RAW MATERIALS AND PROCESS CHEMICAL RECOVERY IN INDUSTRIAL WASTEWATER POLLUTION CONTROL

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Summary

This article illustrates the different methods employed to recover raw materials and process chemicals in various industries. Although only a few industries such as car painting, metal cutting, electroplating, textile, abattoir and pesticide formulation have been illustrated in case studies, almost all the industries can recover raw materials and process chemicals from their waste streams. The case studies show that the investments on new processes or systems used to recover raw materials and process chemicals have a short payback period and hence bring huge savings to those industries. Thus, each industry should try to recover raw material and process chemicals from waste streams.

1. Introduction

There are several types of recycle/recovery/reuse strategies that may be explored for waste minimization. One approach can be in-process recycling: i.e. the recovery of material for reuse at the same facility at which it is generated. However, this is too restrictive. A useful classification can be:

- direct recycle for primary (generator) use or in-process recycling;
- use by a second industry as a raw material (secondary recycle);
- energy recovery;
- utilization in pollution control systems.

Some examples on recovery/recycle/reuse are given below and some case studies are detailed in subsequent sections:

- Using a vapor recovery system to recover organic solvents in printing can reduce the fresh solvent requirement as well as air pollution caused by the solvent vapor.
- Using an ultrafiltration (UF) system to recover dyestuffs from textile industry wastewater will help in reusing the recovered dyes.
- When dragout recovery operations are practiced, the recovered solutions can be returned to the original process.
- Rinsewaters from various operations may be suited for use as makeup water for the manufacturing process.
- In polymer manufacture, the grinding pumpout solution from polymer manufacture can be returned for reuse in the original process rather than disposing it off.
- Potential examples for secondary recycle are the use of waste solvents generated in electronics as raw materials in paint manufacture and the use of paint sludge as sealant materials. The availability of waste exchanges can facilitate such transfers

2. Case Studies

2.1. Car Industry

Ultrafiltration (UF) is used in the car painting industry especially where electrophoretic method of painting is adopted (see Figure 1). Around 25–45% of paint consumed goes into the wastewater stream. This can be completely recovered if a UF system is incorporated in the process. This will also help in reusing the permeate in the process by which water economy can be adopted.

Solvent/paint waste streams from automated paint spraying operations may also be treated using UF. These types of wastes are typically generated when the paint color is changed and the lines are cleaned with paint solvent to flush out the old paint. An automobile manufacturing plant, which installed a UF system to recycle paint cleaning solvent, reported a payback period of only 5.3 months due to savings in waste disposal and fresh solvent costs. However, low fluxes were encountered because paint solutions typically contain high levels of dissolved polymers, which form a gummy, gel-like layer on the membrane surface. This layer is difficult to remove hydrodynamically and also has a low permeability.

In a particular car industry in France where they adopt cathodic painting, 70 cars are painted in an hour (250 000 cars/year). The total surface painted is 4500 m^2/h (65 m^2/car). A good rinsing requires 1 L of water per square meter of surface. 95% of this rinse water can be recycled if UF is used in the process. In this industry, 135 m^2 of membrane area (3 modules of 45 m^2 each) was used. Table 1 shows the cost estimation in implementing the recovery of raw material and related economic benefits. From the table it can be seen that the capital cost of UF can be recovered within four months of operation.

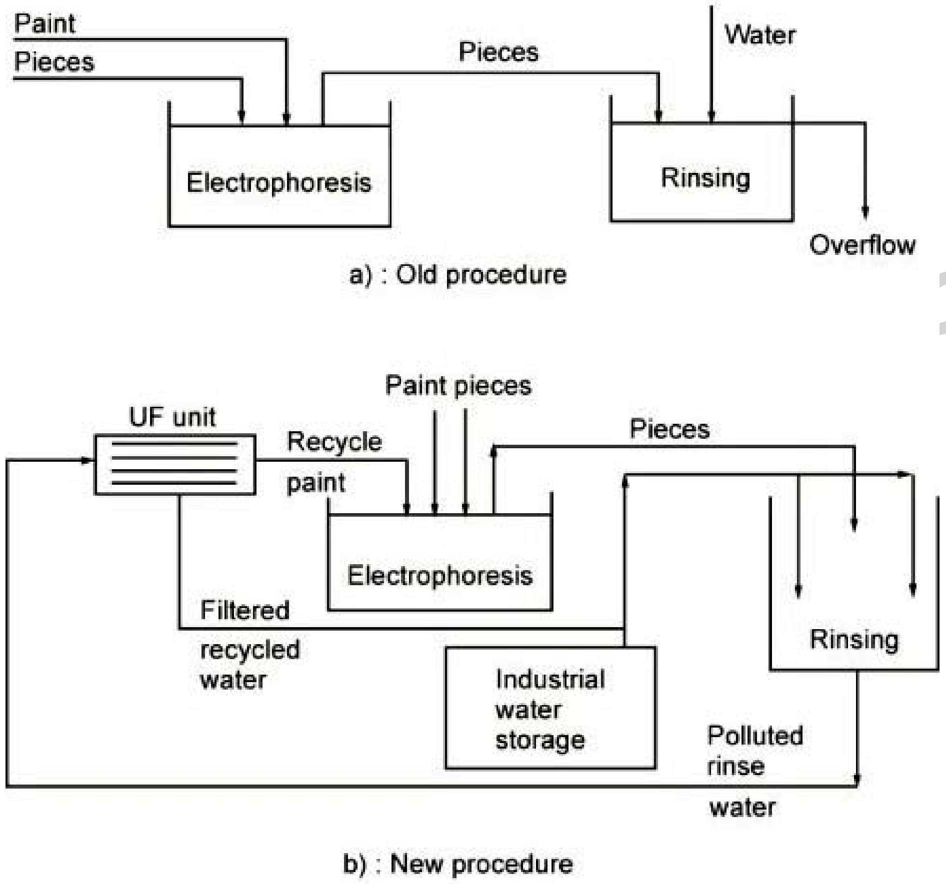

Figure 1. Old and new processes used in car painting industry

(a) Capital cost modules, pumps, control units etc.	**$450 000**
(b) Operational cost energy cost (3 pumps at 18 kW/hr; 8000 hr operation/yr at 6c/kW)	**$25 920/yr**
(c) Maintenance cost changing membranes once in 3 yrs and regular maintenance	**$23 000/yr**
(d) Recovery paint recovery (9 g/m^2 × 4500 m^2/hr × 3500 hr/yr × $0.01/g = $1 417 500) and demineralized water recovery ($135 000)	**$1 552 500/yr**
if the amortization period is 5 years, amortization/yr [from (a)]	$90 000/yr

annual operation and maintenance cost [(b)+(c)]	$48 920/yr
annual saving due to the recovery of paints and demineralized water [(d)]	$1 552 500/yr
Economy	**$1 413 580/yr**

Table 1. Economic benefits from recovery of raw materials in a car painting industry

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Biographical Sketches

Veeriah Jegatheesan is currently a senior consultant with Australian Water Technologies, Sydney, Australia. He obtained his B.Sc.Eng., M.Eng. and Ph.D. degrees from University of Peradeniya, Sri Lanka (1983), Asian Institute of Technology (AIT), Thailand (1992) and University of Technology Sydney (UTS), Australia (1999), respectively. His areas of interests are designing and modeling water and wastewater treatment systems, modeling water quality in drinking water distribution systems, cleaner production/industrial waste minimization and environmental impact assessment. He has published over 30 articles as journal papers, international conference papers, books, book chapters and technical reports in his areas of interest. In addition to his current position as a senior consultant with Australian Water Technologies in modeling biofilm growth and disinfectant decay in drinking water distribution systems, Dr. Jegatheesan has worked in the capacity of senior consultant in water and wastewater treatment systems in Thailand, senior measurement engineer in Sultanate of Oman and teaching assistant in department of civil engineering and engineering mathematics of the university of Peradeniya, Sri Lanka.

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