WATER AND WASTE WATER MANAGEMENT IN METAL (STEEL) INDUSTRIES

Steel plants use a tremendous amount of water for waste transfer, cooling, and dust control. The plants have sintering mills, coke plants, electricity and gas for furnaces, chemical by-products and chemical processes, water cooled rolls, pumps, slab furnaces, mandrels, extrusion equipment, waste water treatment, transfer lines for sludge and slurries.

The production of iron from its ores involves powerful reduction reactions in blast furnaces. Cooling waters are inevitably contaminated with products especially ammonia and cyanide. Production of coke from coal in coking plants also requires water cooling and the use of water in by-products separation. Contamination of waste streams includes gasification products such as benzene, naphthalene, anthracene, cyanide, ammonia, phenols, and cresols together with a range of more complex organic compounds known collectively as polycyclic aromatic hydrocarbons (PAH).

- Rolling plants use a tremendous amount of water to cool the rollers and flush the impurities away from the finished stock. This coolant is a mixture of oils and water which gets contaminated with bacteria and must be disposed of as a hazardous waste.. Eventually the bacteria die off.
- Pumping energy costs rise as the pumps and lines become clogged.
- Scale and other deposits on boilers, heat exchangers and cooling towers rob the process of energy efficiency and cost maintenance time and chemical treatment costs.

Treatment of Industrial waste water

The different types of contamination of wastewater require a variety of strategies to remove the contamination
1. Solids removal
2. Oil & grease removal
3. Removal of biodegradable organics
4. Activated sludge process
5. Trickling filter process
6. Treatment of other organics
7. Treatment of acid & alkalis
8. Treatment of toxic materials

Technologies used in Steel plants are:

1. Cooling Tower

Cooling towers are heat removal devices used to transfer process waste heat to the atmosphere. Cooling towers may either use the evaporation of water to remove process heat and cool the working fluid. Common applications include cooling the circulating water used in oil refineries, chemical plants, power stations and building cooling. .They are often associated with nuclear power plants in popular culture.

2. D.M. Plant

DM Plant is an Ion exchange technology used to remove salts (cations and anions) from water. Soluble chemical compounds, when dissolved in water, become ionized; that is their molecules dissociate into positively and negatively charged components called ions. Consider common table salt, sodium chloride. In its solid form, this compound consists of one sodium atom (Na) and one chlorine atom (Cl) tightly coupled together (NaCl).

When dissolved in water, however, the compound splits into two ions Na+ and Cl- A Typical two-bed DM Plant consists of two FRP vessels connected in series along with its internal fittings.

The first unit consists of high capacity strongly acidic cation exchange resin, which converts positive ions of salt and replaces them with hydrogen ions to form respective acids, which are absorbed in next vessel by strongly basic anion exchange resin. The water obtained by this process shows conductivity less than 30 µS/cm and Total Dissolved Solids less than 10 ppm. Further high purity water can be achieved by Mixed Bed Deionizers, which are designed to produce high purity treated water. They can be used as polishing units after two beds DM Plant to obtain high purity water.

---

3. STP

Following are the two methods to treat waste water in sewage treatment plant.

A Conventional Method

Conventional sewage treatment may involve three stages, called primary, secondary and tertiary treatment.

• **Primary treatment** consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment.
• **Secondary treatment** removes dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous, water-borne micro-organisms in a managed habitat. Secondary treatment may require a separation process to remove the micro-organisms from the treated water prior to discharge or tertiary treatment.
• **Tertiary treatment** is sometimes defined as anything more than primary and secondary treatment. Treated water is sometimes disinfected chemically or physically (for example, by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

B Ozonation Method

The incoming raw sewage pass through a bar screen chamber to remove coarse suspended solids, fibers, plastics etc. and is collected into a septic tank / holding tank. The tank will have 24 – 48 hours holding capacity, with suitable compartments to separate the heavy sludge solids present in the incoming sewage.

A sewage transfer pump will transfer the raw effluent into a manual self-cleaning filter, and then pressure sand filter & then onward to an ozonator. Ozone will be injected into the raw sewage and mixed in to a contact chamber / holding tank. The ozone will oxidize the organics present in the sewage, thereby reducing the BOD / COD levels of the sewage to acceptable limits.
The ozonated effluent will be filtered through a pressure sand filter to remove trace suspended solids / turbidity, etc. The outlet water can be reused suitably for toilet flushing, gardening, etc.

---

4. River water treatment

Water purification is a process of removing undesirable chemicals, materials, and biological contaminants from raw water. The goal is to produce water fit for a specific purpose. In general the methods used include Physical processes such as.

• Pre-Ozonation
• flocculation
• filtration / Aeration
• chlorination
• pH Correction

Treatment of waste water/effluent generated during Steel Rolling:

1. **Hot Rolling:**

Prior to rolling, continuous casting is reheated; heated ingots are rolled to semis; Rolling reduces thickness/sometimes width of the Hot rolled product after shearing/cutting. Some plate mills are equipped with surface preparation/heat treatment facilities.

Important Consideration:

Cold material heating (furnaces) requires energy;

Emission depends on fuel –

(a) Oil leads to SO_x (S), NO_x (temperature), Low NO_x burners being developed,

(b) Natural gas leads to lower air pollution,

(c) Induction heating (low energy input) for correction to temperature profiles in products;

Reheating creates oxidation of products, scales are formed. Roiling breaks in scales and flows with waters to cool the rolls; Flakes of iron oxide dust in last strand requires capture.

Treatment:

Mill scale (magnetite) low in oils recycled to similar plate; Water may contain oil and scale. Scale may therefore contain oil. Difficulties on sinter strand (visible emission-problems in electrostatic precipitators). Better to be sold; Direct reduction, with scale can be mixed with other wastes/ores (fuel/reductant in kilning operations); Oil from mill scale removed by solvent extraction/extraction in a critical fluid (CO_2) (costly); Dumping recommended provided ground water pollution is eliminated; Largest consumer of water but most of it is recycled.

Two distinct water lines recommended:

(a) One treating indirect cooling water and requiring minimal care/treatment (motor-room, reheating furnaces, control rooms, etc.)

(b) Direct cooling waters (scale breakers/flushing, roll cooling, crop pit, scarfing machine, hot run table, down coiler, hot and cold saws).

Treatment through clarifier/filters. Solids to be vacuum filtered.

2. **Cold Rolling/Forming:**

Flat products is processed by cold rolling after acid treatment (pickling) for thin scale removal; Cold mill may be of reversing or tandem train design; annealing; Shape control, slitting, shearing and forming for sale as required.

Important Consideration:

Pickling acid baths (H_2SO_4/HCl) at high temperatures for scale removal; Oil coating to avoid rusting; Acid mist during pickling, contained through enclosed system or using hoods over tanks.

Acid laden air is to be water washed before release; Rinsing water, spills, overflows/other discharges from pickling tanks and fume stack effluent needs treatment and pickled wastewater, Oil-water emulsion leads to high BOD, SS and free oil problems.

Unpleasant odor due to biological growth on oils; Gases (H_2/O_2) produced during electrolytic gases is to be controlled; Stainless steel grades require HF and HNO_3 for pickling and abrasives may be used to remove refractory oxides.

Treatment:

Primary settling tank for oil skimming (Cold rolling forming); Lime and flocculent treatment tanks for finely divided/emulsified solids and oils prepared with addition of alum and acids; Major difficulty in oil removal and to obtain solids that can be filtered;

Neutralization, rapid/slow agitation in tanks with addition of flocculants/polymers, scum skimming and final adjustment are basic methods; Scum can be incinerated after dewatering; Ultra filtration (possibility) for oil recovery/recycle can also be considered.

Oil Removal:

(a) Skimming (0.25 h, HRT depending on waste),

(b) Filtration (beds blind quickly resulting in frequent back wash). Costly (filter material/energy),

(c) Flotation (dispersed air broth). Air/vacuum flotation achieves high degree of separation. Energy efficient;

Neutralization:

(a) Possibility of neutralizing pickling wastewater with alkaline electrolytic cleaning wastewater,

(b) Use of acid effluents to break oil-water emulsion,

(c) Neutralizing pickling wastewater with lime. Producing sludge which after dewatering can be disposed off on land. Sludges containing heavy metals (Passivation baths) should be treated to avoid remobilization of metals.

Recovery of Acids:

(a) H_2SO_4 recovery leads to production of $FeSO_4$.$7H_2O$, sell $FeSO_4$. $7H_2O$ (weed killer, water treatment plant for flocculation, dephosphorization treatment), excess $FeSO_4$ to be dumped under conditions that its solution will not contaminate environment,

(b) ***HCl pickling regeneration techniques recovers iron as pure and fine iron oxide which can be recycled within the steel plant or sold to pigment users or grown with specific magnetic properties*** (ferrites – coating recording tapes/computer memories).

3. Coatings:

Continuous coating limes to apply protective and decorative coatings of Zn, Sn, Al plastic and paints. Some plants have terne (Pb), brass, Cr and Cd coating operations; Zn can be deposited electrolytically (Process is becoming sophisticated); Galvanising by electrolytically or hot dipping in liquid metal (alkaline cleaning, pickling, bright annealing, cooling, coating, induction heating, water quenching, cooling and shearing); Tinning (alkaline cleaning, rinsing, pickling, plating with tin, rinsing, chemical treatment, rinsing, drying, oiling and coiling.

Important Consideration:

Degreasing leads to emission of chlorinated hydrocarbons; Acids can be released into atmosphere; Solvents released during plastic/paint coatings; dilute rinsing waters create some problems, chromating/Phosphating create problems. Cr (+6) is to be converted to Cr (+3).

Treatment: Neutralization and correct oxidation state before releasing to environment, particularly for Cr (+6); Cr (+6) rinse water sent to reduction tank where acid and SO_2 (recycled pickle) to reduce it to Cr (+3); these can join wastes from fume.

Scrubber and other rinse waters to give approximate neutralized water. Neutralization is completed after oil skimming of addition of lime/flocculants. Separation of solids possibly in a clarifier and vacuum filter; Sludge

(high Cr, etc.) from tinning/Cr-plating to be sold; Toxic metal removal by alkaline compounds like lime NaOH; Hydroxides to be converted to insoluble carbonates by CO_2, Lime helps in removal of phosphorus/fluoride; Soluble sulphides (Na_2S) for removal of many heavy metals. Final pH adjustment necessary; use of Activated Carbon provided oils/grease and suspended solids have been removed and can be regenerated or dumped after use; Plastic/painting coating lines should have suction hoods and led off to a combustion facility; Difficulty is in disposal of waste tin/drums containing plasticisers/glues/paints, solvents etc. in excess of their use and must be incinerated.

Source:

http://www.environmentalpollution.in/pollution/steel-industry-pollution/how-to-control-pollution-in-iron-and-steel-industry/7000

http://www.chemtronicsindia.com/steel_industries.htm