

POWDER COATING INDUSTRY: WASTE WATER CHARACTERISTICS AND EFFECTS ON ENVIRONMENT.

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Abstract— *This paper is a brief discussion about the powder coating industry or the Metal Coating Industry, process involved in it, the units involved in the industry; Chemicals used in processes; sources of wastewater in these units and the effect of this wastewater on the environment. The Powder coating industry wastewater was tested for different parameters during the study which is characterized by high BOD, COD, Turbidity, nutrients, and inorganic contents in both dissolved and suspended form. If discharged without proper treatment, the waste water pollutes the receiving water bodies and Environment.*

Keywords— *Powder Coating Industry, Processes, sources, effluent, characteristics, effects on environment.*

I. INTRODUCTION

This In recent times due to rapid growth in the field of industrial and technological development. The need for metallurgical and metal processing industry has gone up. Thus the industries such as Powder coating industry, as it is the sustainable cost effective and durable metal finishing process and has much demand in the market but as the manufacturing process becomes advanced in technology, Environmental Constraints are also important to be followed. Thus this study is important to know the characteristics of the waste water , sources of waste generation in this industry.

A. Powder coating Industry.

The powder coating application process is fundamentally the same as a Painting procedure with the exception of that the "paint" is Liquid state where as powder coating is in dry state. Powder is sprayed on the metal to be covered. The powder adheres to the parts because of powders electrostatic charging and grounding of the parts. Any material can be utilized that can withstand the heat applied for curing the powder and that can be electrically grounded to improve charged molecule attachments. The powder melts and fixes during the heating process.

Before coating on the surface of the metal to be coated surface preparation is the very important step. The process is called pre-treatment.

Pre-treatment is the process in this industry where the waste water is generated.

B. Pre-treatment Process

Prior to the powder coating is applied on any substrate, it is compulsory to undergo pre-treatment so as to improve the toughness of the powder coating. Methods of pre-treatment for metal substrate before powder coating are separated into 2 compose, phosphating what's more, chromating. Each kind of pre-treatment is then sub-separated into as given below.

C. Phosphating

It is also called conversion covering; phosphating is an applying a ferrous or zinc phosphate on the substrate. This coating of pre-treatment process is a vital procedure as it altogether builds the performance of the coated surface.

D. Chromating

Chromating is the most utilized conversion coating process for aluminium jobs which will be powder coated. The chromate layer upholds the adhesion of the metal surface and the lacquered item. Chromate layer is thicker in comparison with phosphate layer thus, it will give an exceptionally great resistance against rusting, yet the grip will be poorer compared with a thinner layer. Thin Chromate layer will bring about great bond, but poorer resistance for rust.

II. STEPS INVOLVED IN PRE-TREATMENT PROCESS IN INDUSTRY AND SOURCES.

Here the detailed pre-treatment process is explained. Several water baths are made and chemicals are mixed according to the requirement and clean water baths are present after each process so that the chemicals of each tank don't mix with others. These Rinsing water are the regularly disposed effluent and are too polluted.

A. Degreasing.

Grease, oil and other surface Pollutant present on the metal surface during preparation will be expelled in this degreasing before Derusting process. Keeping in mind the end goal to shield the surface from being damaged later this cleaning

procedure is done. The cleaning is done under temperatures somewhere in the range of 35-40° C while the span is around 15 to 30 minutes and higher relying upon the surface conditions.

B. Water rinsing

Chemicals added for Degreasing should not be mixed with the De-rusting bath because for Degreasing Alkaline is used and for Derusting Acid is used, so to not spoil the solution prepared Water rinsing is important after every Pre-treatment Step. The water must be clean deionized and must not contain hardness in water.

C. Derusting.

This process is also called as Metal Pickling or Etching. Derusting is process is to remove the thin natural oxide layer on the surface before the Phosphating or chromating. Inhibitors are also often added to protect the metal surface from attack during the etching process. This process is done under temperatures between 35-40°C while the duration is about 3 to 4 minutes and higher depending on the surface conditions.

D. Phosphating

Iron phosphate is the thinnest phosphate films. During the phosphating process, a flat or amorphous metal phosphate topcoat will be formed on the firstly developed iron oxide base. Once treated, the metal surface will have a blue iridescent or blue-gold iridescent colour, depending on the coating weight and the base metal. A typical iron phosphating process consists of

- Phosphate acid base
- Accelerators/oxidizers



Fig.1: Various Pre-processing units.

E. Passivation

De ionizing Rinse or passivation it is called. Here the water mixed with some reagents a solution is prepared. This is the final step and a final coat of pre-treatment just before the actual powder coat. This is the step where the excess charge from the metal job is removed and this is the layer which helps the adhesiveness of the surface so that the durability of the coat applied on it will be increased.

Chemicals used for each unit and the temperature condition to be maintained in the table (Table I).

TABLE I
COMPONENTS OF PRE-TREATMENT BATHS AND RESPECTIVE TEMPERATURE TO BE MAINTAINED.

Bath no.	Name of baths	Composition	Temperature
1	Degreasing tank	Alkaline Cleaning agent (Chemogral)	35-40° C
2	Rinsing Tank	Water	Room temperature
3	De-rusting Tank	Acidic De-rusting Agents (Chemopickle) contains Concentrated nitric acid	35-40°C
4	Rinsing Tank	Clean water	Room temperature
5	Phosphating	Phospho-C and Accelerators	35-40°C
6	Rinsing Tank	Clean water	Room temperature
7	Passivation	Seal Phospho-C	30-40°C

Depending upon the chemicals and materials used each solution may have different values of parameters tested in lab, the rinsing water between each station also has a large amount of chemical pollutant and may turn out to be a vital element to be considered for treatment. Whereas the rest can be recycled and rarely disposed after the strength of the solution gets reduces.

III. CHARACTERISTICS OF WASTE WATER.

The samples from each pre-treatment process units were collected separately and the basic tests such as pH, Turbidity, TDS, BOD, COD, and Conductivity. The readings were noted down carefully and the readings are represented in the table (TABLE II).

TABLE III
COMPONENTS OF PRE-TREATMENT BATHS AND RESPECTIVE TEMPERATURE TO BE MAINTAINED.

Bath no.	Name of baths	Colour	pH	TDS (mg/L)	Turbidity (NTU)	BOD₅ (mg/L)	COD (mg/L)	Conductivity (mS/cm)
1	Degreasing tank	Brownish, Clay coloured	11.12	2110	103.1	997	2978	87
2	Rinsing Tank	Light Whitish (almost Transpharent)	10.3	820	106.3	750	1876	3.7
3	De-rusting Tank	Dark Green	0.54	2193	28.6	1345	5461	113
4	Rinsing Tank	Milky colour	1.34	1145	27.4	913	3943	33
5	Phosphating	Whitish	2.6	1521	84	1277	4153	13.2
6	Rinsing Tank	Milky colour	4.4	680	26.7	786	3171	2.4
7	Passivation	Bright Yellow	2.07	-	6.7	893	2856	2.2

*all the values are noted through experimental study.

The jobs prepared are dipped in these baths as mentioned above and further taken for a quick drying and then it is painted or coated with powder. According to the study and as told by the workers, water will be disposed at a rare frequency. Water from the rinsing baths are disposed once in a month, half of the volume of Degreasing and Derusting units are disposed after the deposited sludge especially in the derusting bath is removed and the Phosphating and Passivation Solutions are used until they lose their strength.(again 1 year on an Average).

Depending on the frequency of disposal a test sample of mixture of all the effluents was prepared by composite sampling. This prepared test sample was tested for certain parameters to analyze the effect of that waste water on the environment and the characteristics are given below in table (TABLE III).

TABLE IIIII
COMPONENTS OF PRE-TREATMENT BATHS AND RESPECTIVE TEMPERATURE TO BE MAINTAINED.

Sl No.	Parameters	Values	CPCB standards
01	pH	3.36	6.5 to 8.5
02	Colour	Greenish-Grey	Colourless
03	Conductivity	2400 µs/cm	-
04	Turbidity	385 NTU	40
05	COD	4573 mg/L	250
06	BOD5	1667 mg/L	50
07	Total dissolved solids	2361.3 mg/L	1500
08	Oil and grease	113.5 mg/L	10
09	Suspended solids	1950 mg/L	150
10	Acidity	1180 mg/L	-
11	Alkalinity	34.45 mg/L	-
12	Phosphate	217.9 mg/L	2
13	Chromate	84.7 mg/L	2

*all the values are noted through experimental study.

IV. EFFECTS ON ENVIRONMENT OF POWDER COATING INDUSTRY WASTE WATER.

Though the frequency of disposal is not frequent when compared to the rest of the industry which dispose daily, the pollutants present are too harmful. As the table given above (Table III), we can observe the pollutants present and also predict and study the impact of the pollutants on environment.

The Waste from the Powder coating industry preprocessing units are observed to be Acidic, Colored, and Turbid and has lot of solids may be dissolved or suspended. Oil and Grease, BOD, COD are also major pollutants present in this type of waste water. And over all of these it high amount of Phosphate and Chromate in the concentration which is way to greater than the permissible limits. Let us study how the presence of these pollutants in the waste water affects the Environment.

A. Waste water released into sewer.

We have observed that the waste water has lots of chemical load and also suspended and dissolved particles. Its acidic too thus by releasing this waste into sewer not only affects the pipes but also affects the Sewage Treatment Plant. The enzymes present in Biological treatment units will be dead and also affects the normal functioning of the plant by corroding the pipes and other components.

B. Waste water released into River stream.

By releasing waste water from powder coating industry into river stream not only affects the quality of water but also quality of aquatic life. Highly polluted waste water when released into river, Aquatic animals and plants die, due to this there will be a load of Biological waste which decreases the DO content in water and in return increases the BOD.

Chemical Oxygen Demand of the waste water is also more thus this also affects the receiving stream. The pollutants such as Chromate and Phosphate affect the Human health and attack directly to the cells. Thus these are considered to be the Toxic materials in this pollutant. However there were no traces of lead and cadmium during the testing of waste water.

Color and the Foamy formation also make the water aesthetically poor and unfit for use. However as the Concentration of water is very less and the frequency of disposal is not so more thus turbidity and TDS, TSS wont affect much and get diluted into the flow of water. But they can cause a serious issue if the quantity is more with respect to dilution.

C. Waste water effects on Land.

Most of the Industry of these disposes the waste water on land or in sewage, against the environmental norms. When this type of water is disposed on land, it not only affects the soil quality but also the plants and trees in the surrounding.

Small fine solids either in suspended or dissolved state will clog the pores in the soil and the infiltration rate decreases and the pores will be filled by the pollutants. Microbial activity in the soil will be completely killed due to high acidic and chemical content in the water.

The pollutants such as chromate are the most disastrous. They make the land barren and also affect the nitrogen present in the soil. An undesirable deposit (Whitish Grey color as observed) gets settled on the surface of the land and the soil becomes polluted completely.

There are chances of ground water pollution by these kind of waste infiltrates or come in contact with the ground water.

V. NEED FOR TREATMENT OF WATER.

Coating Industry include steps such as “chromating”, “phosphating”, coloring of metal and “passivating” as said above. A large amount of solid suspended and also dissolved waste is generated due to rinsing and washing of the metal components to be coated during the pretreatment. These process baths has liquids or solutions which comprises of harmful pollutants such as metal salts, acids, bases and other dissolved materials. Metal coloring involves the chemical method of converting the metal surface into an oxide or similar metallic compound to give an aesthetically good finishing. Dangerous poisons from such industries must be controlled to avoid the effects on the environment.

There is a need of a treatment which not only reduces the pollutants but also nullify the effect of the chemicals on the receiving body and the treatment plant must be so designed that it must work only when the water is disposed because the disposal of the water will not be discharged regularly and will be less frequent And whenever discharged it will less in quantity but high in concentration. Generally the ionic waste should be targeted. Thus Electro coagulation and some ion exchange processes are the suitable ones when compared to other high cost Treatment method.

VI. CONCLUSION.

Powder coating industry being one of the most effective metal coating and finishing industry produces the waste water which is highly polluted and concentration is more. Based on the parameters of the waste and its characteristics and also the effects on environment, treatment is required and the treatment plant must be effective efficient yet simple.

It should be effective in targeting and treating almost all the pollutant parameters and the effluent from the treatment plant should be under the CPCB (Central Pollution Control Board) norms.

It should be efficient because the coating industry will be most of the time a small or medium sized industry and requires a compact, cost effective yet efficient treatment plant.

Depending upon the type of pollutant and the requirements of the waste Electrocoagulation could be the most suitable kind of treatment method for treatment of this water and it is recommended as a future study for the Powder coating industry pretreatment process waste water.

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