Cost saving for Surface treatment plant

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Abstract: The metal industry is one of the most important and vital industry of the present and the future. This review paper focuses on a) metal process of Surface treatment plant (STP) using four different cleaning processes, such degreasing, electropolishing, pickling, and passivation. b) We can reduce the operating cost of STP (surface treatment plant) by using degreasing modification method and Evaporation operation treatment. We can improve the system by using the new method and minimizing as operating cost and hazardous waste and increase the plant efficiency.

Key Word - Surface treatment plant, degreasing modification method, evaporation operation treatment, operating cost, hazardous waste

1. Introduction:
The surface treatment of metals and plastics is therefore largely a service to many industries and examples of key customers are given below: Automotive, Food and drink containers, aerospace, printing, Information systems, Domestic appliances, Telecommunications, jewellery, spectacles and ornaments, Heavy engineering, Furniture, Construction (building), Clothing, Bathroom fittings, Coinage, Hardware, Medical.

The market structure in volume is approximately: automotive 22 %, construction 9 %, food and drink containers 8 %, electric industry 7 %, steel semi product 7 %, electronic industry 7 %, industrial equipment 5 %, aerospace industry 5 %, unspecified 30 %.

Surface treatment is positioned between initial workpiece or substrate manufacture and final product assembly, completion and packaging. Treatment (both in jobbing shops and many in-house workshops) often has low priority in the production chain, although there are significant exceptions. Low priority can result in insufficient attention to correct and up to date specifications, insufficient attention given in product design to minimize and reduce consumptions, as well as a lack of investment. Surface treatment is usually carried out after the primary metal or plastic has been formed into workpieces or shaped substrates, such as nuts, bolts, pressed or moulded components, sheets, or coils. They may even be sub-assemblies made of several components, often of different materials. These components and sub-assemblies can be complex shapes which have been pressed, cast and/or machined. However, in coil processing the surface treatment is applied before the substrate used. The size varies from wires to steel strip 2008 mm wide. In smaller scale reel-to-reel applications, copper, brass or other alloys are also coated. Printed circuit boards are made from plastic or glass fiber board’s which are already laminated (usually with copper) or plastic films.

Degreasing is the removal of grease and oil from a surface. It is widely used to remove oils and oil-borne soils from objects that have been stamped, machined, welded, die-cast, etc. Degreasing cleans almost all electronic assemblies, electrical components and almost all metals, and nearly any size or shape part can be cleaned. Degreasing is an essential part of the production process, particularly in industries fabricating or assembling metal parts, such as aircraft, appliances, automotive, electronics and railroad. Degreasing is also known as defatting or fat trimming.

Degreasing is a process for removing water-insoluble substances such as Grease, Fats, Oils, Waxes, Carbon deposits, Fluxes, Tars.

This process removes oil, grease, dirt, loose particles and any other contaminants that may exist on the surface of the material and prepares it for further operations such as electroplating or painting. The metal-working industries are the major users of solvent degreasing. Repair stations for transportation vehicles also sometimes use solvent cleaning. The acting principle behind the vapor degreaser process is that the solvents dissolve the contaminants on the workpiece and remove them by dripping off the part. Tiny electronics parts, aircraft components and automotive parts can all be safely, completely and quickly cleaned with this technique.

2. Materials & Methods
The general surface treatment plant is used of metal and plastic industry. Every metal industry has surface plant treatment is small difference in different process. General surface treatment plant has classified into four process & operation. 1. Degreasing 2.Electro polishing/Electroplating 3.Pickling 4.Passivation.
Surface treatment plants are used for cleaning purpose of metal parts/compounds such as iron, steel, copper, ceramic and bellows. Surface treatment plant is unit operation. Unit operation means only physical changes are take place & not only chemical change. Surface treatment plants are normally for cleaning of surface of metal components by using chemical concentration & composition.

Surface treatment plants are operated by manual or automatic by using PLC (Programmable Logic control) or SCADA (Supervisory control and data acquisition). In surface treatment plant there are nos of Trains. In each train there are no of tanks, which are depends upon quantity and types of compounds/materials which is being processed. Generally in small scale surface treatment plant every tank capacity is around 200 liters & two Trains are generally used. Number of Trains are depends upon operating condition such as PH, conductivity, temperature, basket traveling time from one tank to other tank.

Operating parameter such as PH, conductivity, temperature, basket traveling time from one tank to other tank can be monitor by automation (PLC or SCADA) or manual. In rinse tank measure operating parameters are PH & conductivity. If the set point for PH and Conductivity is exceeds more than 50% of set point, then we have to drain the rinse tank to ETP storage tank & fill up fresh water in tank from ETP supply. For Chemical tanks if measuring parameters such as chemicals composition, PH & conductivity are exceeding more than set point range of operating parameter, than these chemical are drain to ETP discharge collection station and collected to HDPE drum. Collected discharges chemicals are sends to Maharashtra pollution control broad (MPCB).

3. Cost saving idea:
We can reduce the operating cost of STP (surface treatment plant) and ETP (Effluent Treatment Plant) by following Ideas:

A. Degreasing modification method:
1. Degreasing method is used to remove oil from metal components which we are going to clean. Generally use of Degreasing chemical for cleaning heavy oily metals is the dilution ratio of 1:20 with water. Small scale plant degreasing tank capacity is 200 liter. Density of degreasing chemical (1050 to 1100 Kg/m3) is greater than the water. Also density of oil is lower than water and degreasing chemical because of lower density; oil is floating above water & degreasing chemicals. After long run of plant the percentage of oil in that solution will increase day by day. Normally small scale plant is running only in two shifts. During night shift plant is under shutdown. So it is observed that in the shutdown period due to density difference black oil will be floated above in that vessel. And that oil manually we can separate or remove from degreasing chemicals on next day before start up of the plant. By this method we can enhance the life of degreasing chemicals. And for more duration we can use same degreasing chemicals.
2. Normally Discard duration of one degreasing tank is 15 day. By this method we can increase the duration up to 30 to 45 Days. That means we are saving fresh 40 liter of degreasing chemical and fresh 400 liters water. And also save the cost of Discard degreasing chemical which have to send to MPCB. That means save the cost of disposal of 400 liters of chemical.
3. Manpower required for loading and discard (unloading) of degreasing chemicals is at least 2 engineers and 2 workers. By doing the above procedure we can save the man-hours consumed. That loaded degreasing chemicals are required to
heat up to 70 degC. For heating that chemicals time required is more than 2 hours. And at the time of discard these degreasing chemicals are required to cool to atmospheric temperature because storage of these chemicals are in HDPP lining tanks. Total saving of time is 8 hours. Ultimately it will reduce the operating cost of plant.

4. Total operating cost of the plant is the addition of fresh degreasing chemicals cost, water cost, Engineers cost, workers cost, cost of personal protective equipment, heating cost (up to 700C) and disposal cost.

5. As per existing operation Degreasing chemical required per year is 24 lots (per month 2 lots). Below calculation is based on 24 lots. Fresh degreasing chemical required per year is 480 liters and fresh water required per year is 4800 liters. Discard chemical will generate for disposal is 5280 liters

6. We can improve the system by using the new method and save the cost and increase the plant efficiency

Table No. 1-Degreasing modification result:

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Parameter</th>
<th>Exiting Process</th>
<th>Modification Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lots/year</td>
<td>24</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Chemical consumption</td>
<td>480 Liters</td>
<td>160 Liters</td>
</tr>
<tr>
<td>3</td>
<td>Manpower’s hours</td>
<td>192</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>Disposal chemical</td>
<td>5280 Liters</td>
<td>1760 Liters</td>
</tr>
</tbody>
</table>

B. Evaporation operation treatment:

Evaporation is an operation that is carried out in industry as a means of concentrating weak liquor/solution by vaporising a portion of solvent. The objective of evaporation is to concentrate a solution consisting of non-volatile solute and volatile solvent. Economy of an evaporator is defined as the number of kilograms of water evaporated per kilogram of steam fed to the evaporator. It is also called as steam economy.

1. Degreasing method is used to remove oil from metal components which we are going to clean. Generally use of Degreasing chemical for cleaning heavy oily metals is the dilution ratio of 1:20 with water. Small scale plant degreasing tank capacity is 200 liter. Medium scale plant degreasing tank capacity is 300 to 1000 liter. Large scale plant degreasing tank capacity is more than 1000 liters. Density of degreasing chemical (1050 to 1100 Kg/m3) is greater than the water. Also density of oil is lower than water and degreasing chemical because of lower density; oil is floating above water & degreasing chemicals. After long run of plant the percentage of oil in that solution will increase day by day.

2. Generally in surface treatment plant more than two degreasing chemical tanks are used. Normally Discard duration of one degreasing tank is 15 day.

3. Medium scale plant discard degreasing chemical is 1000 liters per 15 day. In this discard degreasing chemical 50 liters supraclean degreaser is present.

4. We reduce this 1000 liters discard degreasing chemical to 50 liters by using evaporation operation in spare tank in plant.

5. Evaporation operation can be down by using steam or electrical current.

6. Overall material balance is Feed = Water evaporated + Thick liquor

\[ M_f = M_v + M' \]

Water evaporated = 1000-50 = 950 Liters.

\[ M_s = \text{kg/hr of steam required} \]

\[ \mu_s = \text{Latent heat of condensation of steam at } 126^\circ \text{C} \]

\[ \mu_v = \text{Latent heat of vaporization of water at } 100^\circ \text{C} \]

\[ T_f = \text{Temperature of feed solution} \]

4.187 kJ/kg.K

Data

I. Let feed solution as a discard degreasing chemical

II. Neglecting boiling point elevation

IV. Latent heat of condensation of steam at 399K (126^\circ \text{C}) = 2185 kJ/kg

V. Latent heat of evaporation of water at 373K (100^\circ \text{C}) & 101.325kPa = 2257kJ/kg

VI. Specific heat of feed = 4.187 kJ/kg.K

7. Heat balance over evaporator:

Heat loss by Condensing steam (Latent heat) = Heat gained by Solution to increase its temp to B.P + Heat required evaporator water

\[ M_s \mu_s = M_f \mu_f (T_f - T_B) = M_v \mu_v \]

\[ M_s*2185 = 1000*4.187(373-298)+950*2257 \]

\[ = 314025 +2144150 \]

\[ = 2458175 \]

\[ M_s = 1125.022 \]
Ms = kg/hr of steam required = 1125.02 kg/hr
8. Temperature driving force
Ts = Saturation temperature of steam = 399 K
Temperature driving force
\[ \Delta T = Ts - T = 399 - 373 = 26K \]
9. Rate of heat transfer
\[ Q = Ms \times \mu_s = 1125.02 \times 2185 = 2458168.7 \text{kJ/hr} \]
\[ 2458168.7 \times 1000/3600 = 682824.64 \text{J/s} \]
\[ 682824.64 \text{ W} \]
10. Hot water generator diesel consumption = 21lit/hr
Output = 20000 kcal/hr
\[ = 20000 \times 1.163 \]
\[ = 232600 \text{ W} \]
For 682824.64 W required diesel is
\[ = 21 \times 682824.64 / 232600 \]
\[ = 61.65 \text{ liters} \]
11. Diesel cost after treatment
Diesel consumption = 61.65 liters
Cost of diesel = 61.65 \times 55.80 = 3417.75 RS
12. Disposal cost before treatment = 1000 * 20 = 20000 RS
13. Disposal cost after treatment =
Cost of diesel + disposal cost of slurry
\[ = 3417.75 + 20 \times 50 \]
\[ = 4417.75 \text{ RS} \]
14. Total Saving
Total saving = Previous disposal cost - new disposal cost per lot = 20000 - 4417.75
\[ = 15582.25 \text{ RS} \]
15. As per operation degreasing chemical required per year is 24 lots (per month 2 lots). Below calculation is based on 24 lots. Total saving of new Evaporation operation is 24 * 15582.25 = 373974 RS
16. Manpower required for loading and discard (unloading) of degreasing chemicals is at least 2 engineers and 2 workers. By doing the above procedure we can save the man-hours consumed. We can improve the system by using the new method and save the disposal cost and increase the plant efficiency
17. We have to try minimizing as operating cost & hazardous waste.

4. Results & Discussion:
Surface treatment plant is used for metal cleaning, such as degreasing, electro polishing/electroplating, pickling and passivation.
1. Efficiently used of degreasing chemicals for cleaning the metal surfaces can be done by this method.
2. Due to increased life of degreasing chemicals, minimized the generation of hazardous waste and saved the environment.
3. Saved the operating cost and cost for the degreasing chemicals.
4. Manpower optimization was can be done.
5. Minimizing degreasing hazardous waste & minimizing disposal cost.

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