

PURIFICATION AND TREATMENT OF MINE DRAINAGE IN SOME MINE AREAS OF CHINA¹

by

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Abstract. The methods of purification and precipitation process of turbid mine water are discussed in the paper. The processes of water treatment are coagulation, precipitation, filtration and disinfection. According to each characteristic of water quality, different ways and technological processes of water treatment are carried out. Finally, the purification of mine drainages are shown through some practical examples with obvious environmental benefits.

Additional Key Words: turbidity, purification.

Introduction

Natural mine water (especially from Karst mineral deposit) is generally evaluated as a good quality groundwater, which is chemically dominated by HCO_3 or $\text{HCO}_3\text{-SO}_4$ and is characteristic of low mineralization and low hardness. However, mine water quality is getting worse because groundwater carries a large amount of mine dust and rock debris from wall rocks is flowing over mining areas during mining. Such mine drainage is characterized as muddy water with suspended matter and a high rate of bacterial reproduction; and, therefore it is necessary that the muddy water or contaminated water is purified and treated by some appropriate processes of water treatment in order to reuse it as a water supply.

Purification of Mine Drainage

In general, all the impurities in mine water are divided in suspended matters, colloids and dissolved matters. It is important that the suspended matters and colloidal impurities are removed from mine water by means of purified processes because these impurities are the primary sources of turbid mine water.

Suspended matters occurs by suspension in flowing water; however, they can be separated in still water as the heavy particles precipitate; but the light ones

suspended in still water. It is clear that colloidal particles are stable in waters; and they do not precipitate for a long period of time (even several years long). Waters appears turbid when it is reflected through sunshine. According to special properties of the suspended matters and colloids, the methods of purified treatment usually are coagulation, precipitation and disinfection.

1. Coagulation: Coagulation is a important process in water treatment technology. Coagulants should be put in muddy water (mine drainage) when purifying in reacting tank. Good coagulants to use are those that can create big coagulum in waters. They can bring about some good results such as good purification with no harmful effects. Also, the choice of coagulants depends on the specific water chemistry and water temperature. It is common to use two kinds of coagulants in the coagulation of mine water, some are aluminum coagulants, others are molysite coagulants; and, these coagulants contain $\text{Al}_2\text{SO}_4\cdot 18\text{H}_2\text{O}$, $\text{FeCl}_3\cdot 6\text{H}_2\text{O}$, $\text{FeSO}_4\cdot 7\text{H}_2\text{O}$, polymerized aluminum chloride and macromolecular flocculant. Among them, $\text{Al}_2\text{SO}_4\cdot 18\text{H}_2\text{O}$ is widely used in water treatment, the next is polymerized aluminum chloride.

To initiate mixing, coag ulants should be disposed upon the water to dissolve quickly. It is necessary that coagulants be mixed with water as soon as possible so that all the colloidal matters react uniformly with coagulants. At present, the mix processes with the aid of a water pump and piping are used in most water treatment plants in China. An amount of tiny floccule particles occur after coagulants are mixed with water rapidly. Floccules must be coacervated into certain size (0.6-1.0 mm), they should be fine-grained and solid particles so that they precipitate quickly. Many kinds of reacting tanks can be chosen but those such as partition board reacting tank, turbine reacting tank, mechanical

¹Paper presented at the 1998 National Meeting of the American Society for Surface Mining and Reclamation, St. Louis, Missouri, May 16-21, 1998.

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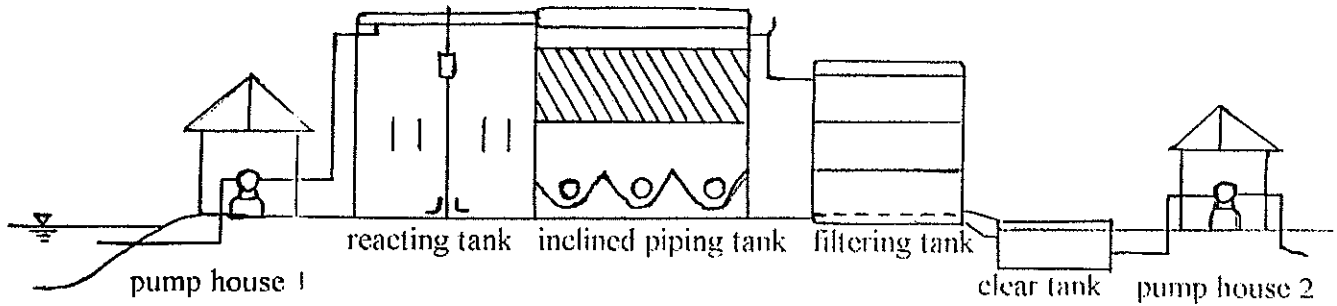


Fig. 1 Schematic diagram showing the purification process

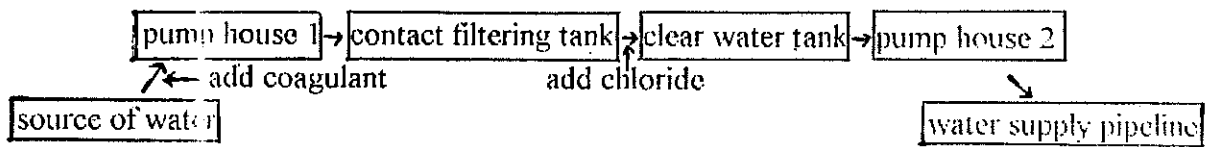


Fig. 2 Purification process of low turbidity water

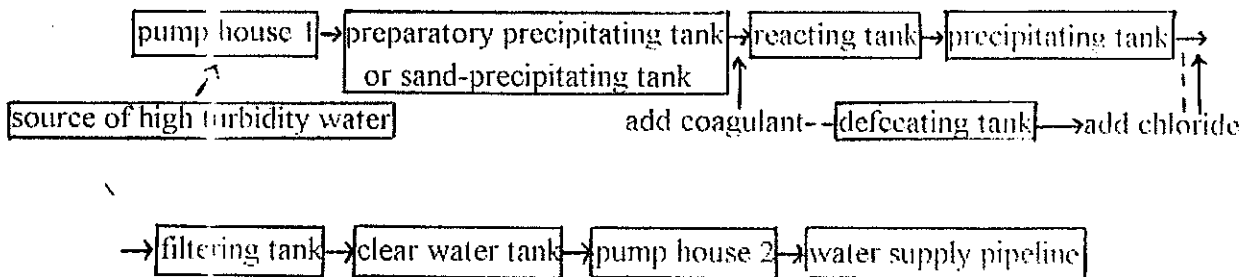


Fig. 3 Purification process of high turbidity water

reacting tank and folding-board reacting tank are widely used in the coagulation reaction.

2. Precipitation: Colloidal matters in water are coagulated into flocs and then they are removed in the precipitating tank after coagulants are mixed with water. At present, flat flow precipitating tanks, radial flow precipitating tanks, inclined board precipitating tanks and inclined piping tanks are used in most water treatment plants.

3. Filtration: Most of big flocule particles are removed after mine water is treated through coagulation and precipitation, and then water turbidity decreases. In order to improve water quality, a small amount of fine-grained impurities and bacterium should also be removed through filtration. The following kinds of filtering tanks are usually used when filtering in water treatment plants, they include: general fast-filtering tank, siphon filtering tank, no-valve filtering tank, shifting rinsing-cover filtering tank, and pressure filtering tank. What water can be filtered depends on the filtering mediums. Quartz sand and grains of anthracite as mediums most in use. Besides these mediums, plastic beads, ceramsite, grains of magnetite can be also used as filtering mediums.

4. Disinfection: The disinfection of mine water can be divided into physical processes and chemical processes. Physical processes include heating, ultraviolet rays and ultrasonic processes; chemical processes include chloride addition, heavy metal ion and other oxidizer processes. At present, the chloride addition is most in use, the treated water can be carried to water supply pipeline for resident use.

In addition, the softening or salt-removal and other water treatment methods can be used in the treatment of industrial water.

Technological Processes of Purification Treatment

According to drinking water standard, the selection of technological processes of mine water purification mainly depends on the specific water chemistry of mine water. It is necessary that chemical analysis of mine water should be carried out so that a reasonable method of purification and its technological process can be worked out.

In general, the technological process of water treatment is shown in Fig. 1 if mine water is treated as a drinking water supply. During this process, first, coagulants is added in mine water and then water is stirred by a water pump vane (wheel) so that coagulant is

mixed with the water. Secondly, flocculus is gradually produced in water after the treated water is pumped to reacting tank, and chloride is added in clear water after flocculus is removed in the precipitating tank and filtering tank. Then the treated water can be supplied to the residential water pipeline.

Mine water mixed with coagulant can be directly filtered, but not through the processes of coagulation and precipitation if water turbidity is relatively low (e.g. the mine drainage from iron mine), thus the process going through reacting tank and precipitating tank can be left out and then the treated water is pumped to resident water supply pipeline after the filtered water added chloride is disinfected. The process is shown in Fig. 2.

In the case of high turbidity water such as water from a coal mine, natural precipitation can be used to save coagulants and achieve the desired results before coagulation and precipitation. Also, a part of the mud and sand in the mine drainage can precipitate and be removed in advance. The purification process is indicated in Fig. 3.

Some Examples of Purification and Treatment of Mine Drainage

According to official statistics in 1986, five water treatment plants had been built for about ten years in Pingding Shan coal mines of Henan Province. The desired capacity of water supply comes to 52,000 m³/d (62% of the capacity of water treatment). Major features of water treatment plants include sand-precipitating tanks, reacting tanks, precipitating tanks, filtering tanks and clear water tanks. After mine water is treated, water sensuous index is good (its turbidity attains 3.5 -65 , but it was 40 -100 previously) and all the suspended matters can be removed, and the bacterial index is also up to the national hygiene standard of drinking water. The treated water is directly supplied to residential water pipeline in the mining area eliminating the shortage of drinking water supply.

The purification technology of mine water treatment is used in Kailuan coal mining area of Hebei Province. The desired capacity of mine water purification attains 70-100 m³/min, 4 million RMB as drainage expense is saved every year. Water quality of all the mine drainage is up to the national drainage standard after waters are treated. The treated water (as industrial water) can be supplied to generating plants and other factories in the mining area. The problem of environmental protection which mine sewage was drained to

neighboring water system (river and pond) before is removed.

Summary

Development of new technology of mine water purification and treatment will contribute to effective water supply in mining areas and also to environmental protection. The selection of technological process of water treatment mainly depends on different water chemistry characteristics in each mining area.

In some mining areas with small water supplies (water supply $\leq 60\text{m}^3/\text{h}$), a new water treatment machine which has a combination of technological processes such as coagulation, precipitation, filtration and disinfection can be used in mine water purification. This kind of machine has been produced in China; some practices indicated that the water treatment equipment is very effective.