Claims

1. A separator plate suitable for use in a closed-cathode proton-exchange membrane (PEM) fuel cell, the separator plate comprising a first set of fluid flow channels each extending from an inlet at a first edge portion of the separator plate to an outlet at a second edge portion or manifold aperture portion of the separator plate, wherein:

the first set of fluid flow channels comprises one or more fluid flow channels, where the one or more fluid flow channels extend across the first edge portion;

the fluid flow channels define a flow field, and the separator plate comprises only one or two of the following (i) to (iii):

(i) an integrated cathode inlet manifold aperture that extends beyond the edge of the flow field;

(ii) an integrated anode inlet manifold aperture that extends beyond the edge of the flow field; and

(iii) an integrated coolant inlet manifold aperture that extends beyond the edge of the flow field.

2. The separator plate according to Claim 1, wherein the separator plate is selected from: a cathode separator plate, an anode separator plate, and a coolant separator plate, optionally wherein the separator plate is selected from a cathode separator plate, and a coolant separator plate.

3. The separator plate according to Claim 2, wherein the separator plate comprises the first set of fluid flow channels on a first face of the plate, and a second set of fluid flow channels on a second face of the plate, optionally wherein the first set of fluid flow channels are fluidly separated from the second set of fluid flow channels.

4. The separator plate according to Claim 3, wherein:

(a) the first set of fluid flow channels are cathode or anode fluid flow channels and the second set of fluid flow channels are coolant fluid flow channels, or

(b) the first set of fluid flow channels are cathode fluid flow channels and the second set of fluid flow channels are anode fluid flow channels, where the separator plate further comprises coolant fluid flow channels within the separator plate between the cathode fluid flow channels and the anode fluid flow channels.

5. The separator plate according to any one of Claims 2 to 4, wherein the separator plate is a cathode separator plate.

6. The separator plate according to any one of Claims 2 to 5, wherein:

the separator plate comprises a first corner formed by a first edge and a second edge adjacent to the first edge;

the first edge portion of the separator plate extends substantially to the first edge of the separator plate and substantially to the second edge of the separator plate; and

the first set of fluid flow channels comprises a plurality of fluid flow channels that extend across the first edge portion and substantially to the first and second edges of the separator plate.

7. The separator plate according to any one of the preceding claims, wherein the first set of fluid flow channels each extend to an outlet at a second edge portion of the separator plate.

~~8. The separator plate according to any one of the preceding claims, wherein the separator plate does not comprise one or more of the following:~~

~~an integrated cathode inlet manifold aperture;~~

~~an integrated anode inlet manifold aperture; and~~

~~an integrated coolant inlet manifold aperture.~~

~~9. The separator plate according to any one of the preceding claims, wherein the separator plate does not comprise one or more of the following:~~

~~an integrated cathode outlet manifold aperture;~~

~~an integrated anode outlet manifold aperture; and~~

~~an integrated coolant outlet manifold aperture.~~

~~10. The separator plate according to any one of the preceding claims, wherein the fluid flow channels define a flow field, and the separator plate comprises one or two of the following:~~

~~an integrated cathode inlet manifold aperture that extends beyond the edge of the flow field;~~

~~an integrated anode inlet manifold aperture that extends beyond the edge of the flow field; and~~

~~an integrated coolant inlet manifold aperture that extends beyond the edge of the flow field.~~

~~11~~8. The separator plate according to any one of the preceding claims, wherein the fluid flow channels define a flow field, and the separator plate comprises one or two of the following:

an integrated cathode outlet manifold aperture that extends beyond the edge of the flow field;

an integrated anode outlet manifold aperture that extends beyond the edge of the flow field; and

an integrated coolant outlet manifold aperture that extends beyond the edge of the flow field.

~~12~~9. The separator plate according to any one of the preceding claims, wherein the separator plate is adapted to connect to a ducting in an appropriately fluidly sealed manner when the separator plate is placed in a fuel cell stack, optionally wherein the separator plate is adapted to connect to a ducting at the first and/or second edge portions.

~~13~~10. An article comprising a separator plate according to any one of the preceding claims and one ducting plate attached to the separator plate by an interlocking connection, where the ducting plate defines an inner ducting volume in fluid communication with the inlet(s) of the first set of fluid flow channels of the separator plate, optionally wherein the article comprises one or two additional separator plates and a membrane electrode assembly.

~~14~~11. A closed-cathode proton-exchange membrane (PEM) fuel cell comprising at least one separator plate as described in any one of Claims 1 to ~~12~~ 9 or the article according to Claim ~~13~~10.

~~15. The closed-cathode proton-exchange membrane (PEM) fuel cell according to Claim 14, wherein the at least one separator plate as described in any one of Claims 1 to 12 is:~~

~~(a) a cathode separator plate;~~

~~(b) an anode separator plate; or~~

~~(c) a coolant separator plate.~~

~~16. The closed-cathode proton-exchange membrane (PEM) fuel cell according to Claim 15, wherein at least two of the separator plates are as described in any one of Claims 1 to 12, and are:~~

~~(a) the cathode separator plate and the anode separator plate;~~

~~(b) the cathode separator plate and the coolant separator plate; and~~

~~(c) the anode separator plate and the coolant separator plate.~~

~~17. The closed-cathode proton-exchange membrane (PEM) fuel cell according to Claim 16, comprising a cathode separator plate, an anode separator plate and a coolant separator plate, wherein all three of the separator plates are as described in any one of Claims 1 to 12.~~

~~18~~12. The closed-cathode proton-exchange membrane (PEM) fuel cell according ~~any one of~~to Claim~~s~~ 11~~14 to 17~~, comprising a first ducting having at least one ducting inlet and an inner ducting volume in fluid communication with the at least one ducting inlet,

wherein:

the inner ducting volume of the first ducting is in fluid communication with the inlet(s) of the first set of fluid flow channels of the at least one separator plate as described in any one of Claims 1 to 12; and

the first ducting is formed from one or more interlocking ducting plates.

~~19~~13. A closed-cathode proton-exchange membrane (PEM) fuel cell stack comprising:

(i) two or more fuel cells, each of the two or more fuel cells comprising:

a first separator plate as described in any one of Claims 1 to ~~12~~9; and

one or more additional separator plates; and

(ii) a first ducting having at least one ducting inlet and an inner ducting volume in fluid communication with the at least one ducting inlet,

wherein:

the inner ducting volume of the first ducting is in fluid communication with the inlets of the first set of fluid flow channels of the first separator plates; and

the one or more additional separator plates are arranged or adapted to accommodate the presence of the first ducting.

~~20~~14. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to Claim ~~19~~13, wherein the one or more additional separator plates are fluidly separated from said first ducting.

~~21. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to Claim 19 or 20, wherein the one or more additional separator plates are separator plates as described in any one of Claims 1 to 12.~~

~~22~~15. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims ~~19~~ 13 or 14~~to 21~~, wherein the first separator plates are cathode separator plates.

~~23~~16. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to Claim ~~22~~15, wherein:

the cathode separator plates are separator plates according to Claim 6; and

the inner ducting volume of the first ducting is in fluid communication with the inlets of the first set of fluid flow channels of the first separator plates.

~~24. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 19 to 23, wherein:~~

~~(a) the first separator plates comprise fluid flow channels for a coolant fluid; and/or~~

~~(b) one or more of the one or more additional separator plates comprises fluid flow channels for a coolant fluid;~~

~~wherein in (a) and (b), the inlets of the fluid flow channels for a coolant fluid are separate to the inlets of the remaining fluid flow channels of the first and one or more additional separator plates,~~

~~optionally wherein the fluid flow channels for a coolant fluid are located on a separator plate that comprises cathode fluid flow channels or anode fluid flow channels, and the fluid flow channels for a coolant fluid are located on the opposite face of the separator plate to the cathode fluid flow channels or anode fluid flow channels.~~

~~25~~17. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims ~~19~~ 13 to ~~24~~16, having one or more of the features selected from the following (a) to (k):

(a) wherein the first ducting comprises at least two inlets;

(b).

26. The c losed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 19 to 25, wherein the at least onefirst ducting is shaped such that fluid approaching the inlets of the first set of fluid flow channels flows in a direction that is substantially parallel to the inlets of one or more of the first set of fluid flow channels with which the inner ducting volume is in fluid communication;
(c) ;

27. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 19 to 26, wherein the first ducting is configured to increase or decrease the fluid flow rate through one or more of the fluid flow channels;
(d) ;

28. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to Claim 27, wherein the first ducting comprises fins or protrusions configured to direct fluid flowing through the ducting into one or more of the fluid flow channels;
(e) ;

29. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 19 to 28, wherein the first ducting is shaped to restrict fluid flow through a portion of the ducting;
(f) ;

30. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 19 to 29, wherein the first ducting comprises a recirculation portion configured to direct fluid flowing through a distal portion of the first ducting, relative to the at least one ducting inlet, towards one or more fluid flow channels located proximal to the at least one ducting inlet, relative to the distal portion of the first ducting;
(g) ;

31. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 19 to 30, wherein the first ducting comprises a first ducting portion configured to direct a first portion of fluid flowing through the first ducting to a first set of fuel cells, and a

second ducting portion configured to direct a second portion fluid flowing through the first ducting to a second set of fuel cells.;

(h)

32. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 19 to 31, wherein:

the first ducting comprises a humidification means located within the first ducting and the humidification means is configured to humidify gas flowing through the first ducting;

(i) or

the first ducting comprises at least two inlets, and the closed-cathode proton-exchange membrane (PEM) fuel cell stack comprises a humidification means proximal to the at least two inlets, and,

where the humidification means is/are configured to humidify gas flowing through the first ducting;

(j).

33. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 19 to 32, the closed-cathode proton-exchange membrane (PEM) fuel cell stack comprises/ing a second ducting having at least one second ducting inlet and an inner ducting volume in fluid communication with the at least one second ducting inlet, where the inner ducting volume of the second ducting is in fluid communication with one or more fluid flow channels other than the fluid flow channels in fluid communication with the inner ducting volume of the first ducting; and

(k).

34. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to Claim 33, comprising a third ducting having at least one third ducting inlet and an inner ducting volume in fluid communication with the at least one third ducting inlet, where the inner ducting volume of the third ducting is in fluid communication with one or more fluid flow channels other than the fluid flow channels in fluid communication with the inner ducting volume of the first ducting or the second ducting.

~~35. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 19 to 34, wherein~~ the ducting is formed from a thermally and/or electrically insulating material.

~~36~~18. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims ~~19~~ 13 to 1~~to~~7 ~~35~~, further comprising:

(a) means or apparatus configured to increase the flow of fluid out of the cathode and/or coolant fluid flow channels, optionally wherein said means or apparatus comprises a suction pump, further optionally wherein said suction pump is configured to recirculate fluid to the inlets of the cathode and/or coolant fluid flow channels; or

~~.~~

(b)

~~37. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 19 to 36, further comprising~~ means or apparatus for restricting the flow of fluid out of the cathode and/or coolant fluid flow channels.

~~38. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 19 to 37, wherein at least one of the first, second and/or third ductings, when present, comprises a mount for a blower or pump.~~

~~3~~19. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims ~~19~~ 13 to ~~38~~18, wherein any of the first and/or~~,~~ second ~~and/or third~~ ductings, when present, are formed from a plurality of interlocking ducting plates.

~~40. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to Claim 39, wherein the seal between adjacent interlocking ducting plates comprises a gasket.~~

20. The closed-cathode hydrogen proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 13 to 19, which is configured to be cooled by air.~~41. The closed-cathode proton-exchange membrane (PEM) fuel cell stack according to any one of Claims 19 to 38, wherein the ducting is formed from a first end part, a second end part, and a central part that fits inside the two end parts in an appropriately fluidly sealed manner and along which the end parts may extendably slide.~~