CLAIMS

1. A salt content analyzer that performs multiple sequential determinations of a salt content of an analyte in a test fluid comprising the analyte and an electro-polymerizable monomer without requiring intermediate cleaning or polishing of a working electrode between determinations, the salt content analyzer comprising:

an analysis vessel that accommodates the test fluid, a counter electrode, and a reference electrode;

a working electrode assembly comprising the working electrode and an access control mechanism, the working electrode assembly being immersible in the test fluid; and

a voltage source that applies an electrical potential to the working electrode;

a measurement apparatus that measures an electrical current passed between the working electrode and the counter electrode when the electrical potential is applied to the working electrode;

wherein:

the working electrode and the counter electrode form an electrochemical cell;

the access control mechanism of the working electrode assembly comprises a movable barrier that exposes a measuring portion of the working electrode to the test fluid through an access gap and forms a fluid tight seal around a covered portion of the working electrode, the fluid tight seal preventing exposure of the covered portion to the test fluid;

during a single determination of the analyte in the test fluid, electropolymerization of the electro-polymerizable monomer occurs at the measuring portion of the working electrode and a polymer film is deposited onto the measuring portion to form a used measuring portion;

after the single determination, movement of the movable barrier exposes a fresh measuring portion of the working electrode for use in a subsequent determination without requiring intermediate cleaning or polishing of the working electrode and forms the fluid tight seal around the used measuring portion formed during the single determination.

2. The salt content analyzer of claim 1, wherein the access control mechanism comprises a first sleeve and a second sleeve disposed over opposite ends of the working electrode and extending lengthwise over the covered portion of the working electrode, each of the first sleeve and the second sleeve having a proximal end, the proximal ends of the first sleeve and the second sleeve defining the access gap between the proximal ends of the first sleeve and the second sleeve, the measurement portion of the working electrode being exposed to the test fluid through the access gap.

3. The salt content analyzer of claim 2, wherein the sleeves comprise an elastomer.

4. The salt content analyzer of claim 3, wherein the elastomer is polypropylene, polyethylene, or polycarbonate.

5. The salt content analyzer of claim 2, wherein the first sleeve and the second sleeve are connected by a plurality of access control wires that maintain the access gap at a constant width between the proximal ends of the first sleeve and the second sleeve.

6. The salt content analyzer of claim 1, wherein salt content analyzer further comprises a reagent metering system comprising a digital syringe that measures amounts of the test fluid provided to the analysis vessel, a mixer that stirs the test fluid in the analysis vessel, and a plurality of valves that provide the test fluid to the analysis vessel.

7. The salt content analyzer of claim 6, wherein the salt content analyzer further comprises a solvent supply that provides water and at least one conductivity solvent to the reagent metering system, the at least one conductivity solvent chosen from N-methylpyrrolidone, methanol, methyl-tert-butyl ether, acetonitrile, and mixtures thereof.

8. The salt content analyzer of claim 6, wherein the salt content analyzer further comprises a solvent supply that provides water and at least two conductivity solvents to the reagent metering system, the at least two conductivity solvents comprising N-methylpyrrolidone and acetonitrile.

9. The salt content analyzer of claim 6, wherein the salt content analyzer further comprises an analyte metering system that provides the analyte to the reagent metering system, the analyte being chosen from crude oil, paraffin oil, gasoline, or diesel fuel.

10. The salt content analyzer of claim 1, wherein the working electrode is a platinum electrode, a glassy carbon electrode, or a graphite electrode.

11. The salt content analyzer of claim 1, wherein the electro-polymerizable monomer is aniline, thiophene, benzo-thiophene, dibenzothiophene, or pyridine.

12. The salt content analyzer of claim 1, wherein the analysis vessel comprises an inert glass, an inert plastic, or an inert ceramic.

13. The salt content analyzer of claim 1, wherein the analysis vessel comprises a stirrer that stirs the test fluid in the analysis vessel during the multiple sequential determinations.

14. The salt content analyzer of claim 1, wherein the salt content analyzer further comprises a purge gas supply that provides a purge gas for flushing out the salt content analyzer between determinations.

15. The salt content analyzer of claim 1, wherein the salt content analyzer further comprises a cleaning solvent supply that provides a cleaning solvent for cleaning the salt content analyzer between determinations.

16. A method of performing multiple sequential determinations of salt content in a petroleum product without intermediate cleaning or polishing of a working electrode between determinations, the method comprising:

providing a salt content analyzer having an analysis vessel, a working electrode assembly comprising a working electrode and an access control mechanism, a voltage source, and a measurement apparatus, the access control mechanism of the working electrode assembly comprising a movable barrier that exposes a measuring portion of the working electrode through an access gap to a test fluid containing the petroleum product in the analysis vessel and forms a fluid tight seal around a covered portion of the working electrode, the fluid tight seal preventing exposure of the covered portion to the test fluid;

mixing the petroleum product and a homogenous mixture to the analysis vessel to form the test fluid, the homogeneous mixture comprising water, at least one conductivity solvent, and at least one electro-polymerizable monomer;

applying a sweeping potential with the voltage source to the working electrode in the test fluid to generate an electric current from a counter electrode in the test fluid to the working electrode, whereby electropolymerization of the electro-polymerizable monomer occurs at the measuring portion of the working electrode and a polymer film is deposited onto the measuring portion to form a used measuring portion;

recording with the measurement apparatus a peak current generated during the application of the sweeping potential;

comparing the peak current with a predetermined calibration curve to determine the salt content of the petroleum product; and

moving the movable barrier of the access control mechanism to cover the used measuring portion of the working electrode and to expose a fresh measuring portion of the working electrode for use in a subsequent determination.

17. The method of claim 16, further comprising:

draining the analysis vessel after the peak current is recorded;

supplying a purge gas to the drained analysis vessel to remove any remaining test fluid in the analysis vessel; and

performing a subsequent determination of salt content of an additional test fluid while the fresh measuring portion of the working electrode is exposed.

18. The method of claim 16, further comprising:

draining the analysis vessel;

supplying a cleaning solvent to the drained analysis vessel to clean the analysis vessel; and

performing a subsequent determination of salt content of an additional test fluid while the fresh measuring portion of the working electrode is exposed.

19. The method of claim 16, further comprising performing multiple subsequent determinations of salt contents of test fluids containing the petroleum product until the movable barrier reaches an end of the working electrode and no additional fresh measuring portion can be exposed by the movement of the movable barrier.

20. An analyzer comprising:

an analysis vessel that accommodates a test fluid, a counter electrode, and a reference electrode;

a working electrode assembly comprising a working electrode and an access control mechanism, the working electrode assembly being immersible in the test fluid; and

a voltage source that applies an electrical potential to the working electrode;

a measurement apparatus that measures an electrical current passed between the working electrode and the counter electrode when the electrical potential is applied to the working electrode;

wherein:

the working electrode and the counter electrode form an electrochemical cell;

the access control mechanism of the working electrode assembly comprises a movable barrier that exposes a measuring portion of the working electrode to the test fluid through an access gap and forms a fluid tight seal around a covered portion of the

working electrode, the fluid tight seal preventing exposure of the covered portion to the test fluid; and

movement of the movable barrier exposes a fresh measuring portion of the working electrode.