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United Nations Environment Programme
Division of Technology, Industry and Economics

Profiting from Cleaner Production

Strategies and Mechanisms
For Promoting
Cleaner Production
Investments
In Developing Countries

Introduction to Capital Budgeting and Financing of Capital Projects

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Exercise

Cleaner Production

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The United Nations Environment Programme
Division of Technology, Industry and Economics
Production and Consumption Branch

Presents a Training Series

Strategies and Mechanisms for Promoting Cleaner Production in Developing Countries

Introduction to Capital Budgeting and Financing of Capital Projects

Exercise

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* Acme Electroplaters: Case Study and Exercise

I. INTRODUCTION

This case study and exercise involves the investigation of a potential Cleaner Production (CP) project at a small electroplating company in a developing country. The focus of this exercise is on identifying the important operating costs both before and after implementation of a CP project. Later in the course we will discuss using the operating costs and initial investment costs to determine the profitability of projects.

First, read the background information on the company and the manufacturing process. Then, with your group, work to answer the question 1 about the existing system. After about 20 minutes, continue on to read about the recommended cleaner production investment for this facility, and answer question 2. If time permits, answer question 3 about initial investment costs.

II. ABOUT ACME ELECTROPLATERS

Background

Established in the late 1970’s, Acme ElectroPlaters is one of the few small companies operating in a heavily industrialised area of a medium-sized city in a developing country. The company has annual revenues of approximately US$200,000 and 75 employees who work an average of 8 hours per day.

Acme's products include metal items such as candlesticks, picture frames, screws, nuts, and bolts that have been electroplated. The electroplating process will be described in more detail below. Acme's customers include both private individuals and other companies.

Electroplating process description

Electroplating involves the coating of a metal work piece such as a candlestick with a thin protective layer of another metal such as zinc, copper, nickel, bronze, tin, chromium, and brass. The purpose of the protective layer of metal is to improve the final product appearance and to increase the product lifetime by preventing rust formation. Acme has two production lines. One is a zinc electroplating line (also called a galvanising line), and one is a copper-nickel-chromium electroplating line.

The electroplating process consists of five main steps, as shown in Figure 1 and is described below:

(a) The *surface preparation step* insures that the surface of the metal workpiece (e.g., a candlestick) is clean so that the thin layer of plating metal will properly adhere. The first activity in surface preparation is the use of a bath of chemicals in water that removes organic contaminants such as grease, oil, paint markings, and dirt. A second chemical/water bath is then used to remove rust and scale. Finally, a third chemical/water bath is used to prevent rust from forming on the workpiece before the next manufacturing step.

The surface preparation step produces several forms of waste, including air emissions, solid sludge at the bottom of the bath tanks, and wastewater. The air emissions consist of chemical vapours from the surface preparation baths. The solid sludge and wastewater both contain oil and grease removed from the cleaned workpieces as well as residual surface preparation chemicals.

(b) The *electroplating step* is an electrochemical process, which coats the thin protective layer of metal onto the workpiece using an electric current. The workpiece is submerged into a water-based bath containing the dissolved metal (or metals) that will be used to coat the workpiece. The electroplating baths also contain other chemicals (e.g., cyanide) that assist the electroplating process. An electric current is run through the bath, and the current pulls the dissolved metals out of the bath solution and deposits them onto the surface of the workpiece. As more workpieces are coated, the dissolved metals in the plating bath are steadily used up. The bath must therefore be regularly replaced in order to assure proper coating of the workpieces.

The electroplating step produces the most significant air emissions at Acme, consisting of chemical vapours from the electroplating baths. The electroplating step also produces solid sludge at the bottom of the electroplating tanks and wastewater, both of which contain oil, grease, and residual electroplating chemicals.

(c) The *rinsing step* is done to remove any residual electroplating chemicals from the newly electroplated workpiece. Proper rinsing with water is very important because any bath chemicals remaining on the parts will degrade the surface finish or interfere with additional manufacturing steps. Therefore, the rinse tanks must be drained and refilled when they are too contaminated to rinse properly.

The rinsing step produces the largest volume of wastewater at Acme. This wastewater is contaminated by residual chemicals from the electroplating baths such as cyanide, heavy metal ions and complex ions. The rinsing step also produces some air emissions in the form of electroplating chemical vapours.

(d) The *post-treatment step* is a series of final activities that further protect the electroplated and rinsed part from moisture attack, tarnishing, and rusting. A chemical/water bath is used to remove any residual cyanide and heavy metals. Finally, the workpiece is put through a heat treatment process to improve its hardness.

The post-treatment step produces wastewater containing residual post-treatment chemicals, as well as air emissions in the form of post-treatment chemical vapours.

(e) The *wastewater treatment step* is used to treat the large volumes of wastewater that are generated by all four of the manufacturing steps described above. During the wastewater treatment step, treatment chemicals are added to the wastewater, and the treatment chemicals interact with the contaminant chemicals. As a result, some of the combined chemicals settle out in the form of solids, called sludge. The chemical sludge is separated from the wastewater, and the treated wastewater is then released to the municipal sewer system.

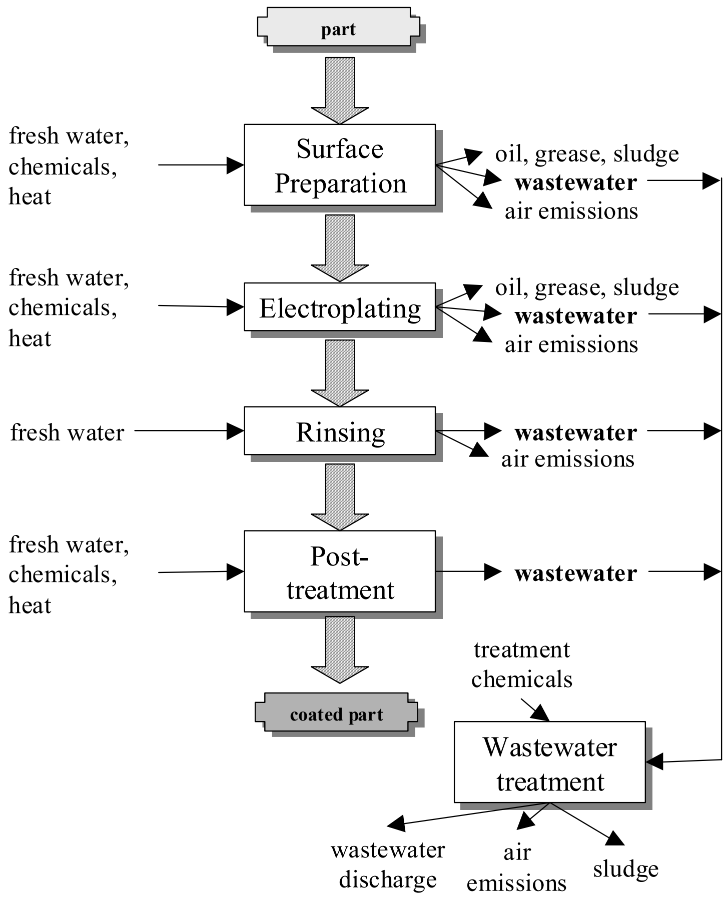

Figure 1 Overall Process Flow Diagram

Cleaner Production at Acme

A "Cleaner Production Assessment" conducted at Acme ElectroPlaters identified many areas for improvement that would simultaneously provide economic savings and environmental benefits. Some of the recommendations made are listed below:

1. **Increase the efficiency of water use during the rinse step of the process**
2. Replace the existing electroplating chemistry to eliminate the need for cyanide, a toxic chemical
3. Improve draining mechanisms to extend the life of each rinse bath
4. Install an agitation system during rinsing to improve the rinsing efficiency
5. Place covers on degreasing baths containing chlorinated solvents to reduce losses by evaporation

The CP recommendation to be discussed further in this case study is number 1 above, which is to modify the *rinsing step* during electroplating. This would significantly reduce water use at the facility. In order to assess the potential profitability of the capital project to modify the rinse step, it is necessary to estimate the initial investment cost of the proposed new rinse system. It is also necessary to compare the annual operating costs of the proposed new rinse system to the annual operating costs of the existing rinse system. As a first step, we will look a little more closely at the existing rinse system and think about annual operating costs for this system.

III. THE EXISTING RINSE STEP

Currently, Acme uses a two-tank static rinse system for rinsing the newly electroplated workpieces. In this system, each rinse tank is filled with fresh water at the beginning of the day, and used all day to rinse workpieces. At the end of the day, the contaminated bath water is sent to the wastewater treatment step. The static rinse system is shown in Figure 2 below.

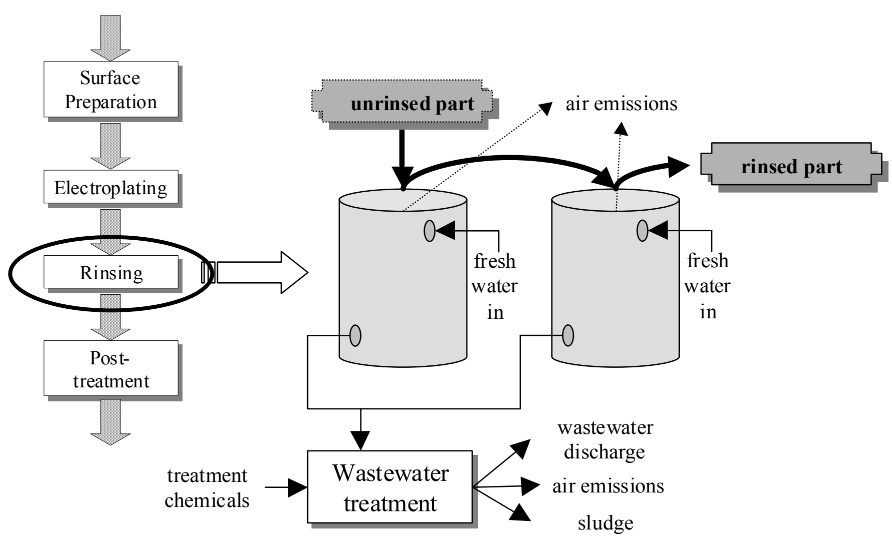

Figure 2 Existing Rinse Step (2-tank static rinse system)

Question 1 – Annual Operating Costs for the Existing Rinse Step

Please list any annual operating costs that you think are relevant for the existing static rinse system shown in the figure above. Use the table below to record your answers. Use only the first column of this table to answer Question 1 – the other columns will be used to answer Question 2 later.

Use this table for recording your answers to both Questions 1 & 2		
USE THIS COLUMNS FOR QUESTION 1	USE FOR QUESTION 2 ONLY	
In the column below, list any annual operating costs that you think are relevant for the existing static rinse system (see Figure 2 above)	If the new system is adopted, does the cost *increase*? *decrease*? *stay the same*?	Which of these are the most significant for project profitability?

IV. THE PROPOSED NEW RINSE STEP

Water consumption at Acme can be reduced considerably by replacing the existing 2-tank static rinse system currently used with a 3-tank counter-current rinsing system where the same rinse water is cycled through three rinse tanks. Fresh water flows into the last tank and runs in the opposite direction of the flow of the workpieces being rinsed. In other words, the fresh water supplied to the third rinse tank is subsequently reused in the second and first rinse tanks. Because of the nature of the piping for the new system, all new tanks are required. The water overflow from the first tank is sent to the wastewater treatment system. This 3-tank counter-current rinse system is shown in Figure 3.

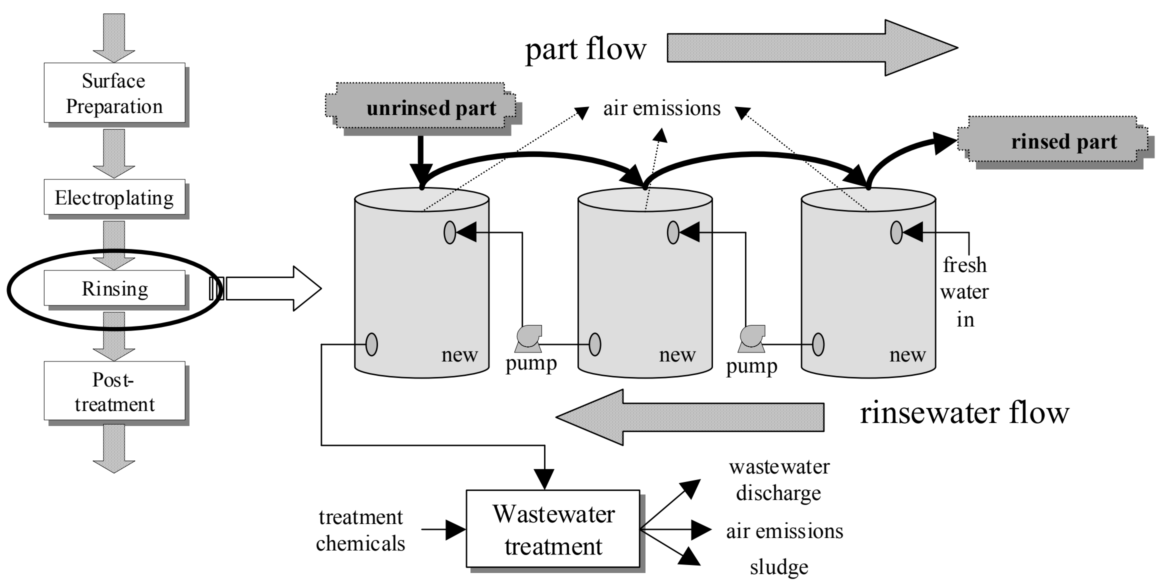

Figure 3 Proposed New Rinse Step (3-tank counter-current rinse system)

Question 2 – Annual Operating Costs for the Proposed New Rinse Step
Compare the proposed new rinse system (Figure 3) to the existing rinse system (Figure 2). If the new rinse system is adopted, how will this impact the annual operating costs for rinsing, which you listed for Question 1? Which annual operating costs might increase? Which might decrease? Which might stay the same?

Can you think of any completely new annual operating costs that might be relevant with the new rinse system?

Of the annual operating costs that would change upon adoption of the proposed new rinse system, which might be the most significant for project profitability?

You can record your answers in the same table used to record your answers to Question 1.

OPTIONAL – If you finish the other questions early, try to answer this question also.

Question 3 – Initial Investment Costs for the Proposed New Rinse System

Assume that Acme is interested in replacing the existing static-rinse system for all of its production lines with the new counter-current rinse system. In addition, assume that only one existing rinse tank from each production line can be adapted for use with the new system. Please list the types of initial investment costs that you would expect to be relevant for this capital project. You may use the table below to record your answers.

Expected Initial Investment Costs for the Proposed New Rinse System