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Treatment of Chrome Effluent of Aerospace Industry by Chemical Precipitation Method

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Abstract - *Aerospace industry is the highly developed industry for the innovation made in the field of rocket science, helicopter design and it is important for the defence purposes for the nation protection. But due to high usage of heavy metals in the aerospace for various purposes such has anodizing, plating and passivation purposes. In the heavy metals usage chrome metal place the major role this is highly toxic, carcinogenic and high threat for the nature.Its treatment is one of the major concern for the industrialists. With this literature the treatment of chrome effluent from HAL aerospace divison, Bengaluru is done by chemical precipitation method. Then the treatment effectiveness, efficiency and maintenance is known.*

Key Words: Hindustan aeronautics limited(HAL)1, Incductiely coupled plasma mass spectrometry(ICP-MS)2, Atomic absorption spectroscopy(AAS)3, Sodium meta bisulfate(Na2S2O3)4, Caustic soda(NaOH)5, etc

1.INTRODUCTION

Water is one of the most important fundamental resource for human being for life. But now a days due to industrialization and modernization water is contaminated due to various pollutants. In which aerospace industry is also one of the major industry causing water pollution due to high usage of heavy metals such has chromium, nickel, cadmium, cyanide etc. Chromium existing in nature as two forms one is hexavalent chrome and another in trivalent chrome state. Where hexavalent chrome is 1000 times more concentrated than trivalent chrome ions. So that treatment of chrome effluent is necessary due to the pollution of water and it effects the human and aquatic life. The chrome effluent is treated by many ways such has ion exchange, reverse osmosis, evaporation, electrolysis, membrane filtration etc. Here chemical precipitation process is used for the treatment of chrome effluent. The wastewater here it is collected from HAL aerospace division, Bengaluru. Then the water is been characterized for quality after hexavalent chrome ions is been reduced by reducing agent to trivalent chrome ions by sodium meta bisulfate. After reduction it is been precipitated by using precipitating agent sodium hydroxide(NaOH). Precipitation process means conversion of soluble ions into insoluble form known as sludge.

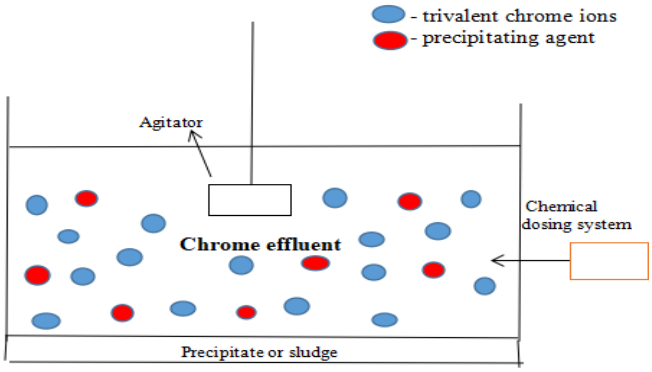

Fig-1: Schematic representation of mechanism of chemical precipitation method

2. METHODOLOGY

In this section information on detail experiments carried for reduction and precipitation adopted for the chrome effluent is been explained.

2.1 Study area 1

Hindustan aeronautics limited(HAL) aerospace divison, Bengaluru is the manufacturing industry focusing on the manufacture of satellite launching vehicle for the indian space research organization. During the manufacturing many process has been done such has Machining, welding, assembly shop, process shop and heat treatment etc., for this process they utilize lot of heavy metals such has cadmium, nickel, zinc and chromium etc. Various products in the aerospace industry has the chromium content. The main process in the aerospace industry produces chrome effluent is the process shop and heat treatment by chrome anodizing and passivation process. From here the chrome effluent is been collected. Sample is collected from the grab sampling from the effluent treatment plant and it is stored in 5°C and analysis has been done.

2.2 Chemical precipitation process 2

Chemical precipitation process is known as the conversion of seperable solid substance from the solution it is by converting substance into insoluble form or by changing the composition of solvent to diminish the solubility of the substance in it. First step in this method is sampling then the taken sample is been characterization by ICP-MS method to know its quality. In which heaxavalent chromium and total chromium is the main content which is been characterized.After this step preliminary reduction of hexavalent chrome to trivalent chrome is done by batch reduction experiment in a 250ml beaker by taking 100ml of sample in it by adding different amount of sodium metabisulfate I.e it is varied from 40-100mg/l in different pH conditions of 1.5-3.5. Reduction process is done in highly acidic condition. The pH condition is varied by using 0.05M H2SO4 and 0.1M NAOH. The amount of reduction is been determined by AAS method in the wavelength of 530-540nm. Efficiency of reduction of chrome is the substraction of initial volume of trivalent chrome ions and final volume chrome ions divides the initial volume. Last process is precipitation process it is done in the jar test apparatus by adding caustic soda as precipitating agent.By taking 500ml of reduced chrome sample in a 1000ml beaker adding different dosages of precipitating agent for rate of rotation 20-30rpm up to 25minutes by varying different pH, mixing time, settling rate and sludge volume through which maximum precipitation is been calculated

The chemical equation for reduction is as follows:

Sodium metabisulfate added to water yields sodium bi sulfate

$$Na2S2O5 + H2O \xrightarrow{\text{yields}} 2NaHSO3$$

Sodium metabisulfate reduces Cr(VI) to Cr(III) ions

$$Cr2O7 + 3NaHSO3 + 3H2SO4 \xrightarrow{\text{yields}} Cr2(SO4)3 + 3NaHSO4 + 4H2O$$

Caustic soda precipitates trivalent chrome ions into chromium hydroxide precipitate

$$Cr2(SO4)3 + 3NaOH \xrightarrow{\text{yields}} 2Cr(OH)3 + 3Na2SO4$$

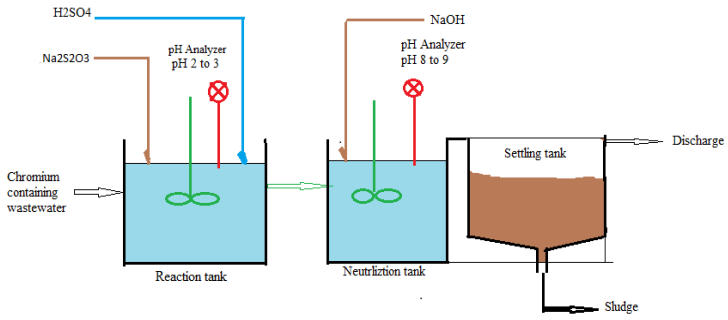

Fig-2: Diagrammatic representation of chemical precipitation setup

3. RESULTS AND DISCUSSION

Table -1: Characterization of chrome sample before and after treatment

Parameters	Sample before treatment	Sample after treatment
pH	2.5-3.0	8.4-8.6
Total residual chlorine(mg/l)	1.5-1.8	0.7-0.9
Ammonical nitrogen(mg/l)	12-14	8.0-9.5
Hexavalent chromium(mg/l)	136-140	0.96-1.5
Total chromium(mg/l)	122-128	0.03-0.05
Lead(mg/l)	0.06-0.09	0.02-0.03
Cadmium(mg/l)	0.03-0.05	0.01-0.02
Copper(mg/l)	0.56-0.65	0.25-0.34
Zinc(mg/l)	0.65-0.85	0.2-0.5
Nickel(mg/l)	0.5-0.7	0.12-0.18

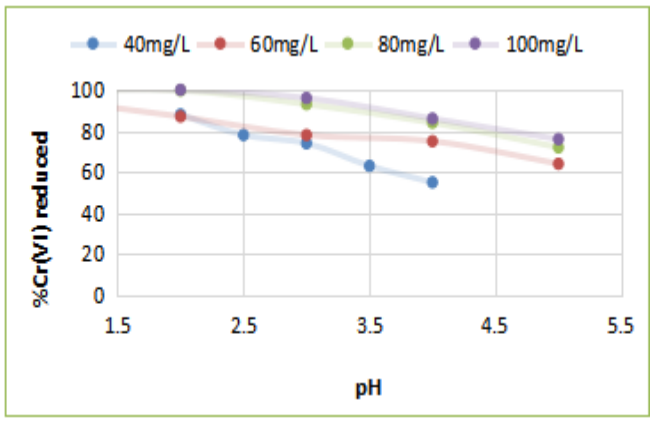

Fig-3: % Cr(VI) reduced at different pH conditions by adding sodium bi-sulfate

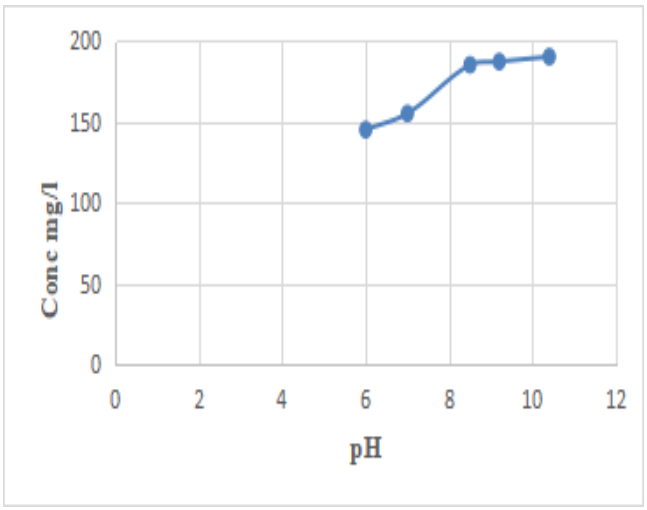

Fig-4: Effect of Cr(III) Conc mg/l vs pH for removal of chrome

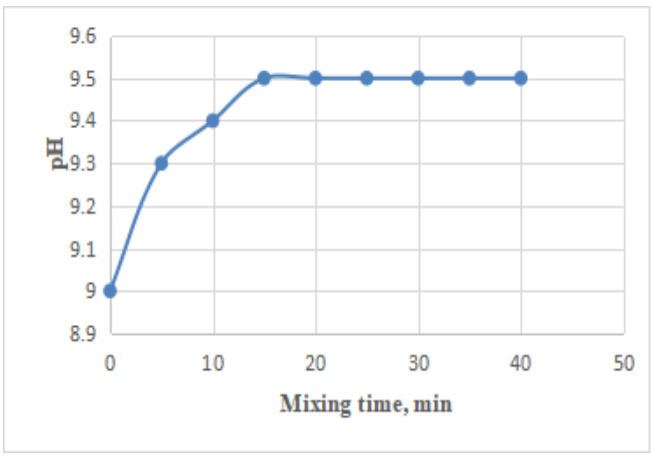

Fig-5: Effect of pH vs mixing time, min for maximum precipitation

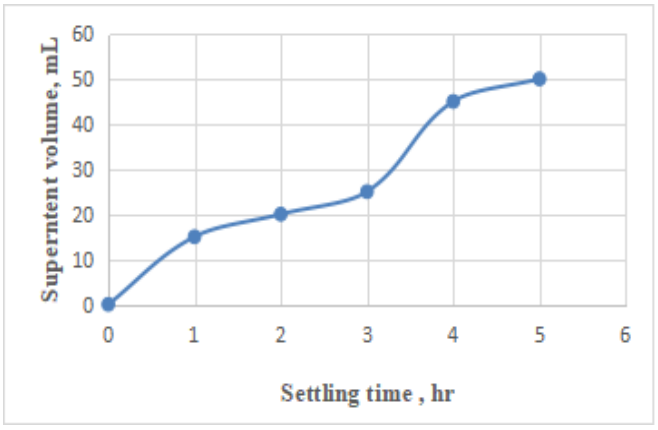

Fig-6: Supernatent volume vs settling time in hrs for Cr(III) precipitation

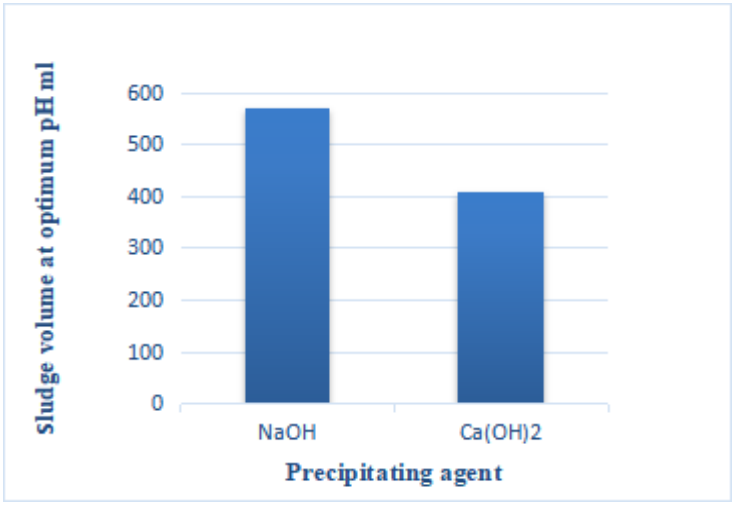

Fig-7: Sludge volume at optimum pH in ml vs precipitating agent added

4. CONCLUSIONS

After all the experimental study of the chemical precipitation method is known to be a cost-effective, maintenance free and less energy input process for the treatment of chrome effluent. During the characterization it is known that aerospace industry is having high content of chrome content in it. The maximum reduction of hexavalent chrome ions occurs by adding 100mg/l of sodium metabisulfate reducing agent at the pH of 2 in acidic medium.The precipitation of trivalent chrome ions is effected by pH 9.1 in which 1.35mg/l of chrome is precipitated, mixing time is low for caustic soda due to high solubility rate of caustic soda, settling rate of chrome supernatent is 5ml/hr and the sludge volume produced is the 569ml.Therefore maximum removal efficiency of 98.97% chrome is been precipitated in the pH range of 8.6. Hence it is proved that chemical precipitation method is best suited for chrome treatment in the aerospace industry.

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