CLAIMS

~~1. A method of deriving parameters for a desired emulsifier for producing specific water-in-fuel emulsions consistent with emulsions produced by a reference emulsifier, the desired emulsifier and reference emulsifier including a desired mixing chamber and reference mixing chamber respectively for mixing fuel and water, the method comprising~~

~~(i) deriving a dimension of the desired mixing chamber for the desired emulsifier based on dimension of the reference mixing chamber of the reference emulsifier, the derived dimension of the desired mixing chamber being one which creates a turbulent type flow at the desired mixing chamber;~~

~~(ii) calculating dimensionless water particle size from the derived dimension; and~~

~~(iii) deriving nozzle dimension of the desired emulsifier for one or more water nozzles for injecting the water into the fuel at the desired mixing chamber from the calculated dimensionless water particle size.~~

~~2. A method according to claim 1, wherein step (i) further comprises~~

~~(iv) calculating an initial dimension of the desired mixing chamber for the desired emulsifier based on dimension of the reference mixing chamber of the reference emulsifier, and~~

~~(v) verifying if the initial dimension of the desired mixing chamber would create the turbulent-type flow at the desired mixing chamber.~~

~~3. A method according to claim 2, wherein if the initial dimension would create the turbulent-type flow, the method includes using the initial dimension as the derived dimension.~~

~~4. A method according to claim 2 or 3, wherein if the dimension would not create a turbulent-type flow, the method further comprises:~~

~~(vi) revising the initial dimension and performing step (v) until a revised dimension is obtained which would create a turbulent-type flow at the desired mixing chamber; and~~

~~using the revised dimension as the derived dimension.~~

~~5. A method according to claim 2 to 4, wherein step (v) includes calculating respective Reynold number of fuel flow of the reference emulsifier and the desired emulsifier.~~

~~6. A method according to claim 5, further comprising the step of checking the calculated Reynold numbers against a Moody Diagram to verify if the derived dimension would create a turbulent-type flow.~~

~~7. A method according to any preceding claim, wherein step (iii) includes determining nozzle dimension ratio from an empirical dimension model of the reference emulsifier based on the calculated dimensionless water particle size.~~

~~8. A method according to claim 7, further comprising deriving the nozzle dimension from the determined nozzle dimension ratio and the derived dimension.~~

~~9. A method according to claim 7 or 8, wherein the empirical dimensional model includes a chart of varying nozzle dimension ratios versus varying dimensionless mean water particle sizes derived from the reference emulsifier.~~

~~10. A method according to any preceding claim, wherein the reference dimension of the reference emulsifier includes diameter of the reference mixing chamber and fuel flow rate of the reference mixing chamber.~~

~~11. A method according to any preceding claim, wherein the derive dimension includes diameter of the desired mixing chamber of the desired emulsifier.~~

~~12. A method according to any preceding claim, wherein water content and water particle size of the emulsion to be produced by the desired emulsifier is consistent with those produced by the reference emulsifier.~~

~~13. A method according to claim 12, wherein the water content is between 6% and 40% as percentage of water volume to fuel volume and water particle sizes of substantially between 2 and 6 microns.~~

~~14. A method according to any preceding claim, further comprising deriving a number of water nozzles for the desired emulsifier.~~

~~15. A method of determining parameters for a desired emulsifier for producing specific water-in-fuel emulsions with an intended fuel flow-rate from a reference parameter map, the reference parameter map being derived from the method of any preceding claim and comprises a plurality of values of dimensions of the desired mixing chamber and corresponding desired values of water nozzle dimensions at respective desired fuel flow rates,~~
~~the method comprising:~~
~~identifying one of the desired fuel-flow rates which corresponds to the intended fuel flow-rate,~~
~~obtaining corresponding values of the dimensions of the desired mixing chamber and water nozzles from the identified fuel-flow rate; and~~
~~using these corresponding values as the parameters for the desired emulsifier.~~

~~16. A method according to claim 15, wherein the identifying step includes interpolating between two desired fuel-flow rates to identify an interpolated fuel-flow rate which corresponds to the intended fuel flow-rate; and~~
~~obtaining corresponding values of the dimensions of the desired mixing chamber and water nozzle from the interpolated fuel-flow rate.~~

~~17~~1. An emulsifier for producing water-in-fuel emulsions, comprising
a mixing chamber for mixing fuel and water; the mixing chamber having a diameter of between about 8.00mm and about 47mm;
a fuel inlet for directing fuel into the mixing chamber at a rate of about 0.60m^3/hr to about 108m^3/hr; and
one or more nozzles arranged to receive water from a water inlet and to inject the water into the mixing chamber; each of the nozzles having a diameter of between about 0.50mm and 6.60mm.

~~18~~2. An emulsifier according to claim ~~17~~1, adapted to produce water-in-fuel emulsions with water particles sizes between 6% and 40% as percentage of water volume to fuel volume and water particle sizes of substantially between 2 and 6 microns.

~~193~~. An emulsifier according to claim ~~171~~ or ~~182~~, wherein the mixing chamber has a diameter of about 8.00mm, the or each water nozzle has diameter of about 0.50mm and the fuel inlet is arranged to direct fuel into the mixing chamber at a rate of about 0.60 m^3/hr.

~~204~~. An emulsifier according to claim ~~171~~ or ~~182~~, wherein the mixing chamber has a diameter of about 10.00mm, the or each water nozzle has diameter of 1.10mm and the fuel inlet is arranged to direct fuel into the mixing chamber at a rate of about 3.00 m^3/hr.

~~215~~. An emulsifier according to claim ~~171~~ or ~~182~~, wherein the mixing chamber has a diameter of about 12.00mm, the or each water nozzle has diameter of 1.55mm and the fuel inlet is arranged to direct fuel into the mixing chamber at a rate of about 6.00 m^3/hr.

~~226~~. An emulsifier according to claim ~~171~~ or ~~182~~, wherein the mixing chamber has a diameter of about 14.00mm, the or each water nozzle has diameter of 1.90mm and the fuel inlet is arranged to direct fuel into the mixing chamber at a rate of about 9.00 m^3/hr.

~~237~~. An emulsifier according to claim ~~171~~ or ~~182~~, wherein the mixing chamber has a diameter of about 16.00mm, the or each water nozzle has diameter of 2.20mm and the fuel inlet is arranged to direct fuel into the mixing chamber at a rate of about 12.00 m^3/hr.

~~248~~. An emulsifier according to claim ~~171~~ or ~~182~~, wherein the mixing chamber has a diameter of about 18.00mm, the or each water nozzle has diameter of 2.50mm and the fuel inlet is arranged to direct fuel into the mixing chamber at a rate of about 15.00 m^3/hr.

~~259~~. An emulsifier according to claim ~~171~~ or ~~182~~, wherein the mixing chamber has a diameter of about 19.00mm, the or each water nozzle has diameter of 2.70mm and the fuel inlet is arranged to direct fuel into the mixing chamber at a rate of about 18.00 m^3/hr.

~~26~~10. An emulsifier according to claim ~~17~~1 or ~~18~~2, wherein the mixing chamber has a diameter of about 21.00mm, the or each water nozzle has diameter of 2.95mm and the fuel inlet is arranged to direct fuel into the mixing chamber at a rate of about 21.00 m^3/hr.

~~27~~11. An emulsifier according to claim ~~17~~1 or ~~18~~2, wherein the mixing chamber has a diameter of about 26.00mm, the or each water nozzle has diameter of 3.70mm and the fuel inlet is arranged to direct fuel into the mixing chamber at a rate of about 33.00 m^3/hr.

~~28~~12. An emulsifier according to claim ~~17~~1 or ~~18~~2, wherein the mixing chamber has a diameter of about 35.00mm, the or each water nozzle has diameter of 4.95mm and the fuel inlet is arranged to direct fuel into the mixing chamber at a rate of about 60.00 m^3/hr.

~~29~~13. An emulsifier according to claim ~~17~~1 or ~~18~~2, wherein the mixing chamber has a diameter of about 47.00mm, the or each water nozzle has diameter of 6.60mm and the fuel inlet is arranged to direct fuel into the mixing chamber at a rate of about 108.00 m^3/hr.

~~30~~14. An emulsifier according to any of claims ~~17~~1 to ~~28~~12, wherein the number of water nozzles is four.

~~31~~15. An emulsifier according to any of claims ~~17~~1 to ~~26~~10, wherein the fuel has a viscosity of 2.8 centistokes to 24 centistokes measured after heating.

~~32. A method of designing and sizing the parts of the desired emulsifier to produce water-in-fuel emulsions more particularly but not exclusively, of water content in the range of 6% to 40% and water particle sizes of 2 to 6 microns, the method comprising the steps of deriving the design and sizes of the parts of the desired emulsifier from a reference emulsifier which has been tested and verified to produce water-in-fuel emulsions of water content in the range of 6% to 40% and water particle sizes of 2 to 6 microns.~~