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METHOD OF CONCENTRATING LIQUID-CONTAINING MIXTURES

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The present invention deals with an improved system for concentrating liquid-containing mixtures. More particularly, it relates to the concentration of heat sensitive materials prone to caking and particularly to concentration of such materials to relatively high concentrations of the solid phase.

The problem of concentrating liquid containing mixtures is one often faced by the process engineer. Numerous types of evaporators for vaporizing the liquid component of the mixture and thus obtaining a concentrate of non-vaporized materials have been suggested. Thus, for example, the use of steam coils immersed in the liquid mixture, submerged burners, etc., are well known in the art. However, particular difficulty has been encountered in the concentration of a variety of materials which are sensitive to overheating and tend to cake. Thus, for example, in the clay industry considerable difficulty has been encountered in concentrating clay water suspensions to the upper range of solids content wherein the material becomes extremely viscous. Similar problems are encountered in the concentration of alum-water slurries, calcium carbonate slurries, titanium dioxide-water mixture, gypsum slurries, cement and lime slurries.

Means are now taught for concentrating liquid-containing mixtures, particularly liquid-solid mixtures in a manner offering extremely high thermal efficiency, elimination of the caking of solid components, as well as highly effective use of streams to be concentrated for reducing thermal strain about the elements of the burner zone. More specifically, the present invention deals with a thermal concentrator wherein a non-submerged burner zone is employed and feed liquid mixture to be concentrated is circulated as an annular curtain about the discharge portion of the burner zone. The liquid "curtain" insures highly effective contact between the hot flue gases of the burner zone and the mixture to be concentrated, the resulting vaporized liquid components being withdrawn overhead. In a preferred embodiment, the liquid mixture to be contacted is circulated about the burner zone so as to relieve thermal stress while being itself preheated, the liquid mixture then being discharged as a "curtain" about the burner zone discharge portion.

In general, the liquid blanket about the discharge of the burner zone will form a relatively enclosed zone forcing the flue gases largely into a reservoir of liquid mixture in the lower portion of the concentrator wherein the flue gases further contact the mixture with the resulting additional vaporization of liquid components.

In a further desirable embodiment, a secondary supply of air or other oxygen-containing gas for the burner zone is introduced towards the discharge portion of the fuel-air passageway in the burner zone and serves to control the gas outlet temperature and thus protect overheating of heat sensitive materials. The secondary air also serves to air cool the burner tubes and refractory, thus preventing their warping, cracking or overheating, as well as overheating of the liquid-containing material to be concentrated which is preferably being circulated about the burner zone shell.

The present invention offers numerous advantages. It employs a flash type evaporator characterized by non-submerged burner while having extremely high thermal efficiencies in the range of 90 to 95 percent. The liquid

mixture to be concentrated cools the burner tubes while itself being preheated and thus prevents thermal stress, as well as high temperature spots which might cause caking of the solid components of the mixture. By having a "curtain" of feed liquid surround the flue gas as it is being discharged from the burner zone caking is eliminated when the hot gases and liquid material initially contact each other. The exhaust gases, i.e., evaporated liquid and flue gas, are essentially saturated at all times with the liquid to be vaporized thus preventing any after-drying and caking on the walls of the tank. Intimate gas liquid and solids contacted at elevated temperatures may thus be insured with it being possible to employ a wide range of burner gas temperatures, e.g., 400 to 2500° F., while maintaining proper conditions to prevent overheating of heat sensitive components of the liquid mixture.

The present invention, as indicated previously, may be employed to concentrate a wide variety of liquid containing mixtures. In addition to the previously noted admixtures, the present invention can be employed in the concentration of chemicals from their reactant solutions, e.g., urea from water and pulp and paper waste liquors from water, or recovering polymers from the reacting solutions, such as polyolefins, e.g., polyethylene, polypropylene from paraffinic organic diluents, e.g., methyl chloride. While the present invention has particular importance in the clay and/or mineral industries where it is necessary to concentrate solids from water slurries, it obviously can be employed in the broad treatment of a variety of liquid-containing mixtures. Further, the present invention finds utility in the concentration of liquid-liquid mixtures, as well as of liquid-solid mixtures. Thus it can serve to evaporate the more volatile liquid component and produce a concentrate of the less volatile materials. Examples of such operations are the normal concentration of liquid solutions, such as acid concentrators, e.g., phosphoric acid, sulfuric acid, etc., as well as the general concentration of true liquid solutions. The present invention can be used in the concentration of soluble salt solutions for crystallization, purification and/or recovery. The present process offers a more economical method of steam distillation due to the higher thermal efficiency of steam generation, or can be used as an extremely efficient continuous process stream heater, for example, the heating of clay-water slurries from 65° F. to 120° F.

By way of clarifying the nature of the present invention, the term "non-submerged burner" is employed to denote that the present burner zone is suspended above the surface of the principal liquid reservoir in the concentration zone and that a flowing liquid curtain rather than enclosure by relatively stationary liquid reservoirs insures liquid-gas contact. The term "liquid curtain" denotes the relatively rapid flowing liquid mass surrounding the discharge portion of the burner zone.

It is to be clearly understood that the present concentrator is distinguished from various conventional spray drying systems, wherein a liquid mass of material is atomized by hot gases discharging across the path of the liquid mass. In the present process the liquid mass essentially discharges about the hot gas stream and a relatively continuous liquid curtain is formed about the flue gases discharging from the burner zone.

Various aspects and modifications of the present invention will be made more clearly apparent by reference to the following descriptive example and accompanying drawing.

With reference to the drawing, shown therein is a typical apparatus-process configuration employing the essential elements of the present invention. Concentrator **21** may take the form of a tank or similar vessel. A liquid-containing mixture is fed thereto through line **24**.