temperature at or above an upper threshold temperature within an insulated underwater housing that contains an actuator coupled to a flow control device;

initiating a flow of water from a surrounding water through a heat exchanger within the insulated underwater housing if the temperature is at or above the upper threshold temperature;

sensing the temperature at or below a lower threshold temperature within the insulated underwater housing; and

terminating the flow of water through the heat exchanger if the temperature is at or below the lower threshold temperature.

19. The method of claim 18, comprising maintaining the temperature of an underwater mineral extraction component within a temperature range, wherein the underwater mineral

extraction component comprises the insulated underwater housing, the actuator, and the flow control device.

20. The method of claim 19, wherein initiating the flow of water comprises opening a valve to enable the flow by natural buoyancy and temperature differences between the heat exchanger and the water surrounding the insulated underwater housing.

CLAIMS

1. A system, comprising:

an underwater assembly, comprising:

a flow control device: and

an actuator coupled to the flow control device, wherein the actuator is configured to actuate the flow control device;

an insulated housing surrounding the flow control device and the actuator, wherein the insulated housing is configured to retain heat; and

a thermal control system comprising a heat exchanger coupled to the actuator, wherein the thermal control system is configured to control a temperature of the actuator, and the thermal control system comprises a controller configured to initiate a flow of fluid through the heat exchanger when a temperature of the actuator is at or above an upper threshold temperature and configured block the flow of fluid through the heat exchanger when the temperature of the actuator is at or below a lower threshold temperature.

2. The system of claim 1, wherein the heat exchanger comprises a heat exchanger volume isolated from an interior of the insulated housing, and the thermal control system is configured to circulate the fluid through the heat exchanger volume.

3. The system of claim 2, wherein the thermal control system comprises an inlet passage extending from an exterior through a wall of the insulated housing, through the interior of the insulated housing, and to an inlet of the heat exchanger.

4. The system of claim 3, wherein the thermal control system comprises an outlet passage extending from an outlet of the heat exchanger, through the interior of the insulated housing, and through the wall to the exterior of the insulated housing.

5. The system of claim 4, comprising a valve coupled to the outlet passage, wherein the thermal control system is configured to open or close the valve in response to at least one temperature threshold.

6. The system of claim 5, wherein the valve comprises a thermally actuated valve unit having a thermal actuator coupled to a valve mechanism, and the thermal actuator is configured to open or close the valve mechanism in response to the at least one temperature threshold.

7. The system of claim 5, wherein the thermal control system comprises an actuation system configured to open or close the valve in response to the at least one temperature threshold, wherein the actuation system comprises a temperature sensor, the controller, and an actuator.

8. The system of claim 2, wherein the heat exchanger comprises a coil disposed about the actuator, and the coil is configured to circulate the fluid.

9. The system of claim 2, wherein the heat exchanger comprises a plurality of fins coupled to the actuator and a conduit coupled to the plurality of fins, and the conduit is configured to circulate the fluid.

10. The system of claim 2, wherein the heat exchanger comprises a jacket disposed about and coupled to the actuator, and the jacket defines a volume configured to circulate the fluid.

11. The system of claim 2, wherein the thermal control system comprises a pump configured to force circulation of the fluid through the heat exchanger volume.

12. The system of claim 2, wherein the fluid comprises sea water that enters the heat exchanger volume from an exterior of the insulated housing.

13. The system of claim 1, wherein the actuator comprises an electromechanical actuator.

14. A system, comprising:

an underwater thermal control system, comprising:

a heat exchanger configured to control a temperature of an actuator disposed in an insulated housing;

an inlet passage configured to pass a water flow from an exterior of the insulated housing into the heat exchanger;

an outlet passage configured to pass the water flow from the heat exchanger to the exterior of the insulated housing;

a valve coupled to the outlet passage, wherein the valve is configured to open and close to control circulation of the water flow through the inlet passage, the heat exchanger, and the outlet passage; and

a controller configured to open the valve when a temperature of the actuator is at or above an upper threshold temperature and configured to close the valve when the temperature of the actuator is at or below a lower threshold temperature.

15. The system of claim 14, comprising a thermostat configured to measure the temperature of the actuator.

16. The system of claim 15, wherein the thermostat comprises a temperature sensor, the controller, and a valve actuator coupled to the valve.

17. The system of claim 16, wherein the thermostat is configured to operate a pump to force the water flow through the heat exchanger.

18. The system of claim 14, comprising a mineral extraction component having the actuator.

19. A method, comprising:

sensing a temperature at or above an upper threshold temperature within an insulated underwater housing that contains an actuator coupled to a flow control device;

initiating a flow of water from a surrounding water through a heat exchanger within the insulated underwater housing if the temperature is at or above the upper threshold temperature;

sensing the temperature at or below a lower threshold temperature within the insulated underwater housing; and

terminating the flow of water through the heat exchanger if the temperature is at or below the lower threshold temperature.

20. The method of claim 19, comprising maintaining the temperature of an underwater mineral extraction component within a temperature range, wherein the underwater mineral extraction component comprises the insulated underwater housing, the actuator, and the flow control device.

21. The method of claim 20, wherein initiating the flow of water comprises opening a valve to enable the flow by natural buoyancy and temperature differences between the heat exchanger and the water surrounding the insulated underwater housing.