Overview

New patented and patent pending processes devoloped by HPT Research, Inc. provide viable economic and enviromental solutions to the myriad of problems associated with AMD treatment. The ***Ionic State Modification Process (ISM)*** consistently removes high concentrations of heavy metals to near or below detectable limits in acid drainage waters.

Numerous tests conducted on AMD from the Iron Mountain Mine and Leviathan Mine in Northern California reduced metal concentrations to non-detectable levels. Similar results were attained from exhaustive tests conducted on AMD from the Berkeley Pit in Butte, Montana. The Butte tests were funded through the EPA's New Innovative Technology Program.

The HPT process has several unique ***Features, Advantages and Benefits*** that place it in the forefront of new AMD treatment technology:

The process -

- extracts all of the heavy metals while producing a relatively small volume of a metal hydroxide sludge.
- produces a pure anhydrous calcium sulfate void of any metal contamination with potential value as an agricultural soil amendment or for safe on-site disposal.
- has the capability of reducing sulfates in the final effluent to extremely low ppm levels
- produces a final effluent of a quality that will easily meet discharge limits. Frequently, the final effluent quality meets or exceeds Federal Drinking Water Standards.
- generates the majority of the required raw material treatment additive directly from the acid influent stream. In other words, it manufactures a specific compound from the AMD that is then re-injected to perpetuate the metals separation process.

AMD Treatment Process

The HPT process used for AMD treatment relies upon recently developed technology that provides the means of altering the chemical and physical properties of metal contaminants within aqueous solutions. What is described will not be found in college chemistry books or industrial wastewater treatment manuals. It has only existed for a short period of time and is just now (Summer/Fall of 1999) being introduced to the treatment and remediation industry.

The flow diagram shown is a generic representation of AMD treatment process. Because each AMD site differs in the types and concentrations of contaminants, pH values, concentration of sulfates, and alkaline metals and other physical and chemical chracteristics, it is often necessary to alter the number of treatment components to address individual waste stream characteristics. This diagram represents the basic components and configuration necessary to treat the majority of AMD sites.

Stage 1

As depicted in the diagram, the process is initiated when a proprietary chemical additive is injected into the raw influent. This additive is crucial in setting the stage for the next sequence of reactions which occur within the Ionic State Modification (ISM) Reactor. The reactor is the heart of the process. The electrodes within the ISM Reactor are surrounded by unique patented magnets capable of producing exceptionally strong, focused magnetic fields. As DC current is applied to the electrodes, the combined forces have the ability of modifying the ionic composition of targeted metal ions within the waste stream. The reaction causes these targeted contaminant materials to either be reduced or oxidized to a chemical state that allows them to precipitate using conventional precipitation chemistry.

Following treatment in the ISM Reactor, the waste stream flows to the first clairifier (#1 Clarifier) for the removal of metal contaminants. A polymer flocculent is injected which causes the charged particles to agglomerate (gather in large pieces) and precipitate to the bottom while allowing the treated solution to flow to the next step of the process. A unique feature of this first stage of the treatment process is that only the targeted metals are removed providing a highly effective means of separating the toxic materials from the other naturally occurring compounds found in the water.

At periodic intervals, the metal hydroxide sludge is evacuated from the bottom of the clarifier and further processed via a filter press or other dewatering device in an effort to reduce total volume and produce a relatively dry sludge cake. The filtrate produced by this process is directed back to the headworks for reprocessing in the the Stage I components. By targeting the removal of specific metal compounds in the Stage I process, the total volume of metal hydroxide sludge is greatly reduced dramatically decreasing disposal costs.

Stage 2

Following processing in Stage 1, the waste stream is directed to the second clarification process (#2 Clarifier) for sulfate reduction. Another base additive is injected which causes the sulfates to precipitate. Again, the precipitant is evacuated from the bottom of the clarifier in the form of an anhydrous calcium sulfate void of any heavy metal contamination. The calcium sulfate produced by this process is very unique insofar as it exhibits a completly different crystalline structure than ordinary gypsum and contains no water molecules compared to common gypsum which contains two.

The clarified effluent produced in the Stage 2 process is directed to a storage and distribution tank. The clarified solution is extremely unique in its physical and chemical properties and does not naturally exist in this stable form. This material and the process of its manufacture have been patented by HPT Research, Inc. Basically, it is a pure hydroxide. It displays an exceptionally high pH but without the normal corrosivity associated with hydroxide solutions. As depicted on the diagram, a portion of this material is redirected back to the headworks and injected to the raw influent stream as the proprietary "A" base additive.

This one feature of the treatment process, i.e., **the ability to generate a major portion of the primary treatment additive from the waste stream,** is a major technological achievement that will have a profound influence on all future AMD treatment. No other treatment process is capable of "breeding" its own raw material additives.

The majority of the clarified solution produced in Stage 2 (that which is not redirected to the Stage I process) is subjected to a final pH neutralization process. This water is then considered the final treated effluent; void of any contamination, and for the most part, relatively low in sulfate levels. This treated effluent is safe for discharge to the environment or could possibly be used for other recycling applications.

Additional Discussion

- As previously mentioned, the flow diagram and the process description reflect the basic components used for AMD treatment. Because of the differences in contaminant levels and the complexity of the chemical compounding at individual AMD sites, it is often necessary to employ a series of ISM Reactors to effect complete removal of the contaminants. In some applications an additional sulfate removal component is utilized to achieve residual sulfate levels below 50 ppm in the final effluent.

No two AMD waste streams are the same. Specific treatment procedures must be formulated on an individual site basis. The process developed for the Iron Mountain AMD differs substantially from that which was used for Leviathan Mine and the Berkeley Pit. Numerous bench tests involving samples of AMD from throughout the West required slightly differing procedures to achieve complete contaminant removal.

- **Treatment Production Capabilities:**
  The AMD treatment process developed by HPT Research, Inc. is scaleable from small 5 to 10 gpm treatment units up to several million gallons per day. Large volume systems would utilize several 200 to 500 gpm units operating in parallel. Smaller systems (30 to 50 gpm) can be constructed in trailer vans or cargo containers for portability. Large production facilities would be constructed on site.

- **Power Requirements:** It is estimated that a system capable of operating at 50 gpm would require a 50 Kw, 440-volts 3-phase power. This would include the power for operation of multiple reactors, pumps, clarifier and sludge processing equipment.

- **Sludge Disposal:**The anhydrous calcium sulfate produced by the process is free of metal contamination and may have a value as an agricultural soil amendment. In some applications it may be possible to land apply the solids at the mining site. The metal hydroxide sludge, in some applications, may have some minor residual value as a recyclable material. Although it may not represent much value it may assist in offsetting freight disposal costs. An alternative would be to dispose of the material at a proper disposal site based upon the leaching characteristics of the solid cake. Preliminary leach tests of the metal hydroxide sludge indicated that for the most part they were insoluble. this determination can only be made on an individual sample analysis.

- **Third Party Testing:** All of the claims made by HPT Research, Inc. pertaining to the effectivenes of the AMD treatment process, the reductions in heavy metals, residual sulfate levels and the quality of the final processed effluent can be substantiated by third party testing. Extensive testing has been conducted by Lawrence Livermore National Laboratory, California State University Fresno and Montana Tech in Butte, Montana. Tests results are available to interested parties.