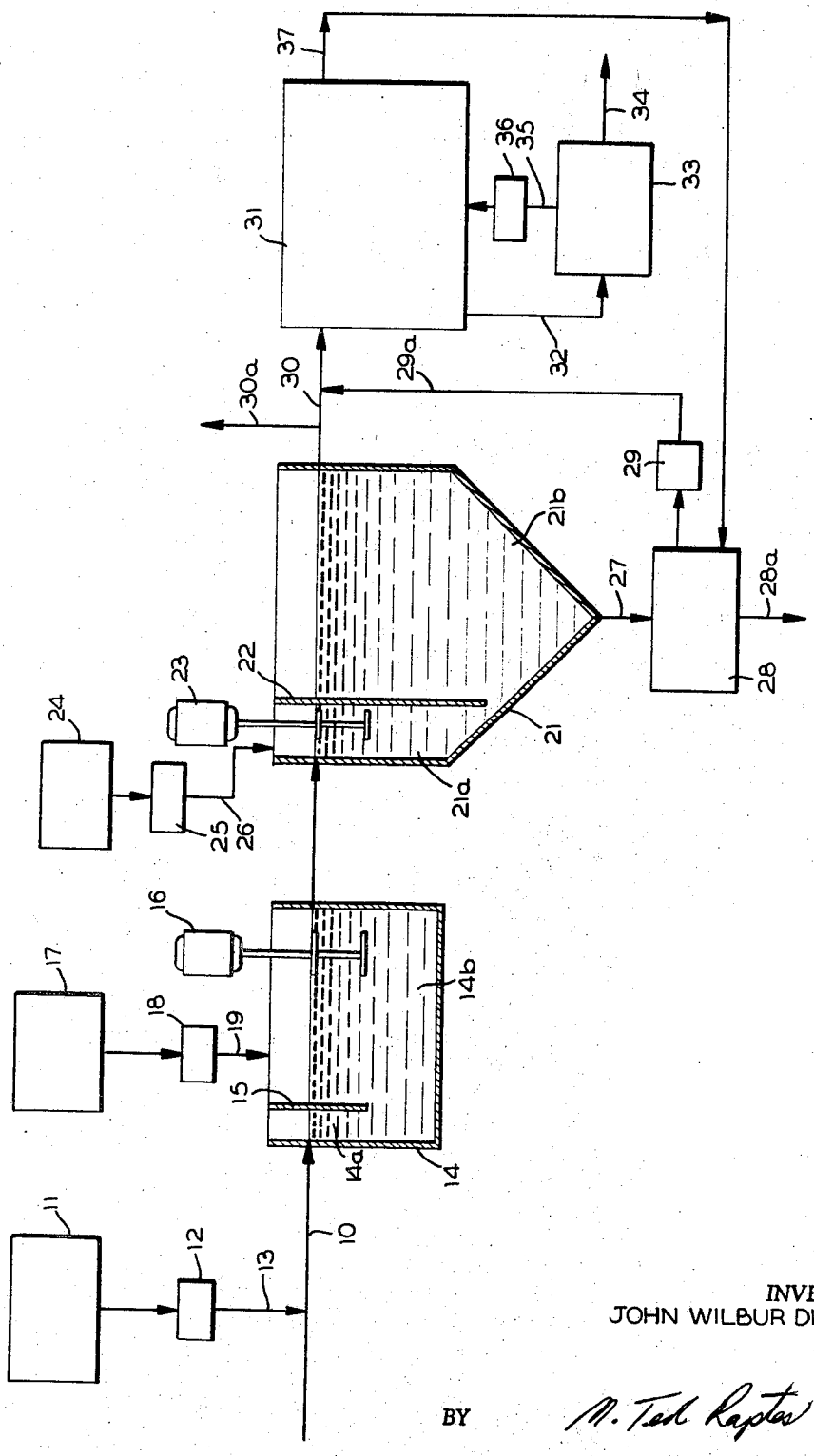
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PROCESS OF TREATING COAL MINE ACID DRAININGS

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INVENTOR
JOHN WILBUR DIXON

BY M. Ted Raptes

ATTORNEY

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PROCESS OF TREATING COAL MINE ACID DRAININGS

John Wilbur Dixon, 541 Pine St., Johnstown, Pa. 15902

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This invention relates to a process for the neutralization of coal mine acid drainings. More particularly, the invention relates to ion-exchange treatment of coal mine acid drainings to produce a mine discharge which will not pollute streams and rivers.

In recent years, serious pollution problems have arisen from the discharging of coal mine acid drainings directly into rivers and streams. The drainings are derived from surface waters that filter down through the earth and into coal seams. The waters dissolve many of the materials contacted such as the sulfur and iron pyrites in the coal. Thereafter, through chemical phenomenon, such as oxidation, sulfuric acid and salts thereof are formed in the waters. The acid-laden waters are normally removed from the mines and discharged into nearby streams. Generally, streams are considered polluted when they are saturated with drainings to a point that all alkalinity of the stream has been exhausted. A stream or sector thereof is usually considered to be impregnated with drainings when the waters thereof are generally mixed to a degree that they have a pH value of 4.0 or less at practically all times and throughout the stream.

The streams and rivers receiving the mine drainings from various sources become polluted thereby and this creates a condition against the public interest. In accordance with this invention, a process is provided for treating and neutralizing the mine drainings to overcome the pollution problem.

Accordingly, an object of this invention is to provide a flexible process for treating mine drainings in order that drainings of various acid strength and volume may be treated.

Another object of this invention is to provide a process for treating mine drainings by economical ion-exchange procedures.

Another object of this invention is to provide a process using ion-exchange procedures for treating mine drainings whereby the resultant treated discharge will meet the requirements set forth by various regulatory agencies with respect to preventing pollution of streams and rivers.

Another object of this invention is to provide a process for treating mine drainings by the controlled addition of cationic and anionic electroyltic polymers as ion-exchange materials.

The mine drainings and waste are considered acidic in character when they contain mineral acids and/or salts to the extent that the total acidity, determined by the hot method using phenolphthalein indicator, exceeds the total alkalinity, determined to the bromphenol blue end point, at pH 4.0

The mine drainings are treated by this invention by controlled addition of cationic and anionic ion exchange resins in a particular sequence of steps.

Referring now to the drawing, the procedure of the invention will be described in a particular apparatus embodiment.

Influent coal mine acid drainings enter the treating apparatus through inlet line **10** to a mixing tank **14** containing a baffle **15** and mixing device **16**. A cationic polymer of suitable viscosity is contained in tank **11** and controlled additions thereof are metered through a metering device **12** and through line **13** into the drainings passing through line **10**. The mixture of cationic polymer and the drainings enter the baffled zone **14***a* of mixing

tank **14**. A base material such as sodium carbonate is contained in tank **17** and controlled additions thereof are metered through a metering device **18** and through line **19** into zone **14***b* of tank **14**. The total mixture is agitated by mixing device **16**.

The mixture of drainings, cationic polymer, and base material are passed through line **20** to a settling tank **21** containing a baffle **22** and enter zone **21***a* thereof. An anion-exchange polymer is contained in tank **24** and controlled additions thereof are metered through a metering device **25** and through line **26**. Zone **21***a* is provided with a mixing device **23**. The mixture in zone **21***a* contains a precipitate which begins to settle towards drain **27**. The clarified water passes into zone **21***b*. Concentrated floc material passes through drain **27** into a filter means **28** to be dewatered. The filtrate from dewatered floc is pumped through pump **29** through line **29***a* to line **30**. The dewatered floc is removed through line **28***a* and passed to land fill or disposed of by other conventional means.

The supernatant liquid flows from the top of tank **21** through line **30**. The effluent is in a treated state that it may be discharged into streams and rivers through line **30***a* without causing pollution. However, if a potable water is desired, portions of the effluent in line **30** may be passed to an aerated filter means **31**. The filter means may contain sand and charcoal or coke. Passage therethrough removes residual iron and reduces the sulfate content. Potable water is obtained through line **32** and is stored in tank **33**, to be removed for use when desired through line **34**. Backwashing of the aerated filter means may be accomplished by pumping water by means of pump **36** from tank **33** through line **35** into the filter means **31**. Backwash drain effluent is removed through line **37** which is passed to filter **28**, for the removal of floc picked up by the backwashing operation.

The foregoing is a description generally of the procedure and apparatus of the invention. Specifically, the materials used and the effects thereof in the treatment of the drainings will now be set forth.

With respect to the treatment of the drainings, the cationic exchange resin has a high exchange capacity by its abilty to solubilize and disperse itself throughout the drainings. The amount of cationic exchange resin to be used is generally about ½ to 3 parts per million of the drainings. This amount effectively removes the maganese compounds, soluble iron, etc., from the drainings.

Although there are a variety of synthetic cationic electrolytic polymers commercially available which would be suitable, those supplied as viscous liquids are particularly suitable for this invention. These materials are polyelectrolytes which act as coagulant aids which influence the growth rate of the floc produced and produces a larger floc than is possible with normal coagulants. Particularly suitable is one sold commercially as "Coagulant Aid No. 223" which is supplied by Hagan Chemicals & Controls, Inc. of Pittsburgh, Pa. The viscosity thereof as used is 270 centipoises at 25° C., 12 r.p.m. as determined by the Brookfield procedure. The material is highly alkaline and has a pH of about 12.0. In more dilute solutions, the viscosity does not differ from that of water. The cationic material is diluted to a very low concentration in water for feeding purposes in controlled dosages to the drainings and the degree of concentration is variable dependent on the degree of treatment desired, and the strength of the draining being treated.

It is to be pointed out that the particular point of addition of the cationic material is critical and should be added to the drainings prior to their introduction into the mixing tank wherein the base material is added. In this manner, the colloidal particles contained in the drainings are thought to be absorbed into the cationic material along with suspended solids.

The next step of the procedure is the precipitation of the colloidal particles and suspended solids treated with the cationic material. A base material is added in an amount sufficient to react with the sulfuric acid contained in the drainings. Particularly suitable is sodium carbonate or sodium bicarbonate which will neutralize the acid and the resulting solution is essentially neutral. The salts formed are precipitates which add to the floc of the cationic material. The mixture is agitated and passed to a settling tank.

In the settling tank, an anionic electrolytic polymer is added which acts as a weighting agent to add enough weight to the floc formation and precipitate so that it will settle rapidly and clarify the water. Various anionic polyelectrolytes are available commercially which are suitable. These polyelectrolytes act as sludge conditioners and are usually supplied as a flake-like material. The material is dissolved in water for feeding purposes and the feed solutions are quite viscous and those solutions containing about 0.3% by weight (about 1 p.p.m.) of the material are generally preferred for this invention. A particularly suitable anionic polyelectrolytic material is "Calgon" ST 269 supplied by The Calgon Corporation of Pittsburgh, Pa. The material has a Brookfield viscosity of 100 centipoises, 12 r.p.m. at 25° C. in a 0.2% solution.

In accordance with this invention coal mine acid drainings which had the following analysis were treated:

pH		2.9
Acidity (hot method test)	p.p.m.	1040
Ferric ion	do	140
Sulfate ion	do	1110
Electric conductivity test		1840

Four samples of the drainings were separately treated according to the procedures outlined heretofore and the resulting effluent water of each sample analyzed as follows:

Sample No.	Ferric ion	Sulfate ion
1	1.4	780
2	0.7	980
3	0.9	1080
4	0.7	1070

The hot acidity of each sample was 0 and the pH was about 7.9. The "hot acidity" referred to is a standard test for testing acidity of waters, and the procedure therefor is set forth in "Standard Methods" Water and Waste Water, eleventh edition, 1960, pp. 42, 43.

It is to be understood that modifications will occur to those skilled in the art upon reading the foregoing description. All such modifications are intended to be included within the scope of the invention as defined by the appended claims.

What is claimed is:

1. A continuous process of treating coal mine acid drainings which comprises mixing therewith a cationic electrolytic polymer diluted to a viscosity substantially equal to that of the drainings, thereafter agitating said mixture with a base material, adding an anionic electrolytic polymer to said mixture of drainings, cationic polymer and base material, removing precipitated material from said mixture to thereby obtain neutralized drainings suitable for discharge into streams and rivers whereby no pollution thereof results.

2. The process of claim 1 wherein said base material is sodium carbonate.

3. The process of claim 1 wherein said base material is sodium bicarbonate.

4. The process of claim 1 wherein said cationic polymer is mixed with said drainings in an amount of about ½ to 3 parts per million of said drainings.

5. The process of claim 1 wherein said anionic polymer is added as a solution containing about 1 p.p.m. of polymer.

6. The process of claim 1 wherein said base material is added in amounts sufficient to neutralize the acid content of said drainings.

7. The process of claim 1 wherein said neutralized drainings are further treated in an aerated filter means to obtain potable water.

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MICHAEL E. ROGERS, *Primary Examiner.*