Recycling and Reuse of Wastewater in Steel Industry

Vanitha C.H[1], Dr D.P. Nagarajappa[2]
[1]Dept of Civil Engineering
[2]Professor, Dept of Civil Engineering
[1, 2]UBDTCE, Davangere, Karnataka, India

Abstract- *Water management plays a vital role in steel industry. The present work is carried out in cold rolling mill aiming to recovery maximum water. In CRM process the acid waste, alkaline waste and oil and grease wastewater generated. This wastewater is treated in effluent treatment plant and then it is desalinized to avoid the salt concentration in water circulation system by implementing ultra filtration and RO system. The process wastewater are treated in* RO_1 *system , cooling tower blow down water are treated in* RO_2 *system and reject wastewater from* RO_1 *and* RO_2 *are treated in* RO_3 *system. It is found there is membrane fouling in RO3 system due to increase in hardness at the inlet it is reduced by adding lime and soda ash. Results shows that most salts are removed by UF and RO treatment and high quality of water is obtained. It is found that reusing the desalinated wastewater found more economical then discharging.*

Keywords- Desalination, Reverse Osmosis, Ultra Filtration, Membrane Fouling, Lime Soda Ash.

I. INTRODUCTION

Water management plays a vital role in steel industry. Due to scarcity of water recycling and reusing water become popular in industries. The large quantity of fresh water required in steel industry. Steel is produced through two alternatives routes; the electric route which produce steel by melting scrap in an electric arc furnace (EAF) and the integrated cycle, where steel is produced from virgin raw materials. The average water intake for integrated steel work is $28.6m^3$ per ton of produced steel, with an average water discharge of $25.3m^3$ per ton of steel. For the electric route the average intake is $28.1m^3$ per ton of steel, with an average discharge of $26.5m^3$ per ton of steel. Consequently, the overall water consumption per ton of steel produced is low (from $3.3m^3$ to $1.6m^3$) and water losses are mainly due to evaporation. In steel industry overall water consumption in steel site is low, but most of the water is consumed in evaporation and about 90% of water is discharged after cooling and/or cleaning and often used by other utilities. In industry major concern is availability of fresh water as well as quality of water, the important challenge for water resource management is to maintain sustainability in production cycle in water as well as in steel, can be reused and recycled.

II. BACKGROUND

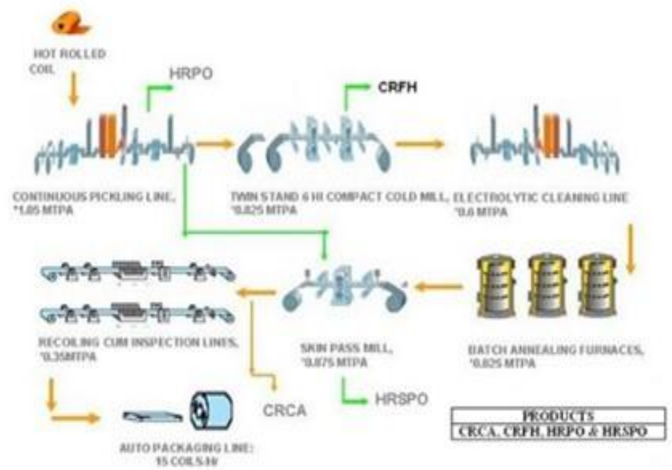

Fig.1: Schematic Diagram of Cold Roll Mill Process. (Source: JSW operation and maintenance manual, 2011)

Hot rolled products often undergo further processing in the cold rolling. The first process in the cold rolling mill is picking, in which hydrochloric, sulfuric or nitric acid are used to remove the oxide film which forms during hot rolling. The material is then cold reduced by compression between rollers and following a degreasing stage, may have it metallurgical properties altered by annealing. A final rolling stage or skin pass the product and improve surface hardness. Cold rolled have a high quality surface finish and precise metallurgical properties for use in high specification products such as mobiles, white goods etc there are three main wastewater types at the Cold Rolling Mill: waste acid, alkaline and grease wastewater. They are from different Cold Rolling Mill lines including: Acid Regeneration Plant (ARP), Pickling And Cold Rolling Mill (PLCM), Hot-Dip Galvanizing Line (CGL), Continuous Annealing Line (CAL) and Tandem Cold Mill Line (TCM).Apart from above waste water, the cooling tower blow down water, STP water from VV Nagar and the washed water from ESP are treated in CRM plant and that water is recycled in the plant and reused in the process.

III. STUDIES AND FINDINGS

In a cold roll mill process three main types of wastewater generated such as acid waste, alkaline waste and grease waste about 229.11m^3/h. In order to recycle and reuse the wastewater it undergoes treatment. The physical chemical treatment is carried out to remove oil and grease, iron particles and neutralized acid waste with lime. Then biological treatment is carried to reduce the organic loading and then to reduce the salt concentration in circuits it is fed to the RO-1 skid, it is recovery about 78% and cooling tower blow down water generated in a plant about 112m^3/h are fed to RO-2 skid it recoveries about 73%. The reject from RO-1 and RO-2 skid and backwash water about 152.37m^3/h are fed to RO-3 skid, it found that membrane fouling results in high cleaning frequency and thus a lower average permeate flux and also damages the mouth endings due to increase in pressure, due to increase in a hardness at inlet. It is reduced by chemical precipitation method such as lime soda ash process. The lime is to remove chemicals that cause carbonate hardness and soda ash is used to remove chemicals that cause non carbonate hardness. Jar test has been carried out to know the dosage of lime to reduce the carbonate hardness and then to precipitate non carbonate hardness the soda ash is added by maintaining optimum pH. The sludge obtained in this process is dewatered and water is reused and sludge cake is sent to micro pellet plant to recovery the materials.

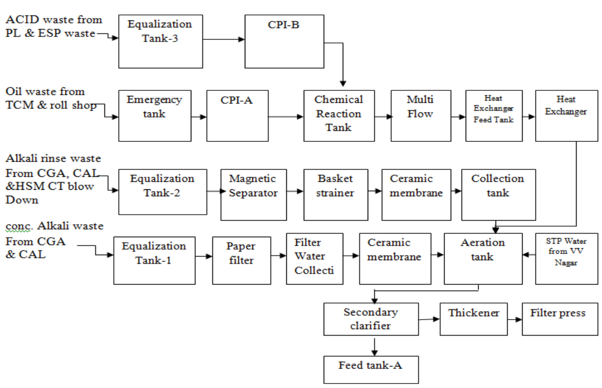

Fig 2: Flow Diagram of Effluent Treatment Plant in Cold Roll Mill

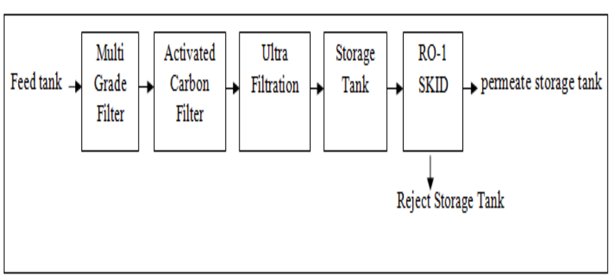

Fig 3: Process Flow Diagram of RO1 System

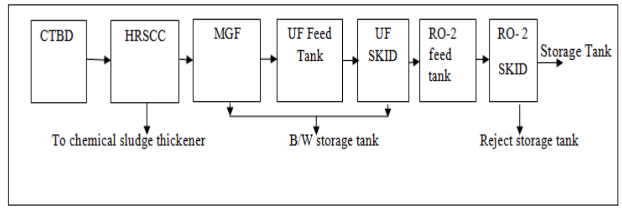

Fig 4: Process Flow Diagram of RO2 System

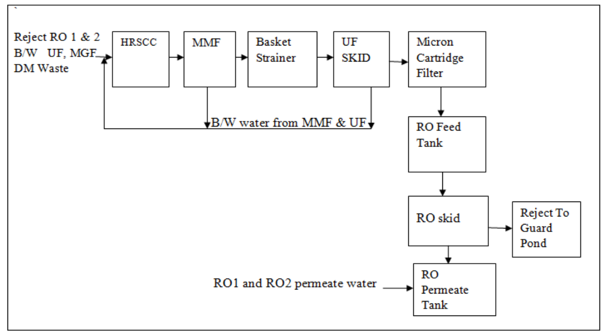

Fig 5: Process Flow Diagram of RO3 System (combined Reject from RO1 and RO2)

IV. RESULTS AND DISCUSSION

The acid wastewater from the mill pickles and roll products, surface cleaning with hydrochloric acid, so the wastewater has relatively low pH and high concentration of ferric acid and ferrous compounds. The alkaline wastewater from cleaning products with detergents, the water has relatively high pH and COD. The third part of wastewater is the oil waste water which comes from the pickling and cold rolling mill and contains lots of oil sludge and high concentration of COD. Addition to process wastewater the wastewater generated during washing of electro static precipitator also treated and it contain lots of Iron and TDS. The HSM cooling tower blow down Water also treated which contain high concentration of salts. The different kinds of wastewater are treated individually in effluent treatment plant. The process wastewater 2600m^3/day, ESP wastewater 500m^3/day, HSM CT blow down water 700m^3/day and VV Nagar STP wastewater 500m^3/day are treated in ETP. The removal efficiency of COD, BOD, O&G and ferrous composition are excellent. To lower residual suspended solids and salts and to meet the mandatory regulation standards or recycle and reuse the process wastewater after treated in ETP it is treated in RO1 system. The RO1 system has three stages. The feed flow is 3942 m^3/day and permeate flow 3100m^3/day it recovery about 78%. Cooling tower blow down water has high concentration of salts and to recycle or reuse the water the salts content to be reduced it is done by treating in RO2 system by applying pressure about 7 to 9kg/cm^2. The feed flow is 2178m^3/day and permeate flow is 1620 m^3/day and it recovery about 74.38%. Reject from RO1, RO2, backwash water from UF and MGF and DM waste, about 120m^3/h are treated in RO3 skid at a pressure of 15 to 20 kg/cm^2 and type of membrane used is sea water membrane. It is found that the pressure is increasing and it requires a continuous cleaning, due to continuous cleaning the efficiency of a membrane is reduced and due to increase in pressure there is damage of mouth endings. The fouling of membrane is due to increase in hardness at the inlet. The hardness should be reduced at the inlet to increase the efficiency of RO3 membrane. It is done by chemical precipitation method such as lime soda ash process. Jar test has done by adding a lime to remove carbonate hardness in HRSCC-1. In HRSCC-1 the initial pH is 8.08 and hardness above 700ppm. To reduce hardness at the outlet the pH is maintained 9.8 to 10.4 by adding lime and soda ash of 130ppm, dolomite 60ppm, ferric chloride 20ppm and poly 0.4ppm and the analysis has done. Maintaining hardness at the inlet 300ppm to 500ppm at a feed flow 80m^3/h to 90m^3/h the pressure is not increasing and it is remaining almost constant due to there is no fouling of membrane and this results the reduction of effect of water hammering on mechanical equipments. The Permeate quality of water is increased and RO3 recovery is 70%. After final treatment about 6500m^3/day permeate water are stored in permeate storage tank and the rejected wastewater from RO3 skid about 770m^3/day are collected in guard pond located at the lowest level of the steel works. The water from this guard pond is pumped to ore washing, greenery development, firewater pump house etc. The suggestions for future studies in cold roll mill plant are proposing a stage wise cleaning of RO membrane to remove a already deposited particles. For a disposal of RO3 reject, it is proposed to install an evaporator's facility to recovery water for reuse in the plant and to ensure that there is no discharge of effluents outside the steel complex. Other way to disposal of RO3 reject is to construct the solar ponds in the form of number of smaller pond constructed adjacent to each other and connected by pipe line. Smaller ponds are easy to manage and maintain and also this will enable us to manage the pond especially during windy conditions.

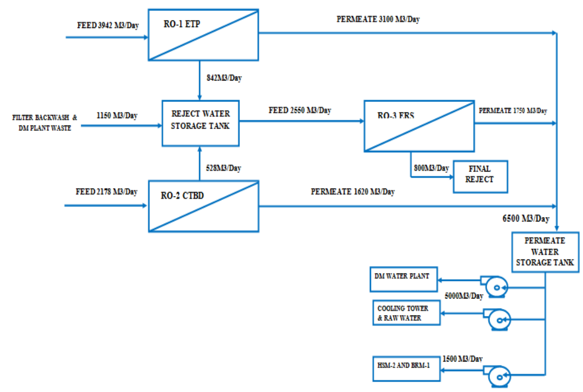

Fig 6: Flow Diagram of Ro Balance Sheet

V. CONCLUSIONS

It has been concluded that from experimental investigation of treatment and testing of CRM process wastewater and cooling tower blow down water by using RO technology are as follows. From the study in CRM plant the total 4500m3/day wastewater generated which are treated in effluent treatment plant. The analysis results shows that after treated in ETP, the physical parameters are completely removed and pH maintained almost neutral for both high acid and alkaline wastewater. After treated in ETP, the results show that the removal efficiency of chemical parameters is excellent. Also the biological parameters such as biological oxygen demand and chemical oxygen demand were also gives the 99% and 99.21% removal efficiency respectively. The result shows that the salt removal efficiency of RO1 and RO2 excellent and the recovery of RO1 and RO2 skid are 78% and 74.38% respectively. Based on experimental results maintaining pH 9.8 to 10.4 and soda ash of 130ppm in HRSCC the fouling of RO3 membrane is reduced and efficiency of permeate water increased and recoveries up to 70% . From this treatment about 6500m3/day water recovered and this water can be recycled and reused in CRM plant and it has been reducing usage of fresh water and also prevent the discharging of polluted wastewater into the environment.

VI. ACKNOWLEDGEMENT

The Authors are Thankful to Principal, University B. D. T. College of Engineering, Davanagere. And Head of Civil Engineering Department, University B. D. T College of Engineering Davanagere.

REFERENCES

[1] Irena Petrinic, Jasmine Korenak, Damijan Povodnik, Claus Helix-Nielsen, (2015), "A Feasibility Study of Ultra filtration/Reverse Osmosis (UF/RO) - Based Wastewater Treatment and Reuse in the Metal Finishing Industry", Journal of Cleaner Production, volume (101), pp 292-300.

[2] Valentina Colla, Teresa Annunziata Branca, Felica Rosito, Carmelo Lucca, Beatriz Padilla Vivas, Vanesa Menendez Delmiro, (2016), "sustainable reverse osmosis application for wastewater treatment in the steel industry", Journal of Cleaner Production, volume(130) pp 103-115.

[3] Xue-Ni cheng, yan-wen Gong, (2018), "Treatment of Oil Wastewater from Cold Rolling Mill through Coagulation and Integrated Membrane Process", Journal of Environmental Engineering Research, volume 23(2), pp 159-169.