significant limitations. In conventional electrocoalescencers, both electrodes are immersed in the emulsions. The immediate consequence is that the technique cannot be reliably used when the content of water in the emulsion is high, for example, greater than 40 wt.%. The high content of water may limit the level of applied potential to the electrodes so that even moderate fields may cause electrostatic breakdown. Even when the content of water is moderate or low, the separated water droplets tend to align themselves in the direction of the imposed field and form a chain-like structure across the gap between the electrodes. The formation of this chain may increase the chance of electrostatic discharge and arc across the gap. The electrostatic discharge poses a risk of explosion, as well as corrosion of the electrode or electrode coatings, and increased contamination due to chemical decomposition of oil around the electrodes. Moreover, the electrostatic discharge/breakdown may reduce the rate of coalescence by suppressing the strength of the background electric field, the rate of charging the droplets, and the efficiency of the separator. Additionally, traditional electrostatic separators fail where the aqueous phase has high salt content.

[0013] A separation method is needed that is cost-effective, works for emulsions having small droplet size, works irrespective of the salt concentration of the aqueous phase, and does not pose a risk of explosion or require addition of chemical additives to the emulsion.

Summary ~~of the Invention~~

[0014] Various embodiments of the ~~invention~~present disclosure relate to methods and systems for separating two or more phases of an emulsion or other mixture. In certain embodiments, the ~~invention~~present disclosure introduces a net and unipolar charge into the mixture such that adjacent droplets therein acquire net and unipolar charges and, surprisingly, enhance coalescence of like-phase droplets, thereby

destabilizing the mixture and producing, or enhancing production of, two or more consolidated liquid phases.

[0015] Some embodiments discussed herein provide successful separation of two or more phases of an emulsion or other mixture despite high conductivity of a dispersed phase, despite high salt content, and/or despite the presence of a surfactant or other emulsifier. In some embodiments, the conductivity of the mixture is between 1 mS/m to 1 S/m or as high as 10 S/m. The systems and methods described herein are applicable to a wide variety of electrical conductivity ranges. Certain embodiments described herein can separate a variety of mixtures having wide ranges of salt and/or surfactant content without any special adjustment in configuration of electrodes or other invasive manipulation.

[0015a] In one aspect of the present disclosure, there is provided a method for separating two or more phases of emulsion mixture (e.g., an emulsion), the method comprising the steps of:

(a) providing the mixture with a net and unipolar charge (e.g., such that adjacent droplets therein acquire net and unipolar charges), thereby enhancing coalescence of like-phase droplets therein and producing, or enhancing the production of, two or more consolidated phases; and

(b) collecting the two or more consolidated phases.

[0015b] In another aspect of the present disclosure, there is provided a system for separating two or more phases of a mixture (e.g., an emulsion), the system comprising:

(a) a container or support for containing or supporting the mixture therein or thereupon, wherein the container or support comprises (e.g., is) a grounded collector electrode, and wherein the container or support comprises a ramp, lip, edge, and/or other elevated portion;

(b) an emitter electrode not in physical contact with the mixture; and

(c) a power source configured to apply a potential difference between the emitter electrode and the collector electrode at or above a corona discharge threshold, wherein a gaseous medium (e.g., nitrogen, oxygen, air, argon, helium, etc., or a mixture thereof) is located between the emitter electrode and the mixture, and wherein the container or support is configured to permit passage of a first phase of the mixture therethrough and/or thereover while disallowing passage of at least a second phase of the mixture therethrough and/or thereover upon application of the potential difference between the emitter electrode and the collector electrode at or above the corona discharge threshold (e.g., taking advantage of the differential spreading or pumping effect of corona discharge separation), thereby causing or promoting separation of two or more phases of the mixture.

[0016] ~~In one aspect, t~~The ~~invention~~present disclosure also provides a method for separating two or more phases of a mixture (e.g., an emulsion), the method including the steps: (a) providing the mixture with a net and unipolar charge (e.g., such that adjacent droplets therein acquire net and unipolar charges), thereby enhancing coalescence of like-phase droplets therein and producing, or enhancing the production of, two or more consolidated phases; and (b) collecting the two or more consolidated phases.

[0017] In certain embodiments, step (a) includes bombarding the mixture with ions via corona discharge.

[0018] In certain embodiments, step (a) includes providing an emitter electrode (e.g., sharp electrode) and a collector electrode, wherein at least the collector electrode (e.g., blunt electrode) is in physical contact with the mixture and a potential difference is applied between the emitter electrode and the collector electrode at or above a corona discharge threshold.

[0019] In certain embodiments, the emitter electrode is not in physical contact with the

controlled/modulated to optimize the quality of the discharge (V-I) characteristics and the breakdown limit (e.g., to increase the electrical breakdown limit) based on sea elevation of a location where the separating of the two or more phases takes place.

[0049] ~~In another aspect,~~ The ~~invention~~present disclosure is also directed to a system for separating two or more phases of a mixture (e.g., an emulsion), the system including: (a) a container or support for containing or supporting the mixture therein or thereupon, wherein the container or support includes (e.g., is) a grounded collector electrode, and wherein the container or support includes a ramp, lip, edge, and/or other elevated portion; (b) an emitter electrode not in physical contact with the mixture; and (c) a power source configured to apply a potential difference between the emitter electrode and the collector electrode at or above a corona discharge threshold, wherein a gaseous medium (e.g., nitrogen, oxygen, air, argon, helium, etc., or any combination/mixture thereof) is located between the emitter electrode and the mixture, and wherein the container or support is configured to permit passage of a first phase of the mixture therethrough and/or thereover while disallowing passage of at least a second phase of the mixture therethrough and/or thereover upon application of the potential difference between the emitter electrode and the collector electrode at or above the corona discharge threshold (e.g., taking advantage of the differential spreading or pumping effect of corona discharge separation), thereby causing or promoting separation of two or more phases of the mixture.

[0050] In some embodiments, the electrode (emitter and/or collector) discussed herein are bare. In some embodiments, the electrodes (emitter and/or collector) discussed herein are coated.

[0051] In certain embodiments, the power source is a conventional power source (e.g., a battery, DC power supply, AC power supply, or AC/DC supply. In certain embodiments, the

power source is an electrostatic generator (e.g., a Van de Graaf generator).

[0052] In some embodiments, the system is a skimmer, a gravitation separator, or a centrifugal separator. In some embodiments, the system is a skimmer that has been retrofitted to carry out the separation of the mixture. In some embodiments, like-charge induced separation can accelerate the separation process when the mixture is stored in a container.

[0053] In some embodiments, the temperature and/or pressure of the gaseous medium is controlled/modulated, based on sea level elevation of the system, to optimize the quality of the discharge (V-I) characteristics and the breakdown limit (e.g., to increase the electrical breakdown limit).

[0054] In various embodiments, features described with respect to the methods above can be applied to the system as well.

[0055] The methods and/or systems can perform a pre-treatment step in an existing system (e.g., a retrofit of a gravitational and/or sedimentation mixture separation process), or they can be combined with other techniques. For example, in some embodiments, methods and systems described herein may promote coalescence between small droplets to form larger droplets, which are then more easily handled by traditional separation systems (e.g., gravitational, sedimentation, and/or chemical additive separation processes).

[0056] Elements of embodiments described with respect to a given aspect of the ~~invention~~present disclosure may be used in various embodiments of another aspect of the ~~invention~~present disclosure. For example, it is contemplated that features of dependent claims depending from one independent claim can be used in apparatus and/or methods of any of the other independent claims.