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(54) **HYDROGRAVITY SYSTEM AND PROCESS FOR RECLAIMING AND PURIFYING A SOLID, MULTIPLE DOMAIN FEEDSTOCK**

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(57) **ABSTRACT**

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The hydrogravity separation of a multiple component solid feedstock comprises granulating the feedstock to produce particles substantially of individual components having different densities. A dispersion mixer having a high shear and/or turbulent zone is utilized to disperse agglomerated particles and a quiescent hydrogravity tank is utilized to effect binary separation of one or more of the heaviest or one or more of the lightest feedstock components by utilizing an aqueous solution having a specific gravity intermediate of the various components. A high degree of purity is obtained by feeding particles of a selected component to a plurality of sequential dispersion mixers and hydrogravity separation tanks. In a similar manner, remaining thermoplastic particle components can be selectively removed and purified.

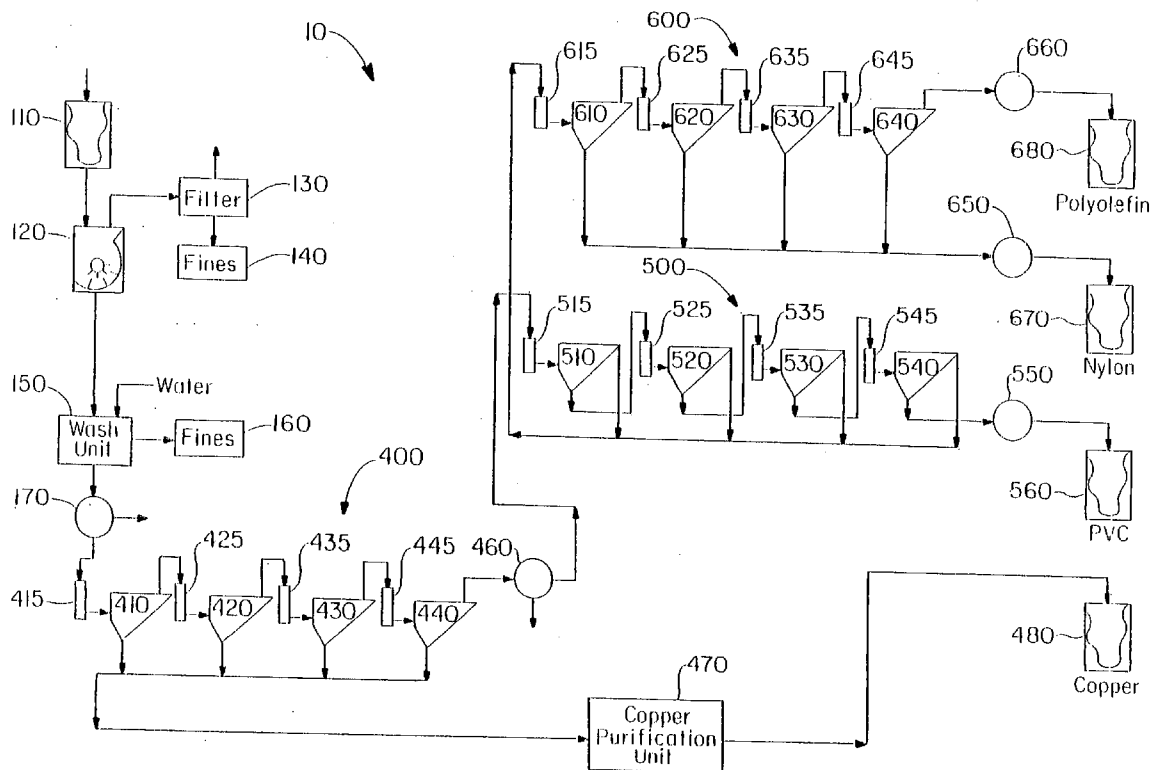
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Related U.S. Application Data

(63) **Continuation-in-part of application No. 10/774,158, filed on Feb. 6, 2004.**



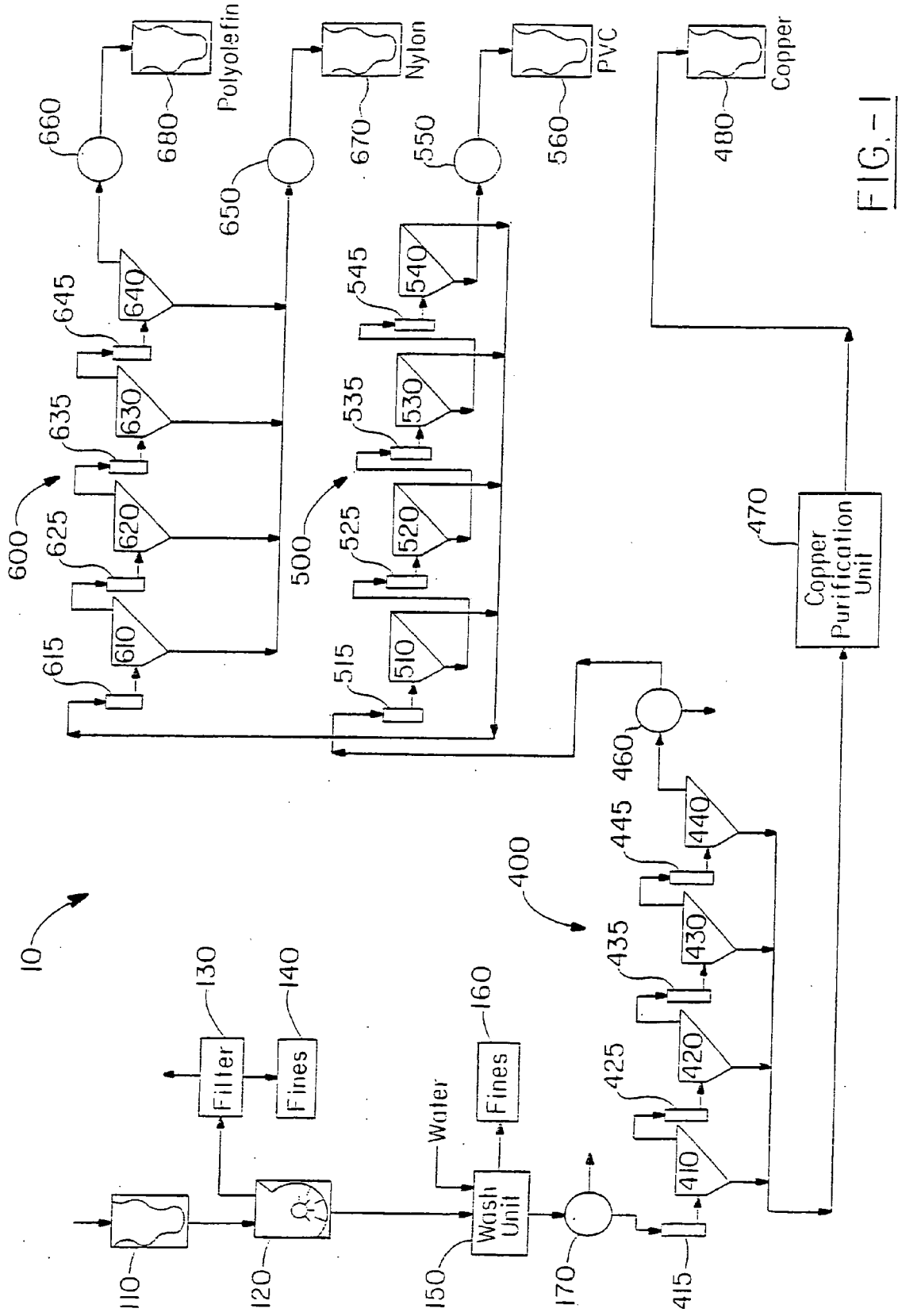


FIG. -I

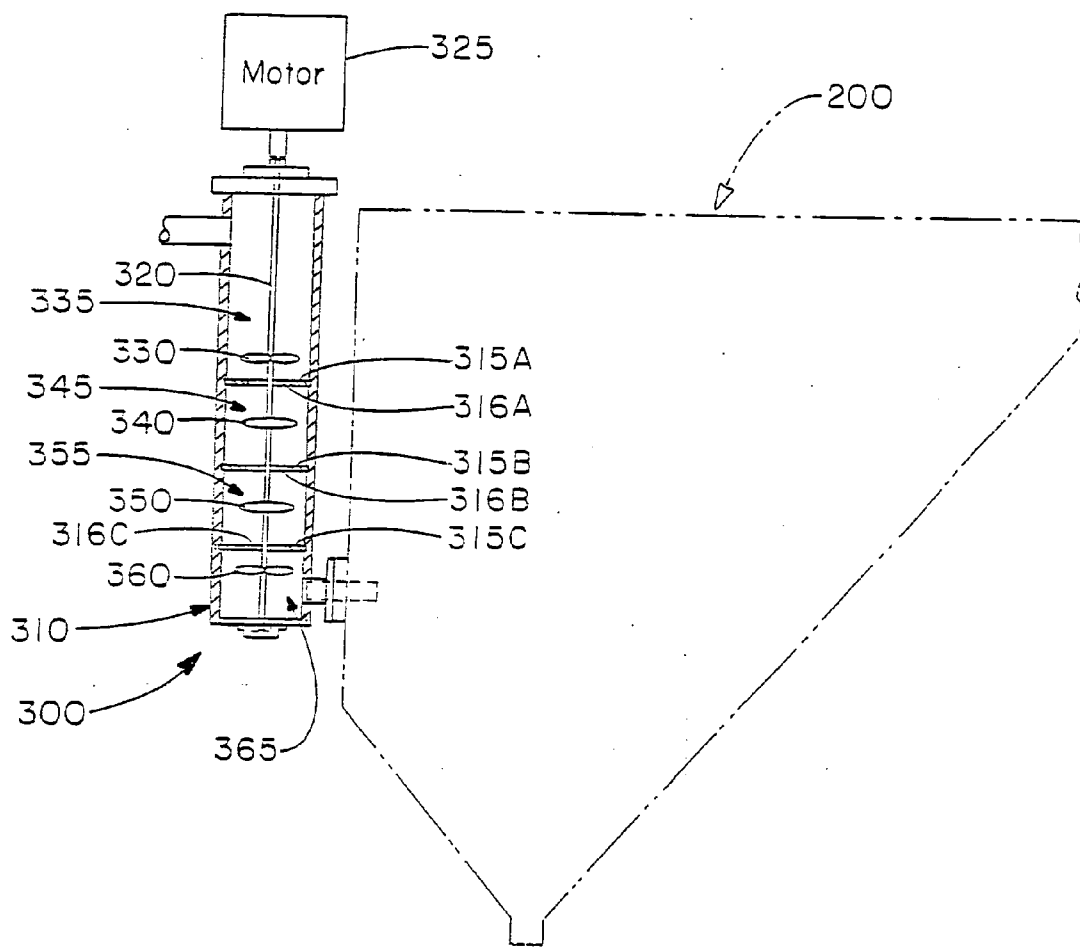


FIG. - 4

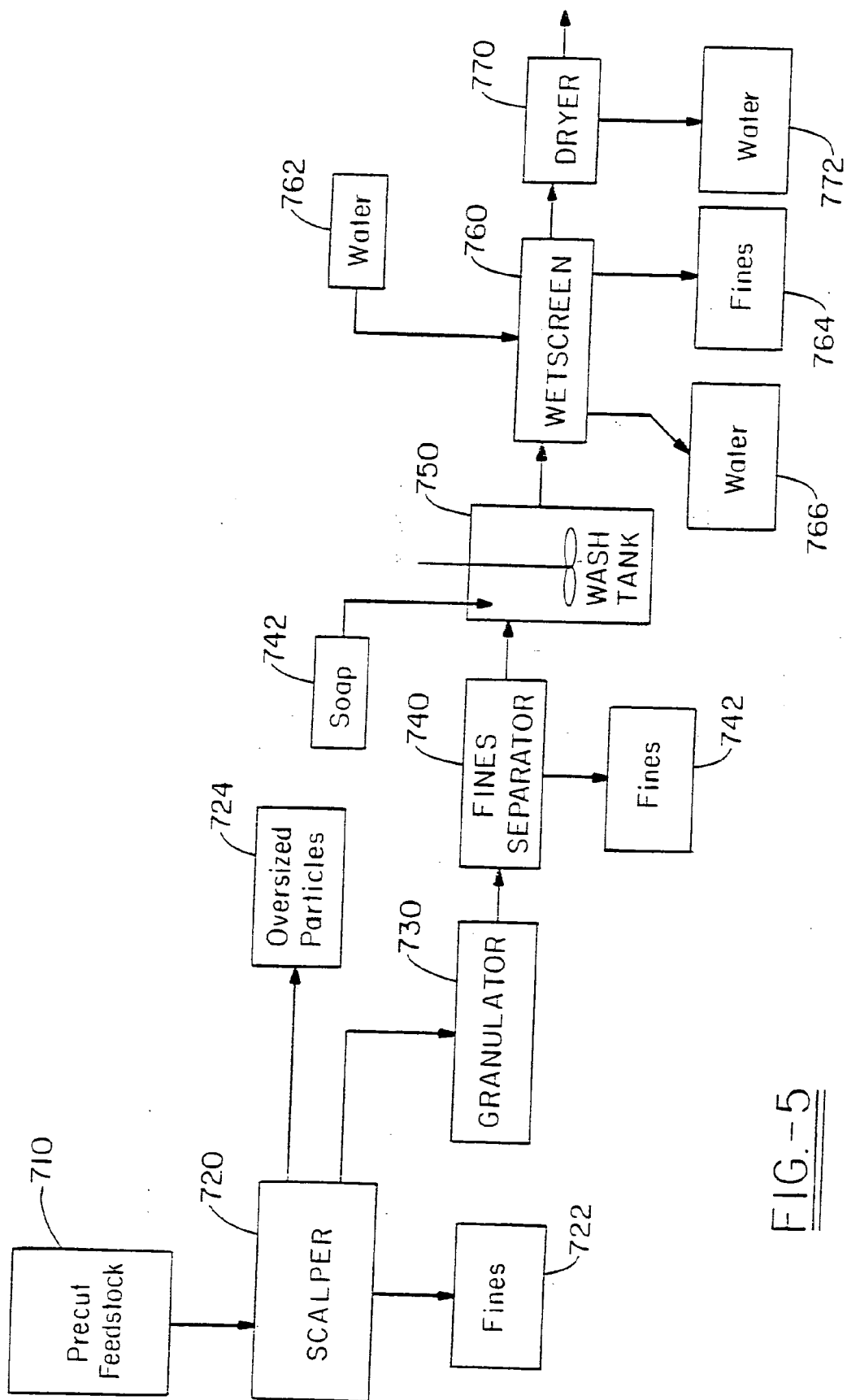


FIG. 5

HYDROGRAVITY SYSTEM AND PROCESS FOR RECLAIMING AND PURIFYING A SOLID, MULTIPLE DOMAIN FEEDSTOCK

CROSS REFERENCE

[0001] This application is a continuation-in-part of U.S. application Ser. No. 10/774,158 filed Feb. 6, 2004 for A HYDROGRAVITY SYSTEM AND PROCESS FOR RECLAIMING AND PURIFYING A SOLID, MULTIPLE DOMAIN FEEDSTOCK.

FIELD OF THE INVENTION

[0002] The present invention relates to reclaiming one or more selective, different density solid components, such as plastic (e.g. polyvinyl chloride, polyethylene), metal (e.g. copper, iron), etc., which initially can be physically bonded to each other, from a multiple domain solid feedstock. More specifically, the present invention relates to using binary hydrogravity separation of small sized particles of the solid multiple domain feedstock to selectively separate the particles into at least two different density components in a quiescent settling tank containing an aqueous solution having a specific gravity intermediate to one or more of the heaviest feedstock components or intermediate to one or more of the lightest thermoplastic feedstock components.

BACKGROUND OF THE INVENTION

[0003] Heretofore, plastics have been selectively dissolved by certain solvents and separated from other plastics or non-plastic materials as by filtration. This format requires high temperatures, and potential problems with solvent vapors, and the like.

[0004] U.S. Pat. No. 5,616,641 relates to a floatation separation process wherein in a floatation bath sufficient alkali metal salt or alkaline earth metal salt of a phosphate, a pyrophosphate, a metaphosphate or a polyphosphate is dissolved to provide a concentration greater than 1.0 grams per cubic centimeter and generally about 1.05 to about 1.6 g/cc. A particular salt is sodium dihydrogen phosphate. Preferably, the floatation process is employed to separate physical mixtures of plastic parts.

SUMMARY OF THE INVENTION

[0005] Articles and products which serve as feedstock and contain multiple domains such as layers or regions of two or more different solid components are reclaimed by a binary hydrogravity separation. Initially, the feedstock is granulated to reduce the size of the multiple components into small particles of substantially a single component, optionally screened to remove oversize particles and fibers, and washed to remove dirt. Optionally, but desirably, fines are removed. The particles are then slurried in a liquid and fed through a dispersion mixer to a hydrogravity separation tank containing desirably a non-phosphorous aqueous solution, having a specific gravity which is intermediate to the specific gravity of one or more of the feedstock components whereby they are separated into feedstock components of a higher specific gravity or a lower specific gravity than the aqueous solution. A plurality of processing units each preferably containing a hydrogravity separation tank and a dispersion mixer to disperse agglomerated particles enable recycling, and subsequent reclaiming of selected compo-

nent(s) in a substantially pure form. In a similar manner, the various remaining components can be separated, recycled, and purified using different specific gravity solutions. Such a system is suitable for the separation of particles having different specific gravities.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 is a schematic flow diagram of one embodiment of a hydrogravity reclaiming system of the present invention containing different operation stages for removal and purification of solid components having different specific gravities;

[0007] FIG. 2 is a side elevation of a hydrogravity separation tank;

[0008] FIG. 3 is an end side elevation of the hydrogravity separation tank;

[0009] FIG. 4 is a cross-sectional view of a dispersion mixer which disperses agglomerated particles; and

[0010] FIG. 5 is a block diagram of an alternative embodiment for removing oversized and fine particles.

DETAILED DESCRIPTION OF THE INVENTION

[0011] The system and process of the present invention for reclaiming individual thermoplastic components relate to a feedstock comprising solid, multiple domain or region components having different densities or specific gravities. One large class of components are various individual particles of plastics such as thermoplastic or thermoset polymers. The polymers can either be a homopolymer or a copolymer. While not desired, included within the plastic class are various melt blends of two or more compounds which contain multiple components on a molecular scale. Generally, feedstocks of the present invention contain less than about 10%, desirably less than about 5%, and preferably less than about 1% by weight of a melt blended material based upon the total weight of the feedstock. Non-plastic components include metals, inorganic fillers, various woods, paper, and the like. The multiple domain components are often in the form of layers, regions, areas, and the like.

[0012] Numerous feedstocks can be utilized provided that the components thereof when reduced in size to particles as by granulation, chopping, etc., have different specific gravities or densities. Desirably feedstocks contain at least two or three different plastics; at least one plastic and at least one metal; at least one plastic and at least one type of wood; or at least one plastic and at least one type of paper, and the like. Plastics generally encompass thermoplastic polymers and less desirably thermoset polymers as set forth hereinbelow.

[0013] Examples of specific thermoplastic polymers which can be separated include, but is not limited to, polyolefins such as polyethylene and polypropylene; styrenic polymers; acrylic polymers; polyvinyl esters such as polyvinyl acetate; polyvinyl alcohol; chlorine-containing polymers such as polyvinyl chloride and polyvinylidene chloride; various fluorocarbon polymers such as polytetrafluoroethylene, polyvinyl fluoride, and the like; nylons and other polyamides; polyesters; polyurethanes; polycarbonates; copolymers of the above, and the like.

[0014] Examples of specific thermoset polymers include various phenolic resins, various amino resins, various polyester resins, epoxy resins, various urethanes including urethane foams, various silicone resins, and the like including copolymers of various thermoset resins.

[0015] Other solid items which can be reclaimed by hydrogravity separation include metals such as iron, nickel, platinum, silver, copper, gold, zinc, aluminum, tin, antimony, titanium, chrome, metal oxides, metal sulfides and other metallic compounds, and the like. Still other solid items include various types of wood including plywood, particle board, etc., various types of paper including cardboard, corrugated paper, and the like. Inorganic materials include silica oxides, metal carbonates, clay, limestone, alumina silicates, glass, and the like.

[0016] Examples of articles or products utilized as feedstocks in various embodiments of the invention include polymer insulated wire or cable including thermoplastics such as PVC, nylon, polyolefin, etc.; metal articles such as aluminum, copper, or steel and/or paper; sharps which include medical devices such as syringes, etc. which contain both plastic and metal components; plastic laminates or layered items; plastics items containing inorganic or other non-plastics; carpeting which has a foam backing of one polymer and fibers of another polymer; extrusion "bleeders"; recycled materials containing thermoplastics; vinyl-clad materials such as various window frames, door frames, and the like; automotive components including laminated or layered thermoplastic and/or thermoset parts such as trim, bumpers, paneling, multi-layer gaskets; automotive recycle shredded floss, i.e. components obtained after shredding an entire automobile; and the like. Other articles include various hoses which contain one or more layers, in any order, of a plastic such as PVC, nylon, polytetrafluoroethylene, polyolefin, and the like wherein the fibers can be made from polyester, nylon, and the like. Other items include plastic sprues from different molding operations; change over waste from conversion of one plastic to another plastic as in an extruder; molded items, cast plastics; etc., and various buckets or containers containing a combination of metal reinforcing parts or handles and paper, thermoplastic, and the like. Still other sources include windshield gaskets, molded parts, cast plastics, laminated rigid piping, and the like. Various laminates, or layered plastic including rigid plastics are also suitable as a feedstock.

[0017] In summary, generally any type of article can be utilized having more than one component which can be reduced to particles wherein the various components such as plastic, metal, paper, etc. can be readily separated as by grinding or granulation.

[0018] Overall Operation

[0019] The overall reclaiming system and process include, but is not limited to, the following operation stages.

[0020] Granulation involves sizing the feed stock by cutting the same into suitable lengths and then breaking the same into sized particles of substantially separated domains, desirably screening, washing and/or air separating the particles to remove dirt, dust, grime and the like, and optionally screening the particles to remove fines which may hinder or inhibit subsequent operations.

[0021] A binary hydrogravity separation occurs in a quiescent tank preferably having steep angled walls generally

greater than the angle of repose to prevent particle buildup thereon. The specific gravity of the aqueous solution, which is achieved by adding one or more salts, which include metal hydroxides, metal oxides, metal halides, metal sulfates, metal nitrates, metal nitrites, metal carbonates, and metal complexes, to water is selected to achieve the separation of one or more of the lightest feedstock components, or one or more of the heaviest feedstock components. Thus, an intermediate specific gravity can be selected so that granulated particles added to hydrogravity separation tank will be separated into one or more lighter components as well as one or more heavier components. Alternatively and often preferred, the specific gravity of the aqueous solution is slightly greater than the specific gravity of only the lightest solid component, or is slightly less than the specific gravity of the heaviest solid component which allows recovery of particles of substantially a single feedstock component. The component(s) selected to be reclaimed is desirably added to at least one additional gravity separation tank and then to preferably to a plurality of additional separation tanks (recycled) to further increase the yield and purify the selected, reclaimed component. Desirably both the top and bottom streams of at least an initial separation tank are recycled.

[0022] While the preferred embodiment of the present invention relates to an aqueous solution, it is never the less within the scope of the present invention to utilize non-aqueous solutions such as silicone solutions, oils including hydrocarbon and halo hydrocarbon oils, dry cleaning fluids, and even liquid solutions comprising ammonia or carbon dioxide. The solutions can be used "neat", in blends, or admixed with other chemicals for the purpose of altering their specific gravity. For example, the specific gravity of an aqueous solution of a specific hydrogravity tank can be changed or "dialed in" by adding thereto a second specific gravity solution having either a higher or lower specific gravity to achieve a different specific gravity in the tank or to fine tune an existing specific gravity.

[0023] Dispersion mixers are preferably utilized before each hydrogravity separation tank to sever, divide, and especially to break up agglomerated particles of the feedstock before they are added to a hydrogravity separation tank.

[0024] The selected separated particles from the last hydrogravity tank of a purification operation are collected, optionally washed, dried, and utilized for any desirable purpose such as reuse or resale. Optionally, additional purification processes such as melt filtration can be utilized to remove the last traces of contaminate from the particles.

[0025] In a similar manner, each remaining domain(s) or component(s) is selectively removed and purified.

[0026] System and Processing Components

[0027] The present invention will now be described with respect to reclaiming one or more solid components from an article such as an insulated copper cable, it being understood that, as noted above, generally any article or product having multiple domains of different plastics or other components such as metal, wood, paper, etc., can serve as feedstock which is reclaimed with a high degree of purity.

[0028] Referring to FIG. 1, a hydrogravity system and process for reclaiming and purifying a solid feedstock is generally indicated by reference number 10. In one embodi-

ment, the reclaimed article is a wire cable which contains a plurality of separated copper wires each surrounded with a thermoplastic such as polyethylene or other thermoplastic with the same being contained or encapsulated within an insulating thermoplastic such as polyvinyl chloride or other thermoplastic. The insulated cable has an outer jacket which is generally a thermoplastic nylon or other thermoplastic. In other embodiments, any number of components can be present.

[0029] The solid article, such as a copper cable is generally precut at an angle into lengths generally greater than 4 millimeters (mm) and fed from feedstock container 110 to granulator 120. Generally any type of cutting device or machine can be utilized with a reel type high shear cutting blade being desired.

[0030] The purpose of the granulator is to size, that is to break, chop, shred, etc. the precut lengths into particles of 4 mm or less and desirably from about 0.5 mm or about 1 mm to about 2 mm or about 3 mm or about 4 mm. The exact size desired is a function of the domain size in the feedstock materials and can be readily determined by one skilled in the art. The granulator reduces the feedstock containing layers of different domains, regions, etc., into small particles containing substantially only one domain or component, e.g. a specific thermoplastic or metal. That is, since the various layers, regions, etc., of the feedstock are only physically bonded, granulation of the same readily separates the various components to produce particles of substantially only a single component. Thus, the amount of any particles having two or more thermoplastic components therein is very small, generally less than about 5% by weight, desirably less than about 3% by weight, and preferably less than about 1% by weight, or no percent by weight based upon the total weight of the feedstock. Granulators for producing metal and/or thermoplastic particles are well known to the art and to the literature and generally any suitable granulator 120 can be utilized such as a CMG, made in Italy. For reasons set forth below, fines are desirably removed and filtered or screened in unit 130 and collected in unit 140. Fine sized particles can vary but often are from about 0.1 to about 1.0 mm in size.

[0031] The dry granulated particles often contain dirt, grime, and fines and are thus fed to wash unit 150 wherein they are mixed under high agitation to create a suspension of the particles in water. Any type of high agitation mixing tank can be utilized with high shear agitation and/or turbulent flow being preferred. The washing step may be continuous or batch. The amount of the granulated article, such as thermoplastic and copper feedstock is desirably such that the solids loading of the slurry in the wash unit is desirably from about 10% to about 40% by weight. Generally any soap such as laundry soap or any conventional surfactant, detergent, or wetting agent, known to the art and to the literature which is non-foaming or low foaming can be utilized and aids in wetting the granulated thermoplastic and copper particles.

[0032] The removal of fines from the particular article feedstock, while optionally, is often an important aspect of the present invention since otherwise, they generally clog the reclaiming system because they generally do not settle or float in the hydrogravity tanks but remain in suspension. Generally any conventional compounds or methods of removing the fines from the slurry can be utilized such as flocculating agents, coagulation agents, and the like which

alter the zeta potential of the fines, centrifuging, air separation, sifting, or desirably screening. For example, a screen containing openings of generally less than about 1.0 mm and desirably less than about 0.5 mm can be utilized to permit the fines to fall there through. A vibrating screen or a centrifuging screen is preferred. In addition to the fines, dirt, and grime, the surfactant or soap solution also falls through the screen. A series of one or more spray bars can be utilized to spray a solution or water onto the retained material to aid in removing fines, dirt, grime, soap or detergent solution therefrom. The fines can be collected in container 160.

[0033] The washed thermoplastic and copper particles are substantially dewatered so when they are fed to a hydrogravity separator tank, dilution of the aqueous salt solution is prevented. Generally any type of drying process or apparatus 170 can be utilized with a mechanical or vibratory screen, basket centrifuge or a conventional spin dryer being preferred to remove the excess solution leaving a product having about 0% or about 0.1% to about 15% and desirably from about 3% to about 7% by weight of solution.

[0034] Another embodiment of the present invention with respect to granulating feedstock particles and removing fines therefrom is set forth in FIG. 5. Precut feedstock 710 is fed to scalper 720 which removes and feeds to container 724 oversized particles such as those generally larger than 4 mm, fibers, as well as angel hair which is generally strips or strings of fibers derived from paper, polymer, and the like. Fines fall through a fine size screen and are collected in container 722. The remaining precut feedstock is fed to granulator 730, which can be similar to that described above, wherein the feedstock is broken, chopped, shredded, etc. into small particles of from about 0.5 mm or about 1 mm to about 2 mm or about 3 mm or about 4 mm. The granulator separates the dry feedstock containing different components into particles substantially containing only one component such as a specific type of thermoplastic or metal. Since fines are undesired because they can become suspended or entrained in the aqueous hydrogravity solution, they are removed by fine separator 740 which utilizes one or more fine screens to selectively remove fines and dirt and deliver the same to container 742.

[0035] The dry substantially single component particles are then subjected to a wet system which further removes fines and dirt. The water removal system comprise the various feedstock component particles which are fed to wash tank 750 generally having agitation therein, and contain soap, surfactants, wetting agents, etc., from tank 742. After the washing operation which may be batch or continuous, the wet feedstock particles are fed to wet screen operation 760 wherein water from tank 762 washes the particles to remove the soap or surfactant therefrom and is subsequently collected in container 766. The removed fines and dirt are fed to container 764. The various washed feedstock component particles which are semi-wet are fed to any conventional dryer 770 such as a Gala dryer wherein water is removed to container 772. The dried multiple feedstock component particles can then be fed to any series of hydrogravity separation tanks to remove at least two components, for example at least two different thermoplastics, through a plurality of mixing and hydrogravity separation steps.

[0036] While specific embodiments have been described with regard to the removal of undesired components from

the feedstock such as dirt, angel hair, oversized particles, and fines, it is to be understood that numerous different types of operations and other embodiments can be utilized and that the same are within the concepts of the present invention.

[0037] With respect to the embodiment of copper cable particles, although generally any type of feedstock can be utilized, in the various reclaiming stages a selected component is separated out such as a metal or copper in a first stage. The washed and granulated dewatered feedstock comprising different domain thermoplastic particles as well as copper particles is continuously fed preferably to a plurality of sequential hydrogravity separator tanks wherein the copper, or other non-thermoplastic materials is separated from the thermoplastic components. Desirably before each tank they are fed to a dispersion mixer for de-agglomeration and subsequently fed to the mid portion of a sequential hydrogravity tank. By mid portion it is meant from about 10% to about 90%, desirably from about 20% to about 80%, and preferably from about 30% to about 70% of the total aqueous solution height in the tank.

[0038] Another important aspect of the present invention in one embodiment is the utilization of an aqueous solution having a selected specific gravity which permits binary separation of one or more of the heaviest components to be separated out from the bottom of the hydrogravity tank. Alternatively, a specific gravity can be selected which permits one or more of the lightest components to float to the top of the tank and to be removed therefrom. As previously noted, the one or more selected solid component particles to be reclaimed are sequentially subjected to a plurality of hydrogravity tanks (recycled) having essentially the same specific gravity to obtain a high yield and purity of the selected components. Yet another important aspect is that the aqueous solution has a relatively low viscosity to allow ready separation of the desired component. The viscosity of the aqueous solution will vary depending upon the types of the particles, the size and shape thereof, and type of the one or more salts. A rule of thumb is that the viscosity is generally about 50 centipoises or less and desirably about 25 or less or about 10 centipoises or less.

[0039] Various specific gravity aqueous solutions are utilized which are known to the art and to the literature generally comprising salts that are highly soluble in water and thus create desired, predetermined specific gravities as low as about 1.001 or about 1.1 to as high as about 2.0 or about 3.0.

[0040] Suitable salts are capable of achieving a desired specific gravity for the particular operation stage, and produce a desired low viscosity. The salts or mixtures thereof are generally defined as ionic compounds containing an electropositive component and an electronegative component. Examples of positive components such as ions include alkali metals such as sodium and potassium, alkaline earth metal such as magnesium and calcium, and various transition metals (groups 3-15 of the periodic table) such as aluminum, tin, iron, zinc, and the like. The negative components such as ions include halogens such as chloride, bromide, oxygen or oxygen-containing compounds such as oxide, or hydroxide, or carbonate, nitrogen-containing compounds such as nitrate, sulfur containing compounds such as a sulfate, or the non-metal portion of a metal complex, and the like. Examples of specific suitable salts include potas-

sium carbonate, zinc chloride, ferric chloride, ferrous chloride, calcium chloride, calcium bromide, calcium sulfate, zinc chloride, zinc bromide, zinc sulfate, zinc oxide, sodium chloride, sodium hydroxide, sodium zincate, magnesium chloride, various polytungstate complexes such as hydrated sodium heteropolytungstates, and mixtures thereof, with calcium chloride being preferred.

[0041] Another class of suitable aqueous specific gravity solutions are various drilling or completion fluids such as those generally utilized in well drilling. Such fluids are known the art and to the literature. An example of such drilling or completion fluids generally comprise water, a density increasing agent, and various stabilizers such as a clay stabilizing agent. Examples of such fluids are set forth in U.S. Pat. No. 4,536,297 which is hereby fully incorporated by reference. Another class of suitable aqueous solutions are suspensions of various particles in water. Suspension can be a colloidal dispersion of particles, or obtained through the use of a dispersing aid, and the like. Suspended particles include magnetite such as Fe_3O_4 , barite, shale, galena, clay, limestone, and the like. Such solutions are known to the literature and to the art such as set forth in U.S. Pat. No. 5,240,626, which is fully incorporated by reference.

[0042] Saline solutions are desired but aqueous solutions containing a phosphorus atom such as various phosphates, pyrophosphates, metaphosphates, polyphosphates, or hydrides thereof are not desired and are avoided since they are not environmentally friendly and can lead to build up of algae and the like. In other words, the aqueous solutions of the present invention are generally phosphorus free meaning that the amount of any phosphorus containing salt is generally less than about 5% by weight, desirably less than about 3% by weight, and preferably less than 2% by weight or nil, that is no amount whatsoever, based upon the total weight of all salts in the aqueous specific gravity solution. It is noted that treated water such as that delivered by various municipalities, cities, and other water purification and treatment plants generally inherently contain small amounts of phosphorus salts which are generally less than 5% by weight.

[0043] A small amount of a soap, surfactant, detergent, wetting agent, or defoamer is desirably utilized to reduce surface tension, to hinder crystallization of the salt, to promote the release of air bubbles and to reduce the attraction between particles. Generally any conventional soap, surfactant, etc., can be utilized such as household soaps, laundry detergents, industrial detergents, and the like.

[0044] It has been unexpectedly found that the addition of surfactants, detergents and wetting agents to the aqueous solutions control surface tension and lower the freezing point thereof so that higher density or specific gravity solutions can be formed than otherwise possible. Depending upon the amount and type of surfactant, etc., the freezing point of a solution having a particular specific gravity can be depressed or reduced anywhere from about 0.1° F. to about 30° F.; desirably from about 1.0° F. to about 25° F.; and preferably from about 2.0° F. or about 3.0° F. or about 5.0° F. to about 10° F. or about 15° F., or about 20° F.

[0045] Surfactants can generally be anionic, cationic, non-ionic, amphoteric, and the like and the same are known to the art and to the literature. Examples of suitable cationic surfactants include the various quaternary amines such as a

quaternary ammonium salt having four alkyl and/or aryl bonds connected to the nitrogen atom wherein, independently, each hydrocarbon or functional containing hydrocarbon group has from 1 to 100 carbon atoms. Examples of suitable quaternary ammonium salts are known to the art and to the literature. Examples of other surfactants are set forth in 2003 McCutcheon's Volume 1: Emulsifiers & Detergents (The Manufacturing Confectioner Publishing Company; Glen Rock, N.J.) which is hereby fully incorporated by reference. Whether a surfactant is suitable or not can be readily determined by adding various amounts to the aqueous solution containing particles of the various components and determining whether the particles are wetted out. Anionic surfactants ordinarily comprise alkyl hydrophobic hydrocarbon chains having terminal anionic hydrophilic polar groups such as carboxylate, sulfonate, sulfate, phosphonate and phosphate polar groups. The alkyl can contain from about 2 to about 24 carbon atoms and desirably from about 8 to about 20 carbon atoms. Suitable surfactants comprise fatty acid chains containing about 10 to about 20 carbon atoms and may contain one or more double bonds, if desired, as in naturally occurring fatty acid vegetable oils. Carboxylate surfactants ordinarily comprise alkyl hydrocarbon hydrophobic chains whereas sulfonate surfactants comprise alkyl, aryl, or alkyl-aryl hydrophobic chains which may contain double bonds, ester or amide groups.

[0046] Desired surfactants include the following: Sodium Caprylamphopropionate (Miranol JEM), Sodium 2-ethylhexyl sulfate (Rhodapon BOS, Sulfotex OA), sodium octyl sulfate (Standapol LF), Sultech 2113, Disodium Cocoamphodiacetate (Mackam 75/2C), Disodium Capryloamphodipropionate (Mackam 2CYSF), Cocamidopropyl Hydroxysultaine (Mackam CBS 50), Sodium Capryloamphohydroxypropylsulfonate (Mackam JS), Caprylamidopropyl Betaine (Mackam OAB, DV 6836), methyl ester soybean oil (Septosol SB-D), Diphenylene Oxide Disulfonate (Rhodacal DSB), Lauraminopropionic Acid (Deriphath 151C), alkylpolyglucosides (Glucopon 425), Sodium lauryl ether sulfate (SLES), Octylamine Oxide (Mackamine C-8), octyl betaine (Mackam BW 139), Sodium Alkyl Naphthalene Sulfonate (Petro ULF), linear alkylbenzene sulfonates (Biosoft S-101), Lauramine Oxide, alkylamine oxides (AO 728), alkylether sulfonates (Avel S-74), anionic and nonionic fluorosurfactants such as the various Zonyl surfactants made by DuPont, (e.g. Zonyl FS-62, FSA, FSP, FSE, FS-62, 9361, FSH, FSO, FSN, etc.), cationic/nonionic surfactant blends (Burcoterge CSB), alkylpolyglucosides (AG 6202), tall oil based amides (Burcoimidozoline), propoxylated and ethoxylated fatty acids (Burcoterge LFE 1000), modified ethoxylated carboxylates (Deterge LF 7315), phosphated amphoterics (Deteric CSP), ethoxylated complex amines (Deterge AT 100), diphenyl sulfonate derivatives (Dowfax 8390), phosphate esters (Colatrop 555, Colafax 3373 PE, Colafax 3371 PE), alkylether hydroxysultaines (Mirataine ASC), anionic proprietary blends (Colonial ZF 20), diphenyl sulfonate derivatives (Surfedon LP 300), organic phosphated amphoteric (Deteric CSP), salts of N-lauryl beta iminodipropionate (Deriphath 160C), iminodipropionate amphoteric (Amphoteric 400), proprietary hydrotropes (Monatrop 1250), Cocamide DEA (Ninol 40-CO) and dodecylbenzene sulfonic acid (Biosoft S 101), wherein the number of carbon atoms in any alkyl group is as noted above.

[0047] Another compound which has been found to promote particle dispersion in an aqueous system is various defoamers which are known to the art and to the literature. Examples of suitable defoamers include compounds containing amorphous silica, various siloxanes such as polydimethyl siloxane, and the like such as Dow Corning 200, 1430, 1520, etc.

[0048] The amount of such surfactants, detergents, wetting agents, defoamers, etc., generally varies with the strength of the surfactant, etc., and/or the chemical nature of the aqueous solution, and/or according to specific gravity desired and/or the amount of freezing point depression desired with generally greater proportional amounts yielding a higher specific gravity and/or a larger freezing point depression.

[0049] The hydrogravity separation tank is designed to promote good separation of the multiple domain thermoplastic feedstocks after it is granulated. As a general concept of the present invention, one or more of the heaviest components are removed from the bottom of the hydrogravity separation tank as a slurry, and one or more of the lightest particles float to the top of the tank and are removed or skimmed off, desirably with both the top and bottom each being separately recycled to produce purified components. The specific gravity of the solution in the tank is thus generally intermediate of the one or more heaviest and the one or more lightest density particles. Accordingly, the specific gravity of the solution is at least about 0.02 or at least about 0.05 lighter or heavier and preferably at least about 0.10 or at least about 0.15 lighter or heavier specific gravity units than the specific gravity of any selected component particles. Preferably, in any given stage of the reclaiming operation, only a single heaviest particle component is substantially removed from the bottom or only a single lightest particle component is removed from the top of the separation tank with the remaining particles being removed from the opposite end of the tank.

[0050] An essential aspect of the hydrogravity tanks is that they have a non turbulent or slow flow rate such that the tank effectively separates particles of the heaviest component(s) or separates particles of the lightest component(s) from the remainder of the solution. Accordingly, the separation tanks are not agitated, stirred, mixed, or the like. Such a quiescent tank has sides and bottom surfaces which are greater than the angle of repose of the particles thus eliminating and preventing build up thereof. The angle of repose of the various sides will vary with the physical and chemical properties of the solution, the types of components such as plastic or metal, the shape of the particles, and the like. However, such angles of repose can be readily determined by one skilled in the art. Generally, any side surface or wall of the tank has an angle A or B of at least 45 degrees from the horizon. The angle of the various sides is generally at least 1 degree greater, desirably at least 5 degrees greater, and preferably at least about 10 degrees greater than the angle of repose.

[0051] As long as the above requirements are met, numerous tank designs and configurations exist. One such configuration of a generalized tank of the present invention is set forth in FIG. 2 wherein tank 200 has a top 205, a vertical upper first end wall 210, an inclined upper second end wall 215, and as shown in FIG. 3, generally vertical upper first and second side walls 220 and 225 respectively. The upper

first end wall **210** of the upper portion of the tank extends into inclined lower first end wall **230**. As shown in **FIG. 3**, the upper first side wall **220** also merges into an inclined lower first side wall **235** and the same is true of upper second side wall **225** which merges into inclined lower second side wall **240**, all of which are greater than the angle of repose.

[0052] Utilization of the above described hydrogravity separation tank of **FIG. 2** thus permits the washed and dewatered particles from dryer **170** to be fed through tank inlet **245** to tank **200** and subsequently separated into components, such as at least one component which is discharged as a slurry from the tank bottom egress **250**. The aperture size of egress **250** is sufficient to maintain a fairly constant and continuous removal and can be readily controlled by any conventional valve, with a pitch valve being preferred. The aperture size is also such that a sufficient particle residence time exists in the hydrogravity tank to permit efficient separation of the one or more heavier components and to achieve an aqueous slurry velocity flow which avoids back mixing, entrainment, and the like.

[0053] As shown in **FIG. 2**, hydrogravity separation tank **200** in one embodiment optionally can contain skimmer **260** which comprises a conveyor type belt **265** having paddles **270** dependent therefrom. Rotation of conveyor **265** will cause the paddle to be immersed into the top of the aqueous slurry and skim the floating particles to one edge of the tank where they are collected and transferred to mixing apparatus **300**. Otherwise, the floating particles can simply flow through an outlet opening, weir or other types of removal devices known to the art and to the literature to the next stage of the system or process.

[0054] According to the concepts of the present invention, separation and purification of granulated solids of different components, e.g. plastic, metal, is conducted as opposed to purification of a solution. In order to obtain a high yield and purity of any specific particles of one or more components, such selected particles are feed to a plurality or multiple of subsequent hydrogravity separation tanks wherein the removal operation is repeated with the selective component particles being reclaimed being transferred to all the tanks in one operation stage. The number of such sequential hydrogravity tanks in any operation stage can vary from at least 2 to about 10, desirably from about 3 to about 8, and preferably from about 3 to about 5 until the selected component(s) are highly purified. Naturally, the specific gravity of the aqueous solutions in any plurality of hydrogravity separation tanks of any single operation stage is substantially the same.

[0055] Inasmuch as the various granulated particles upon immersion into an aqueous solution may or will tend to agglomerate due to surface tension or electrostatic attraction, it is preferred to utilize a dispersion mixer before each separation tank to disperse, sever, etc., such agglomerated particles. Alternatively, in a series of purification or recycling steps as shown in **FIG. 1** with regard to separation and purification of the polyolefin, the nylon, the PVC, and the copper, at least one dispersion mixer is utilized per about 2 to about 10 total hydrogravity tanks or, some dispersion mixers can be utilized, that is from about 15% to about 30%, per total number of separation tanks. Desirably a majority, that is greater than 50%, of mixers are utilized and more desirably, a substantial number, that is from about 70% to about 95%, of dispersion mixers per total number of hydrogravity separation tanks in any recycling purification stream.

[0056] A dispersion mixer **300** shown in **FIG. 4** is preferably located before the first hydrogravity tank of the first removal stage and desirably also before every hydrogravity tank therein. The same principle is true with respect to the other removal stages of other component particles. Although dispersion mixer **300** can be a batch mixer, it is highly preferred that a continuous flow mixer be utilized. The dispersion mixer can be of any shape but desirably is elongated and can have one or more mixing zones, with a plurality of zones, such as from about 2 to about 10, and from about 3 to about 5 zones being preferred. Desirably dispersion mixer **300** is in the shape of an elongated tube or cylinder **310** and has a zone separation element such as an annulus **315** located between and defining each zone. Annulus apertures **316A**, **316B** and **316C** can vary from zone to zone so long as it is less than the tube diameter with a desired aperture area of from about 10% to about 50% and preferably from about 15% to about 30% or about 35% of the total tube diameter area. The linear location of each zone separation annulus **315** can vary so that each zone can be of any desirable length and each zone length need not be the same. The zone length to diameter ratio can be of from about 0.5 or about 0.8 to about 5 or about 10.

[0057] One or more shafts can be utilized to rotate a mixing impeller, with one axial shaft **320** being preferred, which extends through mixer **300** and can be rotated by any conventional apparatus such as motor **325**. Generally two types of mixing impellers are utilized. The first is an axial mixing impeller **330**, located in axial flow zone **335**, which sucks in and propels the granulated component particles into the mixer. One or more mixing impellers can be contained in any zone. Any conventional impeller can be utilized in the first or ingress zone such as a marine propeller having two or more blades, or any other substantially axial flow generating impeller.

[0058] The aqueous solution containing the granulated particles therein is then forced through first annulus **315A**, and into first radial flow zone **345** which contains a second type of mixing impeller, one or more radial flow dispersion impellers **340** designed to break up substantially any particles which have agglomerated. It is essential that the radial flow dispersion impeller create high shear and/or high turbulence to separate the agglomerated particles. Such impeller dispersion blades are more functional than a simple impeller inasmuch as the dispersion blades create a hydraulic action which tears agglomerated particles apart and disperses them uniformly throughout the solution. This is believed to be achieved by two different mechanisms. In the first, agglomerated particles hitting the blade are broken apart (sheared) and then in the intense turbulence surrounding the blade, particles hit one another at high speeds and are further broken up. This intense turbulence around the blade generally occurs at a zone extending a couple of inches outward therefrom and is called the zone of attrition. Beyond the turbulent zone the various particles are thoroughly mixed and dispersed. The diameter of the high shear and/or turbulent impeller **340** can vary in length but is generally from about 20% to about 50% and desirably from about 25% or about 30% to about 35% or about 40% of the dispersion mixer diameter. Various types of radial dispersion impeller blades are known to the art and to the literature and can be utilized such as a Cowles® impeller, a Hockmeyer impeller, a so-called "high vane blade", and also a combination of a blade imparting both radial and axial flow.

[0059] In a preferred embodiment of the present invention, the slurry solution is fed from first radial flow zone **345** through second zone separation annulus **315B** to a second radial flow zone **355** having a dispersion impeller **350** which further breaks up the agglomerated particles, etc., and further disperses the same into individual particles. The mechanisms are the same as with regard to first radial flow zone **345** and hence will not be repeated.

[0060] In a preferred embodiment, the aqueous slurry flows through third zone separation annulus **315C** into a fourth zone, which is a second axial flow zone **365** containing one or two axial flow impeller **360**. The axial flow impeller is desirably the same as axial flow impeller **330** and the same, along with the various other aspects of axial flow zone **365**, will not be repeated but rather incorporated by reference with respect to the first axial flow zone **335**. Of course, axial flow zone **365** serves to suck the aqueous slurry from radial zone **355** into axial zone **365** and then expel it as through an egress in the mixer to a pipe or conduit leading to a subsequent hydrogravity separation tank and preferably to a mid-portion side inlet thereof.

[0061] The rpm of rotating shaft **320** can vary considerably depending upon desired throughput or flow rate but generally is from about 500 to about 5,000 and preferably from about 1,700 or about 2,500 to about 3,500 rpm. The flow rate through mixer **300** will generally vary with the tube diameter as well as the diameter of apertures **316A**, **316B**, and **316C** and can be from about 1 to about 50, desirably from about 10 to about 45, and preferably from about 20 to about 40 gallons per minute with respect to a dispersion mixer having a 10 inch diameter.

[0062] While a specific dispersion mixer has been described in detail, it is to be understood that many variations thereof as well as other mixers can be utilized so long as they generally contain at least one and preferably a plurality of dispersion zones which serve to further break up the particles as through high shear and turbulence. For example, a dispersion mixer can contain an inlet pump and/or an outlet pump in lieu of an impeller. Moreover, in the radial flow zones, high turbulence pumps can be utilized or a pump can be run backwards to produce high turbulence and/or shear.

[0063] Hydrogravity Separation

[0064] The hydrogravity separation of a specific wire cable feed stock will now be discussed in view of the above principles, concepts, structures, and descriptions. As noted above, the wire cable comprises a plurality of copper wires each surrounded with a polyethylene thermoplastic with the same being encapsulated in polyvinyl chloride thermoplastic insulation. The outer jacket of the insulated cable is a nylon thermoplastic. In the preferred separation embodiment, only one component is separated (recycled) in each stage or operation with the remaining components to be purified transferred to the next stage.

[0065] The granulated, washed, and dewatered feedstock is fed to first dispersion mixer **415** which, is described herein above, the description, concepts, principles, etc. which are hereby incorporated by reference, contains a plurality of zones having a first axial flow zone, a first radial dispersion zone wherein a dispersion impeller breaks up agglomerated particles as by high shear and/or turbulence, a second radial

dispersion zone followed by an axial output zone. The dispersed particles are then fed to a mid or lower portion of a first hydrogravity separation tank **410**, the description, concepts, principles, etc., of which as set forth herein above such as with regard to tank **200** are hereby fully incorporated by reference. The specific gravity of the calcium chloride aqueous solution in tank **410**, and all subsequent sequential tanks **420**, **430** and **440**, is about 1.40 to about 1.50 which is greater than all of the thermoplastic components but less than that of the copper component. The viscosity of the calcium chloride aqueous solution is low, for example less than about 10 centipoise. The sides of tank **410** have an angle sufficient to prevent buildup of any copper solids and the flow rate throughout the tank is slow and generally free of any turbulence so that quiescent separation is achieved. That is, generally there is a small velocity component in the horizontal direction with a greater velocity flow component in either vertical direction. After a desired residence time to permit good specific gravity separation, the copper-rich particles or stream are emitted from the bottom of tank **410** in the form of a slurry which is transferred to conventional purification unit **470**. Any conventional purification unit can be utilized such as a concentrating table, e.g. a Deister or a Wilfley table, generally of a rectangular shape and tilted towards one corner so the copper particles are directed thereto and collected. The remaining thermoplastic domain particles of nylon, PVC and polyethylene either flow out of the top of the tank as through a weir or are skimmed off and fed to second dispersion mixer **425**. The second dispersion mixer is desirably the same as the first mixer and thus has two radial flow zones for breaking up and separating various agglomerated particles which are primarily a thermoplastic. The various thermoplastic component particles are then fed to a second hydrogravity separation tank **420**, and desirably to a middle or lower portion side inlet thereof.

[0066] Tank **420** preferably contains the same specific gravity aqueous solution as first separation tank **410** and in all aspects is desirably the same as first tank **410**. In other words, the structure, flow, etc., can be a duplicate of the first hydrogravity separation tank. Thus, additional settled copper particles from the bottom of tank **420** are fed to purification unit **470** and the remaining floating particles are either skimmed or flow to third dispersion mixer **435** which is desirably the same as first dispersion mixer **415** and has multiple axial mixing zones, and multiple dispersion zones which further break up agglomerates.

[0067] In a similar manner, the system and process can be repeated any number of desirable times until essentially all of the copper component has been removed from the hydrogravity separation tanks which all contain essentially the same structure and conditions as well as the same specific gravity aqueous solution as first tank **410**, with the remaining thermoplastic particles being removed from the top of the tank and passed through a mixer having the same structure and conditions as first dispersion mixer **415** and then transferred to a succeeding tank. In the embodiment shown in FIG. 1, a total of four tanks are utilized including third hydrogravity separation tank **430**, fourth dispersion mixer **445**, and fourth hydrogravity separation tank **440**.

[0068] The specific gravity solutions in any unit operation or stage purification of particles of a selective feedstock component are stored so that they can be subsequently reused or recycled. Thus, after use of a long period of time

such as a week, a few weeks, a month, or several months, any specific gravity solution utilize in any purification stage of purification of various feedstock components can be cleansed as by filtration or clarification, and subsequently stored in the tank until needed and then reused.

[0069] In accordance with the concepts of the present invention, inasmuch as only copper was removed from the first operation stage, the remaining thermoplastic components are purified in that they are subjected to a plurality of dispersion mixers and hydrogravity separation tanks and contain very little, if any, remaining copper particles therein.

[0070] After the last tank or mixer of the copper separation stage, the aqueous slurry is fed to dewaterer 460 to remove the high specific gravity aqueous solution from the plastic particles and the solution returned to tank 410 (not shown) so that no significant amount thereof is sent to the second purification or operation stage which would alter the specific gravity of the subsequent stage and potentially have a detrimental effect thereon. Generally any conventional dryer or dewaterer 460 can be utilized such as a vibration screen, or a centrifuge dryer, with a spin dryer such as a Gala 3016 dryer manufactured by Gala Corporation being suitable.

[0071] The utilization of the above system and process with regard to a copper cable can result in a yield of generally at least 90%, desirably at least about 95% and preferably at least about 98% or about 99% percent by weight from copper purification unit 470 based upon the total weight of copper added to first separation tank 410. The purity of copper from purification unit 470, which separates thermoplastic particles from the copper, is generally at least about 80%, desirably at least about 90%, and preferably at least about 95% or at least about 98% by weight based upon the total weight of material collected.

[0072] Considering the second operation stage of the system and process of the present invention, the purified thermoplastic particles obtained from the first stage or operation are fed to a plurality of a dispersion mixer and subsequent hydrogravity separation tank units desirably in accordance with the concepts, principles, structure and the description set forth hereinabove and for the sake of brevity will not be repeated. However, the same is hereby fully incorporated by reference with regard to all aspects thereon such as to the structure, shape, flow conditions of the various hydrogravity tanks, the type of dispersion mixers which utilize a plurality of zones having at least one axial flow zone and at least radial dispersion zone.

[0073] In the second operation stage of the reclaiming system and process, PVC is purified by collecting it from the bottom of each tank and feeding it to a sequence of dispersion mixers and hydrogravity separation tanks (i.e. recycled). Any remaining domain thermoplastics such as polyethylene and nylon float to the top and are removed from each tank.

[0074] With respect to the three thermoplastic components derived from a copper cable, the PVC component has the highest specific gravity with nylon having a lower specific gravity and polyethylene the lowest. Accordingly, the specific gravity of each tank within the second operation stage is approximately the same and is about 1.15 to about 1.2 which is slightly lighter than the PVC but heavier than the polyethylene and the nylon. The thermoplastic particles

from the dewaterer 460 are thus fed to dispersion mixer 515 where they pass through different mixing zones separated by an annulus and are subjected to a dispersion impeller whereby an agglomerates of any of the three thermoplastic components are substantially broken into separate and individual thermoplastic particles. The thermoplastic particles are then fed to quiescent hydrogravity tank 510 which have walls of non-repose and non-turbulent flow conditions with adequate residence times such that the various particles can separate from one another and subsequently the lighter polyethylene and nylon are collected from the top of tank 510 and directly fed to the third operation stage. The polyvinyl chloride particles are collected from the bottom of first tank 510, fed to second dispersion mixer 525 where they pass through different mixing zones and are subjected to a dispersion impeller whereby any agglomerates are substantially broken into individual thermoplastic particles. The particles are then fed generally to the middle portion of second hydrogravity tank 520 wherein the separation (recycling) process is repeated. Thus, the lighter polyethylene and nylon particles float to the top and flow out of or are skimmed off the top of second tank 520 are then directly fed to the third operation stage. Any remaining PVC particles settle out of the bottom of second tank 520 and are fed to third dispersion mixer 535, and then to third hydrogravity tank 530 for further separation. Once again, in a manner as described hereinabove, the polyethylene and nylon particles are separated and collected from the top of tank 530 and fed directly to the third operation stage. The PVC particles are collected from bottom of tank 530 and fed to fourth dispersion mixer 545 wherein agglomerates are severed and broken apart and fed to generally the middle of fourth hydrogravity separation tank 540. The fourth and last tank once again permits any remaining polyethylene and nylon particles to be directly fed to the third operation stage. The PVC thermoplastic polymers which are collected from the bottom of fourth separation tank 540 are washed and dried in any conventional manner as a fluid bed, a screen, or a centrifuge 550, with the above noted Gala spin dryer being preferred. The PVC component particles are then bagged, etc. and placed in storage unit 560 for subsequent reuse and/or sale. The aqueous solution from dryer 550 is then recycled desirably to first hydrogravity tank 510.

[0075] In the third unit operation or stage, the thermoplastic components of nylon and polyethylene particles from the second unit operation are fed to first dispersion mixer 615 and then to hydrogravity separation tank 610. As with the prior two purification operations, the component which is desired to be cleaned or purified is recycled to a second dispersion mixer and tank, then to a third dispersion mixer and tank, and then to a fourth dispersion mixer and hydrogravity separation tank. Multiple stages of hydrogravity separation improve product purity. The remaining thermoplastic polyethylene component can be directly collected and dried as for reuse and/or resale. Alternatively, the polyethylene can be subjected to a plurality of a combination of a mixer and hydrogravity tank (i.e. a fourth stage) to improve the purity thereof. Once again, with respect to the overall system and process of the third and/or optional fourth units of operation, the concepts, principles, structures, and description as set forth hereinabove with regard to the mixers, the hydrogravity tanks, and the like are hereby fully incorporated by reference and hence will not be repeated.

[0076] Thus, by way of quick summary, the feed stream from the end of the second operation stage is fed to first dispersion mixer **615** wherein any agglomerated particles are substantially broken apart with the slurry then being fed to first hydrogravity separation tank **610** wherein the heavier nylon particles settle to the bottom of the tank and are collected, washed, and directly fed to nylon dryer **650**. The specific gravity of the aqueous solution of all of the tanks of the third stage operation are all essentially the same and are all slightly less than the specific gravity of nylon and hence is approximately 1.0. Thus, as with the first and second operation stages, if any or a small amount of a thermoplastic component is contained with the heaviest component or an agglomerated particle containing more than one domain, it will float to the top whereupon it is de-agglomerated and fed to a subsequent tank, and so forth until all of the heaviest component has been removed therefrom. Accordingly, the particles which float to the top of first tank **610** are fed to second mixer **625** where agglomerated particles are broken apart, added to second hydrogravity separation tank **620** with the nylon collected from the bottom thereof and fed directly to nylon dryer **650** and the remaining floating polyethylene particles fed to third mixer **635**. The process is once again repeated purifying the polyethylene particles by collecting the heavy nylon particles from the bottom of tank **630** and further breaking any agglomerated floating particles by feeding them to mixer **645**. Finally, any remaining nylon particles are collected from the bottom of tank **640**, washed, and dried in nylon dryer **650** with the remaining particles which float being purified polyethylene particles which are washed, and fed to polyethylene dryer **660**. Both nylon dryer **650** and polyethylene dryer **660**, as before, can be any conventional dryer such as a centrifuge dryer, vibrating screen with a spin dryer such as a Gala dryer being preferred. The separate dried nylon particles can be collected in storage unit **670** for subsequent use and/or sale. The polyethylene particles can also be dried and placed in storage unit **680** for subsequent use and/or sale. As before, the collected aqueous solution from dryers **650** and **660** are recycled to hydrogravity **610** to replenish the aqueous solution thereof.

[0077] With regard to any unit operation concerning separation of particles and preferably only particles of one feed stock component, the particles can be collected and stored as shown in **FIG. 1**. Alternatively, either before or after storage they can be fed to a suitable melt mixing device such as an extruder, and subsequently pelletized for use as such. Melt mixing devices and various extruders, melt filters, and pelletizers are well known to the art and to the literature.

[0078] The above described system and process will be better understood by reference to the following example which serves to illustrate but not to limit the present invention.

[0079] With respect to reclamation of a copper cable containing 1,000 lbs. by weight of feedstock, and according to the format generally described hereinabove and shown in **FIG. 1**, 995 lbs. of feed stock was obtained from granulator **120** with the remaining 5 lbs. being recovered as fines. Depending upon the amount of wire in the cable feedstock, the amount of copper recovered from first operation stage **400** can range from about 10 lbs. to about 150 lbs. with the purity of the copper being generally at least about 80%, at least about 90%, or at least about 95% by weight, and preferably at least about 98% or at least about 99% by

weight. The recovery of the PVC from the second operation stage **500** can range from about 750 to about 975 lbs. with the purity of the PVC being at least about 85% to at least about 90% or, desirably at least 95% by weight, and preferably at least about 98% or at least about 99% by weight of the total weight of the collected PVC stream.

[0080] The amount of the nylon and polyethylene being recovered from the third operation stage **600** each can independently vary from about 5 lbs. to about 100 lbs. based upon the total weight of both components with the purity of each component being at least 85% or at least about 90% by weight, desirably at least about 95% by weight, and preferably at least about 98% or at least about 99% by weight.

[0081] Generally, the system and process of the present invention readily recovers at least about 95%, desirably at least about 98%, and preferably at least about 99% by weight of the initial feedstock.

[0082] If desired, each of the above reclaimed component particles of copper, PVC, polyethylene, and nylon can be further purified by other methods known to the art and to the literature if so desired.

[0083] While the above invention has been described with regard to a copper cable feed stock, it is understood that generally any type of solid feed stocks containing separate domains which are not melt blended, can be utilized including feedstock containing various metals such as aluminum cable, etc.

[0084] While in accordance with the Patent Statutes, the best mode and preferred embodiments have been set forth, the scope of the invention is not limited thereto, but rather by the scope of the attached claims.

What is claimed is:

1. A process for purifying a selected feedstock component, comprising the steps of:
 - a) mixing particles of a feedstock comprising a plurality of components, each component having a different specific gravity;
 - b) feeding said mixed feedstock component particles to a first hydrogravity tank containing a solution having a specific gravity intermediate to one or more heavier feedstock component particles and to one or more lighter feedstock component particles and causing said particles of at least one feedstock component to either sink or float;
 - c) removing selected specific gravity component particles from said hydrogravity tank;
 - d) mixing said removed selected component particles;
 - e) feeding said removed mixed selected component particles to another hydrogravity separation tank containing a solution having substantially the same specific gravity as said first tank solution; and
 - f) removing said selected component particles from said second hydrogravity tank.
2. A process according to claim 1, wherein said feedstock comprises at least three components, and
 - wherein said selected specific gravity component particles are substantially of a single feedstock component.

3. A process according to claim 2, wherein each particle comprises substantially a single component, and including mixing said selected component particles from said second hydrogravity tank and feeding to a third hydrogravity separation tank containing a solution having substantially the same specific gravity as said first tank solution.

4. A process according to claim 3, wherein a mixer for mixing said feedstock component particles exists before each said hydrogravity separation tank;

wherein said feedstock component particles are fed into the side of each said hydrogravity separation tank, wherein the number of separation tanks is from about 2 to about 8, wherein the specific gravity of said at least one different feedstock component particles is at least 0.1 specific gravity units different than the specific gravity solution in each said tank, and

wherein each said hydrogravity solution is substantially free of a phosphorus containing compound.

5. A process according to claim 1, wherein said hydrogravity solution is an aqueous solution.

6. A process according to claim 4, wherein said hydrogravity solution is an aqueous solution.

7. A process according to claim 1, wherein each said mixer has at least one substantially axial flow zone and at least one substantially radial flow zone.

8. A process according to claim 6, wherein each said mixer has at least one substantially axial flow zones and at least one substantially radial flow zones.

9. A process according to claim 1, wherein said feedstock comprises at least three different feedstock components including at least one plastic component and at least one metal component, or at least three different plastic components, or at least two different plastic components and a wood component, or at least two different plastic components and a cellulose component.

10. A process according to claim 6, wherein said feedstock comprises at least three different feedstock components including at least one plastic component and at least one metal component, or at least three different plastic components, or at least two different plastic components and a wood component, or at least two different plastic components and a cellulose component.

11. A process according to claim 1, wherein said feedstock components are derived from copper cables, aluminum cables, or combinations thereof.

12. A process according to claim 6, wherein said feedstock components are derived from copper cables, aluminum cables, or combinations thereof.

13. A process according to claim 1, including purifying said non-selected specific gravity feedstock component particles by feeding said particles to at least one of a tandem comprising a mixer and a subsequent hydrogravity tank having an aqueous solution of a specific gravity such that one of said remaining non-selected specific gravity feedstock component particles is separated.

14. A process according to claim 6, including purifying said non-selected specific gravity feedstock component particles by feeding said particles to at least one of a tandem comprising a mixer and a subsequent hydrogravity tank having an aqueous solution of a specific gravity such that one of said remaining non-selected specific gravity feedstock component particles is separated.

15. A hydrogravity process for reclaiming particles of a ground feedstock, comprising the steps of:

feeding particles of a ground feedstock containing a plurality of different components each having a different specific gravity to a first hydrogravity separation tank, said tank having substantially a phosphorus-free aqueous solution of a specific gravity greater or less than the specific gravity of at least one component of said feedstock particles;

removing particles of either at least one lighter specific gravity component or at least one heavier specific gravity component than the specific gravity of said aqueous solution;

subsequently feeding said selected removed lighter or heavier component particles to a second hydrogravity separation tank having substantially the same specific gravity of said substantially phosphorus-free aqueous solution as said first tank; and

purifying said selected removed component particles by separating said selected lighter or heavier component particles from any other different specific gravity component particles of said feedstock.

16. A hydrogravity process for reclaiming particles of a ground feedstock according to claim 15, including a mixer before at least one of said hydrogravity tanks for mixing said particles of said selected removed lighter or heavier feedstock components,

wherein said selected removed lighter or heavier component are particles of substantially a single feedstock component, and

wherein the amount of any phosphorus containing salt is less than about 3% by weight of said aqueous solution.

17. A hydrogravity process for reclaiming particles of a ground feedstock according to claim 16, including a mixer before each hydrogravity tank, mixing said particles of said selected component and feeding said particles into the side of each hydrogravity tank.

18. A hydrogravity process for reclaiming particles of a ground feedstock according to claim 17, wherein said feedstock comprises a total of at least three different feedstock components comprising at least one plastic component and at least one metal component, or at least three different plastic components, or at least two different plastic components and a wood component, or at least two different plastic components. and a cellulose component.

19. A hydrogravity process for reclaiming particles of a ground feedstock according to claim 18, including purifying said non-selected specific gravity component particles by feeding said particles to at least one of a tandem comprising a mixer and a subsequent hydrogravity tank having an aqueous solution of a specific gravity such that one of said remaining non-selected specific gravity feedstock component particles is separated.

20. A hydrogravity process for reclaiming particles of a ground feedstock according to claim 19, wherein said aqueous solution comprises a salt of an alkali metal, an alkaline earth metal, a transition metal from groups 3 through 15 of the Periodic Table other than phosphorus, and an anion comprising a halogen, oxygen or an oxygen-containing compound, hydroxide, carbonate, a nitrogen-containing compound, or a sulfur-containing compound; or wherein

said aqueous solution is a drilling fluid, or a completion fluid, or an aqueous suspension.

21. A hydrogravity process for reclaiming particles of a ground feedstock according to claim 17, wherein said aqueous solution comprises potassium carbonate, zinc chloride, ferric chloride, ferrous chloride, calcium chloride, calcium bromide, calcium sulfate, zinc chloride, zinc bromide, zinc sulfate, zinc oxide, sodium hydroxide, sodium zincate, magnesium chloride, or a polytungstate complex, or mixtures thereof.

22. A hydrogravity process for reclaiming particles of a ground feedstock according to claim 20, wherein said aqueous solution comprises potassium carbonate, zinc chloride, ferric chloride, ferrous chloride, calcium chloride, calcium bromide, calcium sulfate, zinc chloride, zinc bromide, zinc sulfate, zinc oxide, sodium hydroxide, sodium zincate, magnesium chloride, or a polytungstate complex, or mixtures thereof.

23. A hydrogravity process for reclaiming particles of a ground feedstock according to claim 19, wherein each said mixer has at least two substantially axial flow zones and at least two substantially radial flow zones.

24. A hydrogravity process for reclaiming particles of a ground feedstock according to claim 15, wherein said feedstock components are derived from copper cables, aluminum cables, or combinations thereof.

25. A system for reclaiming particles of a ground feedstock comprising:

- a) a first set of at least one mixer and a plurality of hydrogravity separation tanks each containing a substantially phosphorus-free aqueous solution having substantially the same specific gravity for separating particles of one component of said ground feedstock containing at least three different components, each aqueous solution having a specific gravity which is either greater or less than the particles of a single selected component of said feedstock components, each said feedstock component having a different specific gravity;

said mixer located at least before one of said hydrogravity separation tanks for mixing said particles of said feedstock components before said components are fed to said at least one hydrogravity separation tank,

- b) a second set of at least one mixer and a plurality of hydrogravity separation tanks for further separating a single selected remaining component of said feedstock components, said at least one mixer of said second set located before a hydrogravity separation tank for mixing said particles of said feedstock components before they are fed to at least one said second set hydrogravity

separation tank, each said second set tank having a substantially phosphorus-free aqueous solution of substantially the same specific gravity but which is different than the specific gravity of said first aqueous solution, and is greater or less than only said single selected remaining component of said feedstock so that said second set aqueous solution is capable of separating said second selected component from the remaining feedstock components.

26. A system according to claim 25, wherein in each said set of said mixers and said tanks, independently, the number of mixers and mixing tanks is each from about 3 to about 10.

27. A system according to claim 26, wherein said solution, independently, in each said set of hydrogravity separation tanks is a phosphorus free compound comprising a salt of an alkali metal, an alkaline earth metal, a transition metal from groups 3 through 15 other than phosphorus of the Periodic Table, and an anion comprising a halogen, oxygen or an oxygen-containing compound, hydroxide, carbonate, a nitrogen-containing compound, or a sulfur-containing compound; or wherein said aqueous solution is a drilling fluid, or a completion fluid, or a suspension.

28. A system according to claim 27, including in each set a mixer before each said hydrogravity separation tank, and wherein, independently, the number of mixers and tanks in each said set is at least two, and wherein the amount of any phosphorus containing compound is less than about 3% by weight of said aqueous solution of said first set and said second set.

29. A system according to claim 28, wherein said hydrogravity aqueous solution comprises potassium carbonate, zinc chloride, ferric chloride, ferrous chloride, calcium chloride, calcium bromide, calcium sulfate, zinc chloride, zinc bromide, zinc sulfate, zinc oxide, sodium hydroxide, sodium zincate, magnesium chloride, or a polytungstate complex, or mixtures thereof.

30. A system according to claim 29, wherein said feedstock comprises a total of at least three different feedstock components comprising at least one plastic component and at least one metal component, or at least three different plastic components, or at least two different plastic components and a wood component, or at least two different plastic components and a cellulose component.

31. A system according to claim 25, wherein said feedstock is derived from copper wire cable, aluminum wire cable, or combinations thereof.

32. A system according to claim 30, wherein said feedstock is derived from copper wire cable, aluminum wire cable, or combinations thereof.

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