Claims

1. A refrigerated transport container (10) comprising:

a cargo box (12) defining a closed environment;

a refrigeration unit (20) including a compressor (22), a first heat exchanger (24), which functions as a refrigerant heat rejection heat exchanger and a second heat exchanger (28), which constitutes a refrigerant heat absorption heat exchanger; and

a regenerative scrubber system (38) for removing a selected gas from an atmosphere within a closed environment, the regenerative scrubber system (38) comprising:

a scrubber module having a first scrubber (40a) and a second scrubber (40b), each housing a porous mass of regenerative adsorbent material (42a, 42b) for adsorbing the selected gas;

a first flow diversion device (46) disposed upstream of the scrubber module with respect to the gaseous flow from the closed environment, the first flow diversion device (46) selectively positionable between a first position and a second position;

a second flow diversion device (48) disposed downstream of the scrubber and upstream of the second heat exchanger (28) with respect to the gaseous flow from the closed environment, the second flow diversion device (48) selectively positionable between a first position and a second position; and

a single actuator (50) operatively associated with each of the first flow diversion device (46) and the second flow diversion device (48), the actuator (50) configured for selectively positioning each of the first and the second flow diversion devices (46, 48) simultaneously in either the first position or in the second position.

2. The refrigerated transport container (10) as recited in claim 1 wherein the actuator (50) is configured for selectively positioning each of the first and the second flow diversion devices (46, 48) simultaneously in either a first position for operating the first scrubber (40a) of the scrubber module in an adsorption mode and the second scrubber (40b) of the scrubber module in a regeneration mode, or a second position for operating the second scrubber (40b) of the

scrubber module in an adsorption mode and the first scrubber (40a) of the scrubber module in a regeneration mode.

3. The refrigerated transport container (10) as recited in claim 2 wherein the first flow diversion device (46) comprises:

a first port (61) in flow communication with air within the enclosed environment;

a second port (62) in flow communication with the first scrubber (40a) of the scrubber module;

a third port (63) in flow communication with the second scrubber (40b) of the scrubber module;

a fourth port (64) in flow communication with air outside the enclosed environment; and

a flow diverter (52), the flow diverter (52) selectively positionable in either a first position wherein the first port (61) is in flow communication with the second port (62) and the third port (63) is in flow communication with the fourth port (64), or a second position wherein the first port (61) is in flow communication with the third port (63) and the second port (62) is in flow communication with the fourth port (64).

4. The refrigerated transport container (10) as recited in claim 3 wherein the second flow diversion device (48) comprises:

a first port (71) in flow communication with air within the enclosed environment;

a second port (72) in flow communication with the first scrubber (40a) of the scrubber module;

a third port (73) in flow communication with the second scrubber (40b) of the scrubber module;

a fourth port (74) in flow communication with air outside the enclosed environment;

and a flow diverter (54), the flow diverter (54) selectively positionable in either a first position wherein the second port (72) is in flow communication with the first port (71) and the fourth port (74) is in flow communication with the third port (73), or a second position wherein the third port (73) is in flow communication with the first port (71) and the fourth port (74) is in flow communication with the second port (72).

5. The refrigerated transport container (10) as recited in claim 4 wherein the actuator (50) further comprises a linkage mechanism (56) interconnecting the respective flow diverters (52, 54) of the first and second flow diversion devices (46, 48) for coordinated linear movement for selectively positioning the respective flow diverters (52, 54) in the first or second position.

6. The refrigerated transport container (10) as recited in claim 2 wherein the actuator (50) further comprises a rotary actuator.

7. The refrigerated transport container (10) as recited in claim 6 wherein the first flow diversion device (46) comprises a rotary flow diversion valve (146) having a first internal flow passage and a second internal flow passage and the second flow diversion device (48) comprises a rotary diversion valve (148) having a third internal flow passage and a fourth internal flow passage.

8. The refrigerated transport container (10) as recited in claim 7 wherein the each of the first rotary diversion valve (146) and the second rotary diversion valve (148) comprises a ball valve.

9. The refrigerated transport container (10) as recited in claim 8 further comprising a controller (90) operatively associated with the single actuator (50) that is configured for controlling the single actuator (50) to maintain a concentration of carbon dioxide in the atmosphere within the closed environment of the cargo box (12) within a desired range.

10. The refrigerated transport container (10) as recited in any of the preceding claims, wherein at least one of the scrubbers (40a, 40b) is provided by a scrubber module (140) comprises:

a housing (146) defining an interior volume;

a flow baffle (144) extending longitudinally within the interior volume to define a generally U-shaped flow passage (145) having an upstream portion (145a) on a first side of the flow baffle (144) and a downstream portion (145b) on a second side of the flow baffle (144);

a first sheet (142a) of adsorbent material for selectively adsorbing the selected gas from the air flow, the first sheet (142a) disposed in the upstream portion (145a) of the flow passage (145); and

a second sheet (142b) of adsorbent material for selectively adsorbing the selected gas from the air flow, the second sheet (142b) disposed in the downstream portion (145b) of the flow passage (145).

11. The refrigerated transport container (10) as recited in claim 10 wherein the housing (146) includes an inlet opening (148) to the upstream portion (145a) of the flow passage (145) and an outlet opening (150) to the downstream portion (145b) of the flow passage (145).

12. The refrigerated transport container (10) as recited in claim 11 further comprising a divergent inlet nozzle (152) disposed at the housing inlet opening (148) to the upstream portion (145a) of the flow passage (145), the divergent inlet nozzle (152) diverging in the direction of flow through the inlet nozzle (152)

and/or a convergent nozzle (154) disposed at the housing outlet (150) opening to the downstream portion (145b) of the flow passage, the convergent nozzle (154) converging in the direction of flow through the outlet nozzle (154).

13. The refrigerated transport container (10) as recited in claim 10 further comprising at least one flow directing vane (156) disposed in the upstream portion (145a) of the flow passage (145) and at least one flow directing vane (156) disposed in the downstream portion (145b) of the flow passage (145).

14. The refrigerated transport container (10) as recited in claim 15 wherein the at least one flow directing vane (156) disposed in the upstream portion (145a) of the flow passage (145) and the at least one flow directing vane (156) disposed in the downstream portion (145b) of the flow passage (145) comprise a carbon dioxide adsorbent material.

15. The refrigerated transport container (10) as recited in claim 14 wherein the at least one flow directing vane (156) disposed in the upstream portion (145a) of the flow passage (145) and the at least one flow directing vane (156) disposed in the downstream portion (145b) of the flow passage (145) comprise a support member coated with a carbon dioxide adsorbent material.

Claims

1. A refrigerated transport container (10) comprising:

a cargo box (12) defining a closed environment;

a refrigeration unit (20) including a compressor (22), a first heat exchanger (24), which functions as a refrigerant heat rejection heat exchanger and a second heat exchanger (28), which constitutes a refrigerant heat absorption heat exchanger; and

a regenerative scrubber system (38) for removing a selected gas from an atmosphere within a closed environment, the regenerative scrubber system (38) comprising:

a scrubber module having a first scrubber (40a) and a second scrubber (40b), each housing a porous mass of regenerative adsorbent material (42a, 42b) for adsorbing the selected gas;

a first flow diversion device (46) disposed upstream of the scrubber module with respect to the gaseous flow from the closed environment, the first flow diversion device (46) selectively positionable between a first position and a second position;

a second flow diversion device (48) disposed downstream of the scrubber and upstream of the second heat exchanger (28) with respect to the gaseous flow from the closed environment, the second flow diversion device (48) selectively positionable between a first position and a second position; and

a single actuator (50) operatively associated with each of the first flow diversion device (46) and the second flow diversion device (48), the actuator (50) configured for selectively positioning each of the first and the second flow diversion devices (46, 48) simultaneously in either the first position or in the second position.

2. The refrigerated transport container (10) as recited in claim 1 wherein the actuator (50) is configured for selectively positioning each of the first and the second flow diversion devices (46, 48) simultaneously in either a first position for operating the first scrubber (40a) of the scrubber module in an adsorption mode and the second scrubber (40b) of the scrubber module in a regeneration mode, or a second position for operating the second scrubber (40b) of the

scrubber module in an adsorption mode and the first scrubber (40a) of the scrubber module in a regeneration mode.

3. The refrigerated transport container (10) as recited in claim 2 wherein the first flow diversion device (46) comprises:

a first port (61) in flow communication with air within the enclosed environment;

a second port (62) in flow communication with the first scrubber (40a) of the scrubber module;

a third port (63) in flow communication with the second scrubber (40b) of the scrubber module;

a fourth port (64) in flow communication with air outside the enclosed environment; and

a flow diverter (52), the flow diverter (52) selectively positionable in either a first position wherein the first port (61) is in flow communication with the second port (62) and the third port (63) is in flow communication with the fourth port (64), or a second position wherein the first port (61) is in flow communication with the third port (63) and the second port (62) is in flow communication with the fourth port (64).

4. The refrigerated transport container (10) as recited in claim 3 wherein the second flow diversion device (48) comprises:

a first port (71) in flow communication with air within the enclosed environment;

a second port (72) in flow communication with the first scrubber (40a) of the scrubber module;

a third port (73) in flow communication with the second scrubber (40b) of the scrubber module;

a fourth port (74) in flow communication with air outside the enclosed environment;

and a flow diverter (54), the flow diverter (54) selectively positionable in either a first position wherein the second port (72) is in flow communication with the first port (71) and the fourth port (74) is in flow communication with the third port (73), or a second position wherein the third port (73) is in flow communication with the first port (71) and the fourth port (74) is in flow communication with the second port (72).

5. The refrigerated transport container (10) as recited in claim 4 wherein the actuator (50) further comprises a linkage mechanism (56) interconnecting the respective flow diverters (52, 54) of the first and second flow diversion devices (46, 48) for coordinated linear movement for selectively positioning the respective flow diverters (52, 54) in the first or second position.

6. The refrigerated transport container (10) as recited in claim 2 wherein the actuator (50) further comprises a rotary actuator.

7. The refrigerated transport container (10) as recited in claim 6 wherein the first flow diversion device (46) comprises a rotary flow diversion valve (146) having a first internal flow passage and a second internal flow passage and the second flow diversion device (48) comprises a rotary diversion valve (148) having a third internal flow passage and a fourth internal flow passage.

8. The refrigerated transport container (10) as recited in claim 7 wherein the each of the first rotary diversion valve (146) and the second rotary diversion valve (148) comprises a ball valve.

9. The refrigerated transport container (10) as recited in claim 8 further comprising a controller (90) operatively associated with the single actuator (50) that is configured for controlling the single actuator (50) to maintain a concentration of carbon dioxide in the atmosphere within the closed environment of the cargo box (12) within a desired range.

10. The refrigerated transport container (10) as recited in any of the preceding claims, wherein at least one of the scrubbers (40a, 40b) is provided by a scrubber module (140) comprises:

a housing (146) defining an interior volume;

a flow baffle (144) extending longitudinally within the interior volume to define a generally U-shaped flow passage (145) having an upstream portion (145a) on a first side of the flow baffle (144) and a downstream portion (145b) on a second side of the flow baffle (144);

a first sheet (142a) of adsorbent material for selectively adsorbing the selected gas from the air flow, the first sheet (142a) disposed in the upstream portion (145a) of the flow passage (145); and

a second sheet (142b) of adsorbent material for selectively adsorbing the selected gas from the air flow, the second sheet (142b) disposed in the downstream portion (145b) of the flow passage (145).

11. The refrigerated transport container (10) as recited in claim 10 wherein the housing (146) includes an inlet opening (148) to the upstream portion (145a) of the flow passage (145) and an outlet opening (150) to the downstream portion (145b) of the flow passage (145).

12. The refrigerated transport container (10) as recited in claim 11 further comprising a divergent inlet nozzle (152) disposed at the housing inlet opening (148) to the upstream portion (145a) of the flow passage (145), the divergent inlet nozzle (152) diverging in the direction of flow through the inlet nozzle (152)

and/or a convergent nozzle (154) disposed at the housing outlet (150) opening to the downstream portion (145b) of the flow passage, the convergent nozzle (154) converging in the direction of flow through the outlet nozzle (154).

13. The refrigerated transport container (10) as recited in claim 10 further comprising at least one flow directing vane (156) disposed in the upstream portion (145a) of the flow passage (145) and at least one flow directing vane (156) disposed in the downstream portion (145b) of the flow passage (145).

14. The refrigerated transport container (10) as recited in claim 13 wherein the at least one flow directing vane (156) disposed in the upstream portion (145a) of the flow passage (145) and the at least one flow directing vane (156) disposed in the downstream portion (145b) of the flow passage (145) comprise a carbon dioxide adsorbent material.

15. The refrigerated transport container (10) as recited in claim 14 wherein the at least one flow directing vane (156) disposed in the upstream portion (145a) of the flow passage (145) and the at least one flow directing vane (156) disposed in the downstream portion (145b) of the flow passage (145) comprise a support member coated with a carbon dioxide adsorbent material.