

Supporting Materials

Text S1 Wastewater treatment processes

The process is divided into South and North series to treat mine wastewater in parallel. Within this, the north series consists of 1# reaction pool, 2# oxidation pool, 3# neutralizing pool, the north degassing pool, and the north sedimentation pool. The south series consists of 1# reaction pool, 2# oxidation pool, 3# neutralizing pool, the south degassing pool, and the south sedimentation pool.

The treatment processes are as follows:

1) After mixing acidic and alkaline water, the mining-beneficiation wastewater is conveyed to the primary reaction pools (1#/4# reaction pool) of the north and south series of the multiphase catalytic oxidation reaction system. The reaction pools are continuously fed with a quantitative amount of catalyst and oxidant, intermittently fed with the dense medium carrier, and through the agitation of the stirrer to promote complete contact between the mining-beneficiation wastewater and the treatment chemicals resulting in a catalytic oxidation reaction.

2) The secondary reaction pools (2#/5# oxidation pool) are constructed on the basis of conventional stirring operation with the addition of an aeration system to enable a highly efficient “gas-liquid-solid” multiphase combined catalytic oxidation reaction. The secondary reaction pools can continue the catalytic oxidation reaction of the primary reaction pools (1#/4# reaction pool) to ensure complete contact between the mining-beneficiation wastewater and the treatment chemicals. In addition, it can give full play to the effective oxidation and decomposition of organic matter in the wastewater and reduce COD.

3) Put the lime into the three-stage reaction pools (3#/6# neutralizing pool) for reaction, adjust the pH value to neutral, and continuously maintain sufficient mixing and aeration. In this process, the active ingredients in the catalyst react with the alkali to form colloidal particles. The dense medium carrier and colloidal particles work together to produce a dense colloidal flocculant. The flocculant has catalytic and fast coagulation functions to effectively degrade residual COD in wastewater and adsorbs heavy metal ions from wastewater.

4) The acid-alkali neutralized reaction mixture is continuously aerated in the north/south degassing pool to remove volatile, irritating odorous substances; Flocculation reaction occurs by adding flocculant PAM to the north/south sedimentation pool. The reaction effectively allows heavy metal ions, suspended solids and other substances to settle in the sedimentation pools along with a dense colloidal floc and removes the heavy metals and suspended solids by solid-liquid separation.

5) The sludge from the sedimentation pools is partially returned to the neutralizing pools, where the heavy media carrier is recycled. The remaining part of the sludge is discharged to a safe disposal point; Finally, the supernatant of the sedimentation pools is discharged into the river through the external discharge pipe, achieving the discharge standards for mining-beneficiation wastewater.