Claims

1. A method for heavy metal immobilization, the method comprising:
   - mixing organic-containing media comprising heavy metal with at least one additive to form a mixture; and
   - torrefying the mixture to form biochar, wherein the biochar immobilizes the heavy metal,

wherein ~~when~~ the organic-containing media comprises ≥ 25 weight % organic content, wherein the at least one additive comprises a reducing agent, ~~and when the organic-containing media comprises less than 25 weight % organic content, the at least one additive comprises an inorganic additive~~ wherein the reducing agent comprises: sodium borohydride, hydrazine, aluminium powder, $LiAlH_4$, or a mixture thereof.

2. A method for heavy metal immobilization, the method comprising:
   - mixing organic-containing media comprising heavy metal with at least one additive to form a mixture;
   - torrefying the mixture to form biochar, wherein the biochar immobilizes the heavy metal; and
   - calcinating the biochar following the torrefying to form calcinated material, wherein the calcinating comprises calcinating in an oxidising atmosphere, further wherein the calcinating is at a temperature of 600-1200°C,

wherein the organic-containing media comprises less than 25 weight % organic content, wherein the at least one additive comprises an inorganic additive, wherein the inorganic additive comprises: lime, limestone, $FeCl_3$, $Fe_2(SO_4)_3$, $FeSO_4$, aluminium powder, iron powder, FeOOH, Fe_2O_3, $MgCO_3$, $MgCa(CO_3)_2$, NaOH, KOH, phosphate, monohydrogenphosphate, dihydrogenphosphate, rock phosphate, phosphoric acid, polyphosphate, hydroxyapatite, milorganite, bentonite, kaolinite, zeolite, manganese oxide, iron oxide, or a mixture thereof.

~~2.~~3. The method according to claim 1 or 2, wherein the torrefying comprises torrefying in presence of inert gas.

~~3.~~4. The method according to any preceding claim ~~1 or 2~~, wherein the torrefying is at a temperature of ~~1-500~~25-450°C.

~~4.~~5. The method according to any preceding claim, further comprising treating flue gas produced during the torrefying.

~~5.~~6. The method according to any preceding claim, further comprising drying the mixture prior to the torrefying.

~~6.~~7. The method according to claim ~~5~~6, wherein the drying comprises drying in presence of inert gas.

~~7.~~8. The method according to claim ~~5~~6 or ~~6~~7, wherein the drying is at a temperature of 1-280°C.

~~8.~~9. The method according to any preceding claim, further comprising cooling the biochar following the torrefying.

~~9. The method according to any preceding claim, wherein the reducing agent comprises: sodium borohydride, hydrazine, aluminium powder, $LiAlH_4$, or a mixture thereof.~~

~~10. The method according to any preceding claim, wherein the inorganic additive comprises: lime, limestone, $FeCl_3$, $Fe_2(SO_4)_3$, $FeSO_4$, aluminium powder, iron powder, FeOOH, Fe_2O_3, $MgCO_3$, $MgCa(CO_3)_2$, NaOH, KOH, phosphate, monohydrogenphosphate, dihydrogenphosphate, rock phosphate, phosphoric acid, polyphosphate, hydroxyapatite, milorganite, bentonite, kaolinite, zeolite, manganese oxide, iron oxide, or a mixture thereof.~~

~~11. The method according to any preceding claim, wherein when the organic-containing media comprises less than 25 weight % organic content, the method further comprises calcinating the biochar following the torrefying to form calcinated material.~~

~~12. The method according to claim 11, wherein the calcinating comprises calcinating in an oxidising atmosphere.~~

~~13. The method according to claim 11 or 12, wherein the calcinating is at a temperature of 600-1200°C.~~

~~14.~~10. The method according to any of claims ~~11~~ 2 to ~~13~~9, further comprising treating flue gas produced during the calcinating.

~~15.~~11. The method according to any of claims ~~11~~ 2 to ~~14~~10, further comprising cooling the calcinated material.

~~16.~~12. The method according to any of claims ~~11~~ 2 to ~~15~~11, further comprising:

- mixing the biochar with at least one further additive to form a biochar mixture; and
- molding the biochar mixture,

wherein the mixing and the molding is prior to the calcinating.

~~17.~~13. The method according to claim ~~16~~12, wherein the at least one further additive comprises: clay, sand, stone, fly ash, coal ash, furnace slag, incineration bottom ash, construction waste, egg shell, or a mixture thereof.