Claims

1. A phenolic foam comprising a phenolic resin comprising a plurality of cells, said cells comprising a blowing agent comprising:

at least one hydrofluoroolefin and at least one chlorinated hydrofluoroolefin;

and said blowing agent further comprising at least one C_3-C_6 hydrocarbon;

wherein said phenolic foam has a density of from 10 kg/m^3 to 100 kg/m^3, a closed cell content of at least 85% as determined in accordance with ASTM D6226 and wherein said foam has a $FIGRA_{0.2MJ}$ of 150 W/s or less, when measured according to EN13823.

2. The phenolic foam according to claim 1, wherein said foam has a $FIGRA_{0.2MJ}$ of 125 W/s or less, such as 120 W/s or less, or 110 W/s or less, or 100 W/s or less, or 95 W/s or less, or 90 W/s or less, or 85 W/s or less, when measured according to EN13823.

3. A phenolic foam comprising a phenolic resin comprising a plurality of cells, said cells comprising a blowing agent comprising at least one chlorinated hydrofluoroolefin and at least one hydrofluoroolefin, and at least one C_3-C_6 hydrocarbon, wherein said phenolic foam has a density of from 10 kg/m^3 to 100 kg/m^3, a closed cell content of at least 85% as determined in accordance with ASTM D6226 and wherein said foam has a $FIGRA_{0.4MJ}$ of 80 W/s or less, when measured according to EN13823.

4. The phenolic foam according to any preceding claim, wherein said foam has a $FIGRA_{0.4MJ}$ of 80 W/s or less, such as 75 W/s or less, or 65 W/s or less, or 60 W/s or less, or 55 W/s or less, when measured according to EN13823.

5. The phenolic foam according to any preceding claim, wherein said foam has a total heat release of 7.5 MJ or less, such as 7.0 MJ or less, or 6.5 MJ or less, or 6.25 MJ or less, or 6.0 MJ or less, or 5.75 MJ or less, or 5.5 MJ or less, or 5.25 MJ or less, or 5.15 MJ or less, or 5.0 MJ or less, or 4.8 MJ or less, or 4.6 MJ or less, or 4.4 MJ or less, when measured according to EN13823.

6. The phenolic foam according to any preceding claim, wherein said foam has a closed cell content of 90% or more, such as 95% or more, preferably 98% or more, as determined in accordance with ASTM D6226.

7. The phenolic foam according to any preceding claim, wherein the cells of the foam have an average cell diameter in the range of from 50 to 250 μm, preferably in the range of from 80 to 180 μm.

8. The phenolic foam according to any preceding claim, wherein said foam has a thermal conductivity of 0.020 W/m·K or less, suitably of 0.018 W/m·K or less, preferably 0.0175 W/m·K or less, or 0.0170 W/m·K or less, or 0.0165 W/m·K or less, 0.0162 W/m·K or less when measured at a mean temperature of 10°C, in accordance with EN 13166:2012.

9. The phenolic foam according to any preceding claim, said foam having a limiting oxygen index of 34% or more, preferably 35% or more, suitable 36% or more, such as 37% or more as determined in accordance with ISO 4589-2.

10. The phenolic foam according to any preceding claim, wherein said foam has a stable moisture content of from 3% to 5% by weight when determined at (23 ± 2)°C and a relative humidity of (50 ± 5)% in accordance with EN1249:1998.

11. The phenolic foam according to any preceding claim, wherein the at least one chlorinated hydrofluoroolefin is selected from 1-chloro-3,3,3-trifluoropropene(HCFO-1233zd) and 1-chloro-2,3,3,3-tetrafluoropropene (HCFO-1224yd).

12. The phenolic foam according to any preceding claim, wherein the at least one hydrofluoroolefin comprises 1,1,1,4,4,4-hexafluoro-2-butene (HFO-1336mzz).

13. The phenolic foam according to any preceding claim, wherein the hydrocarbon comprises at least one butane, preferably isobutane, and/or at least one pentane, preferably isopentane.

14. A phenolic foam formed by foaming and curing a phenolic resin foamable composition comprising a phenolic resin, a surfactant, an acid catalyst, and a blowing agent, said blowing agent comprising:

at least one hydrofluoroolefin and at least one chlorinated hydrofluoroolefin,

and said blowing agent further comprising at least one C_3-C_6 hydrocarbon;

wherein said phenolic foam has a density of from 10 kg/m^3 to 100 kg/m^3, a closed cell content of at least 85% as determined in accordance with ASTM D6226 and wherein said foam has a $FIGRA_{0.2MJ}$ of 150 W/s or less (preferably 125 W/s or less, 120 W/s or less, or 110 W/s or less, or 100 W/s or less, or 95 W/s or less, or 90 W/s or less, or 85 W/s or less) when measured according to EN13823.

15. The phenolic foam according to claim 14, wherein the at least one chlorinated hydrofluoroolefin is selected from 1-chloro-3,3,3-trifluoropropene (HCFO-1233zd) and 1-chloro-2,3,3,3-tetrafluoropropene (HCFO-1224yd).

16. The phenolic foam according to any preceding claim, wherein the at least one hydrofluoroolefin comprises 1,1,1,4,4,4-hexafluoro-2-butene (HFO-1336mzz).

17. The phenolic foam according to any preceding claim, wherein the at least one C_3-C_6 hydrocarbon comprises at least one butane, preferably isobutane, and/or at least one pentane, preferably isopentane.

18. The phenolic foam according to any preceding claim, wherein the blowing agent comprises 1-chloro-3,3,3-trifluoropropene and/or 1-chloro-2,3,3,3-tetrafluoropropene and 1,1,1,4,4,4-hexafluoro-2-butene.

19. The phenolic foam according to any one of claims 14 to 18, wherein the phenolic resin has a weight average molecular weight of from 700 to 2000, and/or wherein the phenolic resin has a number average molecular weight of from 330 to 800, such as from 350 to 700.

20. The phenolic foam according to any one of claims 14 to 19, wherein the phenolic resin has a molar ratio of phenol groups to aldehyde groups in the range of from 1:1 to 1:3, suitably from 1:1.5 to 1:2.3.

21. The phenolic foam according to any one of claims 14 to 20, wherein the water content of the phenolic resin foamable composition is in the range of from from 5 wt% to 12 wt%, such as from 6 wt% to 10 wt%, based on the total weight of the phenolic resin foamable composition.

22. The phenolic foam according to any one of claims 14 to 21, wherein the phenolic resin has a water content in the range of from 10 wt% to 14 wt%.

23. The phenolic foam according to any one of claims 14 to 22, wherein the phenolic resin has a viscosity of from 2,500 mPa·s to 18,000 mPa·s when measured at 25°C, such as from 2500 mPa·s to 16,000 mPa·s when measured at 25°C for example from 4,000 mPa·s to 8,000 mPa·s when measured at 25°C.

24. The phenolic foam according to any one of claim 14 to 23, wherein the blowing agent is present in an amount of from 1 to 20 parts by weight per 100 parts by weight of the phenolic resin.

25. The phenolic foam according to any preceding claim having a compressive strength in the range of from 95 kPa to 200 kPa as determined in accordance with EN826.

26. The phenolic foam according to any preceding claim having a density of from 15 kg/m^3 to 60 kg/m^3, such as from 20 kg/m^3 to 50 kg/m^3, suitably of from 24 kg/m^3 to 48 kg/m^3.