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Reuse of Industrial Wastewater Treatment by Coal Washery

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***Abstract* - Natural water is seldom chemically pure. When it rains, organic and inorganic suspended particulate matter, gases, vapors, mists, etc. in the air get dissolved in water, through which it reaches the earth's surface. In addition, water carries surface pollutants and contaminants during its flow over the ground. Water, which percolates into the ground, dissolves various salts, and becomes rich in total dissolved solids. Thus, it acquires a number of impurities while in its natural state. This necessitates adequate treatment of naturally occurring water before it can be used for domestic, industrial, commercial, agricultural, or recreational purposes. The extent of treatment will depend on the end use of the treated water. Use of the treated water even once adds considerably to the amount and variety of pollutants. This necessitates further treatment of the water before it can be reused, although it is not strictly necessary to have water of uniformly high quality for each of the above uses. In view of the limited availability of water for meeting our growing demands, and in the interest of protecting the environment, it is essential to think and act in terms of reducing water consumption, reusing, and recycling once-used water, and minimizing the pollution effects of wastewater resulting from a variety of uses. In this project, a simple technique is introduced to converts dirty water into clean water. The material which are required are Coal (100 grams), Sand (200 grams), Tissue papers and water bottle with cap. These materials are easily available. The requirement of sand and coal depends on the size of the bottle. First take the bottle cap and make some small holes in it and cut the bottom portion of water bottle. After cutting the bottom of the bottle place a tissue paper inside the bottle. In the tissue paper which is inside the bottle put some sand about (100grams) in it. After that wash, the coal (100grams) and place over the sand in the bottle and then pour the remaining sand into the bottle. Close the mixture with tissue paper over the water bottle. Now close the water bottle with the cap with small holes. You can pour the dirty water on the top and get clean water in the bottom. This is a simple way of converting dirty water into clean water.**

***Index Terms* - Coal, Sand, Wastewater, Industries.**

INTRODUCTION

Although the laws and regulations that require industrial wastewater treatment are constantly changing, the fundamental principles on which treatment technologies are based do not change. This work presents a summarized version of the basic chemistry and physics that treatment technologies are based on, with the objective of showing that a command of these principles can enable quick, efficient identification of very effective treatment technologies for almost any given type of wastewater. The fundamental idea upon which the approach suggested in this work is based can be stated as follows: If the mechanisms by which individual pollutants become incorporated into a waste stream can be identified, analysed, and described, the most efficient methodology of removal, or treatment, will be obvious. As an example of the usefulness of this approach to quickly develop an effective, efficient treatment scheme, the leachate from a landfill was to be pre-treated, then discharged to a municipal wastewater treatment facility (publicly owned treatment works [POTW]). Because the waste sludge from the POTW was to be disposed of by land application, a restrictive limitation was placed on heavy metals in the pre-treated leachate. Analysis of the leachate showed that the content of iron was relatively high. Other metals such as cadmium (probably from discarded batteries), zinc, copper, nickel, and lead were also present in excess of the concentrations allowed by the pre-treatment permit, but substantially lower than iron.

CHARACTERISTICS OF INDUSTRIAL WASTEWATER

Industrial wastewater is the aqueous discard that results from the use of water in an industrial manufacturing process or the cleaning activities that take place along with that process. Industrial wastewater is the result of substances other than water having been dissolved or suspended in water. The objective of industrial wastewater treatment is to remove those dissolved or suspended substances. The best approach to working out an effective and efficient method of industrial wastewater treatment is to examine those properties of water and of the dissolved or suspended substances that enabled or caused the dissolution or suspension, then to deduce plausible chemical or physical actions that would reverse those processes. Familiarity with the polar characteristics of water is fundamental to being able to make such deductions. The Polar Water molecules are polar. This polarity arises from the spatial arrangement of protons and electrons in the individual hydrogen and oxygen atoms that make up each water molecule. Considering hydrogen first, it is the smallest of the elements. Hydrogen consists of one proton within a small, extremely dense nucleus and one electron contained within an orbital that is more or less spherical and surrounds the nucleus. An orbital is a region in space where, according to the theory of quantum mechanics, an electron is most likely to be found.

Wastewater can be described as a mixture of undesirable substances, or "pollutants," in water. If the mixture is stable, the pollutants will not settle out of the water under quiescent conditions under the influence of gravity; and one or more treatment processes, other than plain sedimentation, must be used to render the water suitable to be returned to the environment. The key to determining an efficient, effective treatment process lies in the ability to recognize what forces are responsible for the stability of the mixture (unless biological treatment is to be used). This work has described five general types of mixtures: (1) true solutions, where the stability arises from hydrogen bonding between water molecules and the electrical charge associated with each ion; (2) emulsions caused by emulsifying agents, where stability is provided by an agent, such as a detergent, that links small droplets of a liquid substance to water by having one portion of the agent dissolved in the water and another dissolved in the droplets of suspended liquid pollutant; (3) emulsions in which the stability of a mixture of small droplets of a liquid pollutant in water arises from the repulsion caused by like electric charges on the surface of each droplet; (4) colloidal suspensions in which small particles of a non-soluble solid are held away from each other by the repulsive forces of like electric charges on the surface of each solid particle; and (5) solutions in which ions that would not normally be soluble in water under the prevailing conditions are held in solution by so-called chelating agents. In each of the five cases, the most efficient way to develop an effective treatment scheme is to directly address the force that is responsible for the stability of the wastewater mixture.

THE MINING OF COAL

Coal is one fuel which is considered useful whenever thermal energy is required on a large scale. Geologically, coal is an organic rock having a structure of layers, which vary greatly in thickness, lustre and texture. It is removed from the earth either by tunnelling if the coal seams are deep, or by open cast mining when the seams are near the surface. The extracted coal requires processing for the removal of rocks and other mineral impurities, followed by sizing or screening. There are three main varieties of coal, viz. anthracite, bituminous and lignite .Wastes from coal mining may be classified as: solid-including earth, rock and shale and a certain amount of waste coal; liquid-including surplus water which flows out of the mine and acid mine drainage water, which is formed due to reaction between the pyrite FeS_2in the soil, moisture and oxygen; gaseous -consisting of methane, carbon monoxide and carbon dioxide. The solid wastes do not cause serious pollution, but can catch fire spontaneously due to the presence of sufficient combustible coal and organic matter; gaseous wastes can form an explosive mixture with air and must be adequately vented. The acid mine drainage must be neutralized before disposal.

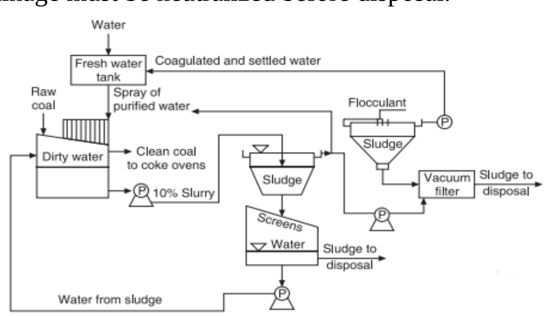

Figure 1: Coal washery reuse of water

Wastes generated during mining operations are characterized by very large quantities, from which a relatively small amount of useful material is recovered. Further, each of the stages forming the coal cycle, viz. coal mining, coal transportation, coal preparation, coal conversion and combustion plus utilization produces wastes, either in solid, liquid or gaseous forms. Each of these wastes has to be handled by different methods for protection of the environment. It lists the adverse effects of mining activity as follows: pollution of air and water, noise pollution, leaching effect from overburden, injuries due to falling rocks and ground vibration during blasting. Loss of (a) productive land, (b) land and property by underground fires and surface subsidence, (c) flora and fauna, (d) top soil due to erosion, (e) forest area also takes place. In addition, adverse socio-economic effects also need consideration. An environmental impact assessment of the mining project is recommended in order to anticipate the ill-effects, provide adequate preventive measures and protect the environment. It gives an overview of available options for managing water pollution problems due to mining activity. Problems associated with mining, transportation, preparation, conversion into usable product and its combustion, and their solutions are listed. A coal washery works on the principle of differences in specific gravity of coal and impurities present with it. Specific gravity of pure coal ranges.

CONVERSION OF COAL INTO COKE

The production of coke by carbonization of coal consists of heating bituminous coal in the absence of air at 1000^{O}C for 12-18 hours in an oven or retort, driving off volatile products which are recovered as tar, light oil and gas. Many plants have facilities to process light oil further into pure benzene, toluene, xylene, and solvent fractions, for distilling tar into useful distillates, and to recover hydrogen, ethylene, sulphur, hydrogen sulphide, ammonium thiocyanate, naphthalene, phenol, pyridine and other products. Coal, properly sized and mixed, is heated in the ovens in the absence of air. Gases formed due to heating are cooled to about 80^{O}C thus condensing most of the tar. The gases then pass through primary coolers where they are washed and cooled further to 30^{O}C. when additional tar and crude ammonia liquor condense. The red hot coke is pushed into quenching cars, where it is cooled by spraying water over it. Surplus water sprayed on the coke drips down into tanks located below the quenching cars. Water for cooling is also pumped into these tanks. About 30^{O}C of the cooling water evaporates and the rest collects impurities in it. In some coke ovens, condensates containing phenols and ammonia are also used for quenching. But this is an objectionable practice because it leads to severe corrosion of the quenching cars. The cooled coke is further crushed and graded for use in blast furnaces, foundry cupolas, and gas production or for household use.

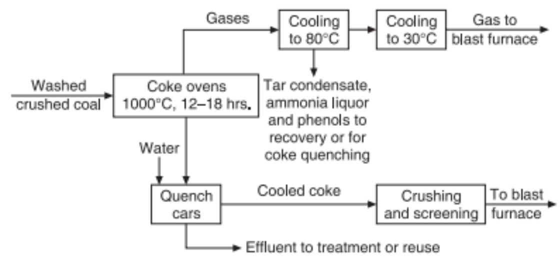

Figure 2: Manufacture of coke

WASTEWATER TREATMENT

When wastes minimization has been implemented to the maximum extent, those contaminants that remain must be treated and disposed of. In fact, several wastes minimization methods discussed previously can be construed to constitute waste treatment; however, other techniques can be employed that are truly end-of-pipe treatment. Although some waste streams can be combined and managed as one, regarding waste treatment processes, it is usually advisable to treat certain waste streams separately. Treatment of tin-plating wastes usually involves removal of oils and greases from the preparing operations, and recovery of tin, and possibly other metals, from the plating bath and rinse wastes. The removal of oils and greases can be done by reverse osmosis, ultrafiltration, chemical coagulation followed by dissolved or dispersed air flotation, in combination with simple skimming. Recovery of tin and other metals is most often accomplished by alkaline, sulphide, phosphate, or carbonate precipitation. If the wastewaters contain fluoride, then use of lime as the precipitating agent will effect removal of fluorides concurrently. If the effluent contains hexavalent chromium, then addition of (slightly soluble) ferrous sulphide will effect sulphide precipitation of tin and other metals, and at the same time reduce the hexavalent chrome to trivalent chrome (far less toxic). If the pH is maintained between 8.0 and 9.0 during this process, then the trivalent chrome will be precipitated as the hydroxide. Thus, tin, other metals, and hexavalent chrome can be removed simultaneously, by addition of ferrous sulphide, pH adjustment, slow mixing, sedimentation, and filtration. These methods, combined, produce an effluent having metals (tin plus other metals, including trivalent chromium) between 2 and 5 mg/L.

Ion exchange can then be employed to reduce the concentrations of these substances to, essentially, non-detect levels. The product water can then be returned to the process for use as either plating bath makeup water or rinse makeup water. Insoluble starch xanthate has been used successfully as a precipitant for tin and other metals over pH levels from 3.0 to 11.0, with optimal effectiveness above 7.0. This process is effective over a wide range of metals concentration levels. When metals, including tin, are removed by a reaction to produce an insoluble compound (precipitation) (for instance, stannous sulphide), the precipitation stage is normally followed by gravity sedimentation, often by use of tube or plate settlers. Because simple precipitation often results in small particles of precipitate that do not settle well, a coagulation step must be added. Coagulation involves the addition of a metal salt or an organic polymer, followed by a very short (15 to 30 seconds) rapid mix, then followed by a period of 15 to 30 minutes of slow mixing before the gravity settling process. These combine to produce a large, relatively heavy floc that settles much faster and more completely than the original small, precipitated particles. Three distinct processes are involved: (1) precipitation, brought about by addition of the chemical (sodium hydroxide, for instance) that reacts with the target metal ions to produce an insoluble compound (metal hydroxide); (2) coagulation, brought about by addition of the coagulant (metal salt or organic polymer); and (3) flocculation, brought about by the slow mixing process. The result is an effluent that has 5–15 mg/L of metal ions. Filtration can reduce the concentration to 2–5 mg/L. If it is desired to produce an effluent reliability lower than 5 mg/L of metals, then ion exchange must be employed.

TREATMENT OF COKE OVEN WASTEWATER

In view of the toxic nature of coke oven waste water, treatment by physical, chemical, biological means and by suitable combinations of the above three have been tried out. It used the oxidation ditch for treating phenolic waste. They saw that acclimatized activated sludge could easily tolerate phenol concentration up to 1000mg and destroy it by 86%. Aeration period of 8 hours was enough to destroy phenols almost completely, besides getting moderate BOD=82.9 %and COD = 58% removals. The raw waste was diluted to 6% while MLSS in the ditch were maintained at 1000 mg/L.If was also seen that the usual indicators of good activated sludge were replaced by the fungus Geotrichum. This fungus may alone be useful in phenol degradation. Pilot plant studies on treatment of phenolic wastes using deep trickling filter. There are various methods of phenol removal, viz. activated carbon adsorption, chemical oxidation with potassium permanganate, sodium dichromate, sodium peroxide, manganese ores, chlorine, chlorine dioxide and ozone, biological oxidation by activated sludge process and trickling filtration and continuous cultivation method in which a small volume of waste water is diluted to get a constant concentration of phenols, it is supplied with nutrients and is fed into the aeration tank containing aerobic bacteria, giving phenol destruction from 1.25 to 1.875 kg/m^3/day. The various methods of phenol removal including (a) physical-catalytic incineration, deep well disposal, use of electrostatic forces, oil-water separation, evaporation and burning, and steam stripping, (b) Chemical - oxidation with chlorine, chlorine dioxide, ozone, adsorption on activated carbon, ion exchange and solvent extraction, and (c) biological methods - single-stage and two-stage filtration, deep trickling filters, activated sludge process, spray irrigation and use of water hyacinth. Raw wastes as such have intolerably high phenol and ammonia concentrations. So, they have to be pre-treated by physical or chemical means to reduce these two pollutants to levels where microbes can handle them successfully. Porous, weakly basic anion exchangers on acrylic matrix for the absorption of phenolic compounds. The ion exchange and surface characteristics of the resins and the nature of the adsorbates were found to govern their absorption performance. They found that the rate of absorption was pH dependent and depended on the presence of electrolyte (TDS) in the waste water being treated. An alkaline solution was a suitable eluent for the absorbed phenol, which could be completely removed from the resin.

CONCLUSION

Through the intermediate experiment, the following conclusions have been drawn: During 42 hours' experiment of coal washing with coking reclaimed water, no obviously negative effects are found in the process of main wash, removal medium, magnetic separation, flotation. Coal surface adsorption and flocculation settlement can remove pollutants in the coking reclaimed water, and the concentration of pollutants in recycling water tends to decline. It is necessary to control the pH value of phenol-cyanogen. Wastewater in a slanting alkalescency state. Otherwise, the pH value will be below the optimum pH value of coal slurry water. Sedimentation in the same region, and the concentration of recycling water goes upward.

REFERENCE

[1] FAN Weitang, DU Minghua. Status and Prospect of Coal Chemical Industry in China[J]. Coal Chemical Industry. 2005,116(1):1～5

[2] LIU Hongliang, CAO Fengzhong. "Springing Phenomenon" of Coal Chemical Industry and the Constraint of Environment and Resources [J]. Journal of China University of Geosciences. 2008.8(1)1 ～4

[3] JI Zhongjian, MENG Xiangrong; YIN Chenglong. Modern technology of purifying coking wastewater[J]. Modern Chemical Industry,2002,22(1):43～48

[4] Yin Chenglong et al. Problems and Solutions of Wastewater Treatment of Coking Plant [J]. Water & Wastewater Engineering,2000,26(6):35～37

[5] State Environmental Protection Administration editorial committee. Water and Wastewater Monitoring Analysis Method[M]. 4th ed. Beijing: China Environmental Science Press, 2002.279 — 283.002:697.

[6] GB/T4757-2001 Coal (mud) laboratory cell flotation test method

[7] MT/T259-1991 Evaluation method of coal floatability C.R.C. Lima, J.M. Guilemany, "Adhesion improvements of Thermal Barrier Coatings with HVOF thermally sprayed bond coats", Surface and Coatings Technology, vol.201, no.8, pp.4694–4701,15 January 2007,

[8] Esfahanian, A. Javaheri, and M. Ghaffarpour, "Thermal analysis of an SI engine piston using different combustion boundary condition treatments", Applied Thermal Engineering, vol.26, p Esfahanian, A. Javaheri, and M. Ghaffarpour, "Thermal analysis of an SI engine piston using different combustion boundary condition treatments", Applied Thermal Engineering, vol.26, pp.277-287,2006.", Surface and Coatings Technology, vol. 203, pp. 91-98, 2008.

[9] Anna Gilbert, Esfahanian, A. Javaheri, and M. Ghaffarpour, "Thermal analysis of an SI engine piston using different combustion boundary condition treatments", Applied Thermal Engineering, vol.26, pp.277-287,2006., Surface and Coatings Technology, vol..202, pp.2152-2161,2008.

[10] T. Hejwowski, and A. Weronski, "The effect of thermal barrier coatings on diesel engine performance", Vacuum, vol.65, pp.427-432, 2002.

[11] E. Buyukkaya, "Thermal analysis of functionally graded coating Al-Si alloy and steel pistons", Surface and Coatings Technology, vol.202, pp. 3856-3865, 2008.

[12] E. Esfahanian, A. Javaheri, and M. Ghaffarpour, "Thermal analysis of an SI engine piston using different combustion boundary condition treatments", Applied Thermal Engineering, vol.26, pp.277-287, 2006., pp.398-402,2007.

[13] Muhammet Cerit, "Thermo mechanical analysis of a partially ceramic coated piston used in an SI engine", Surface & Coatings Technology, vol.205, pp. 3499-3505,2011.