PROCESS/TECHNOLOGY MODIFICATIONS IN WATER POLLUTION CONTROL

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Summary

This article discusses the importance of modification in process/technology in various industries in order to control the pollution produced by those industries. Case studies on the modification of rinsing procedures for metal parts and for the product line between two kinds of yogurts, changes in the mode of transportation in poultry industry and the introduction of biological degreasing of metals show huge benefit due to those modifications. Changing the products as well as input materials, too, bring waste minimization along with sustainable development.

1. Introduction

Changing the production process is an important technique for reducing volume and concentration of pollutants in the wastes. Waste treatment from the source itself should be considered as an integral part of production. Changes in equipment can lead to reductions in the strengths of wastes. This is usually done by reducing the amounts of contaminants entering the waste stream. Slight changes are often made in the existing equipment setup to reduce the waste such as putting traps on the discharge pipeline in poultry plants to prevent emission of feathers and pieces of fat.

2. Case Studies

2.7. Alteration in Washing/Cleaning Procedure (adapted from Riikonen, 1992)

Alteration in washing/cleaning procedure can be achieved by:

- using counter-current washing;
- recycling used solvent;
- reducing the cleaning frequency.

Counter-current washing is one of the efficient ways of achieving waste reduction and water conservation. In counter-current rinsing, the work piece is rinsed in several tanks in series. Water flows counter to the movement of the work piece so that clean water enters the last rinse tank from where the clean product is removed. There is only one fresh water feed for the entire set of tanks and it is introduced into the last tank. The overflow from one tank becomes the feed for the tank preceding it, and so on. Thus the concentration of dissolved salts decreases rapidly from the first to the last tank. Waste water is discharged from the first tank, which initially receives the contaminated product needing to be rinsed. Figure 1 shows the rinsing method adopted in electroplating/metal finishing industries. In a situation requiring a 1000 to 1 concentration reduction, the addition of a second rinse tank (with a counter-current flow configuration) will reduce the theoretical water demand by 97% (see Table 1).

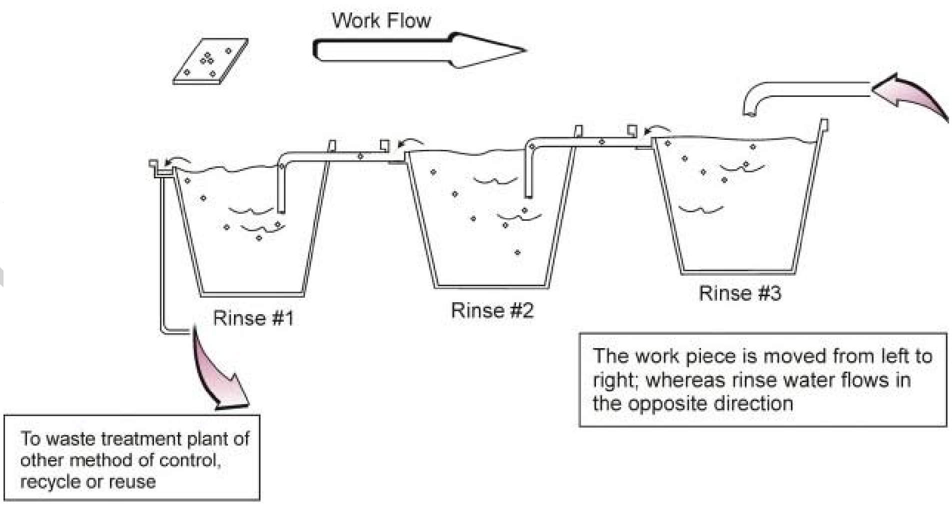

Figure 1. Counter-current rinsing

Type of rinse	Number of rinses	Required flow (L/min)
Single	1	37.9
Series	2–3	2.3–1.4

Counter current	2–3	1.2–0.4

Table 1. Theoretical rinse water flows required to maintain a 1000 to 1 reduction in concentration

Single Running Rinse. The single running (Figure 2) rinse requires a large volume of water to effect an associated large amount of contaminant removal. Although in widespread use, when identified, a single running rinse should be modified or replaced by a more effective rinsing arrangement. The addition of even a single “still” or “dead” rinse tank to the single running rinse greatly reduces the contaminant level introduced into the rinse line.

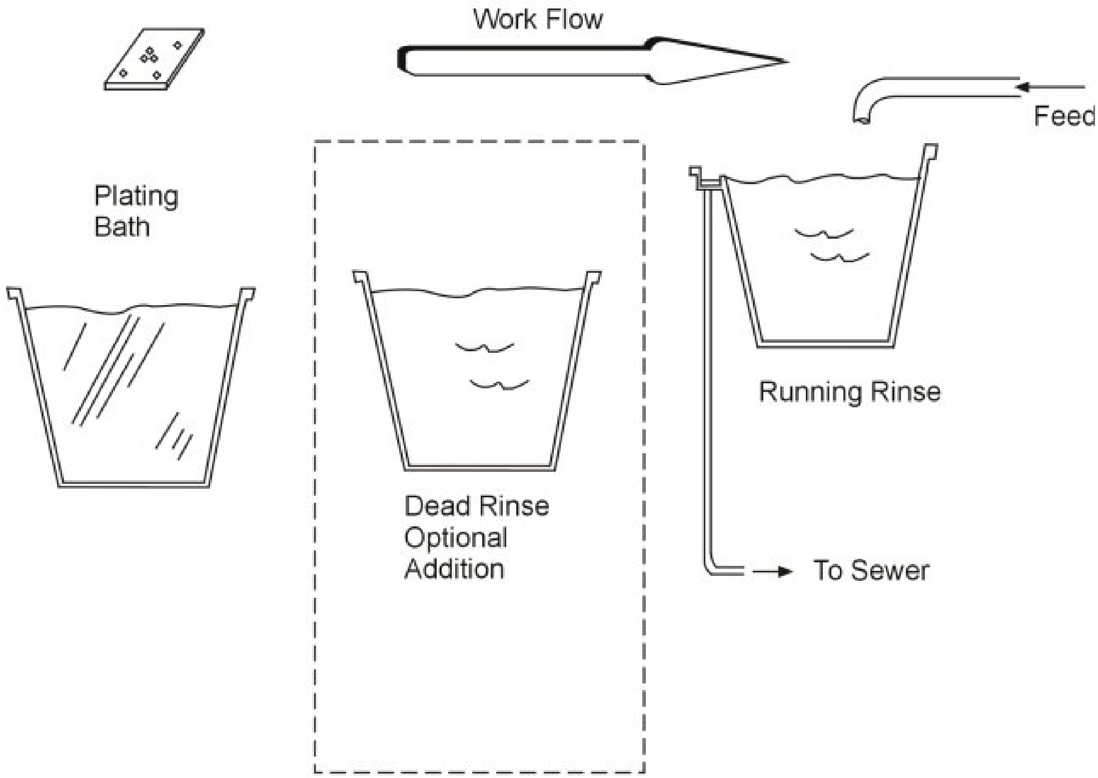

Figure 2. Single running rinse

Spray Rinse. Spray rinsing is considered to be the most efficient of the various rinsing techniques using continuous dilution rinsing. The main concern encountered in its use is the efficiency of the actual spray (i.e. the volume of water contacting the part and removing contaminants compared to the volume of water discharged). This technique is very well suited to flat parts; the impact of the spray also provides an effective mechanism for removing dragout from recesses with a large “width to depth” ratio.

Dead, Still, or Reclaim Rinses. This form of rinsing is particularly applicable for initial rinsing after metal plating. The dead rinse allows for easier recovery of the metal and lower water usage. The rinse water is often transferred to the plating tank that precedes it. The dead rinse is followed by spray or other running rinses.

Combination Rinsing. In many plating shops where multiple lines are employed to plate a variety of metal ions, there exists the possibility for a variety of creative rinsing combinations (which can take advantage of specific process characteristics and requirements) to reduce water use and minimize metal pollutants.

The possible arrangements are quite numerous but all rely on the basic principles outlined, from single plating lines to multiple lines incorporating mixed rinses. In most cases combination rinsing will be found in new plating plants where it was included in the original process design. Older multi-line shops are usually reluctant to undertake the restructuring needed to incorporate combination rinsing techniques. All rinsing techniques point up the fact that it is often more productive for an existing plating operation to look at internal process modifications and process sequence changes than it is to provide end-of-pipe pretreatment without investigating such possibilities.

2.8. Employing New Methods in Production Line Cleaning

In a Dutch company, rinsing was originally carried out between batches of two kinds of yogurts. In the new process, instead of rinsing between batches of different yogurt flavors, the last portion of the first batch is removed by drawing off a few liters of the next batch and so:

- product loss is reduced by 50%;
- discarded yogurt is reused as cattle feed;
- detergent usage is reduced by 20%;
- waste discharged to the treatment is reduced.

The economic benefits due to the modification in rinsing are summarized in Table 2. From Table 2, it can be seen that the payback period for the installation of monitoring instruments is less than a month and the annual savings was Dfl.98 400.

Annual saving due to:	**Dfl.**
• modified rinsing	18 200
• reduction in product loss	11 000
• reduction in discharges of waste	5 500
• reduction in water usage	1 700
• reduction in detergents' usage	54 000
• reduction in discharge of detergents to the wastewater treatment facility	8000
Total annual saving:	**98 400**
Installation of monitoring instruments	6000

Table 2. Economic benefits due to modified rinsing

2.9. Changing the Method of Water Transport

In poultry industry, large quantities of water are used for transportation of waste materials such as intestines, feet, feathers, etc. Due to the nature of the process in these farms the wastewater generated would be highly organic and thus very difficult to treat. If mechanical transport is used instead of water, this problem can be solved very easily. In such a case wastewater would be generated only occasionally when washing the floors or containers (see Figure 3).

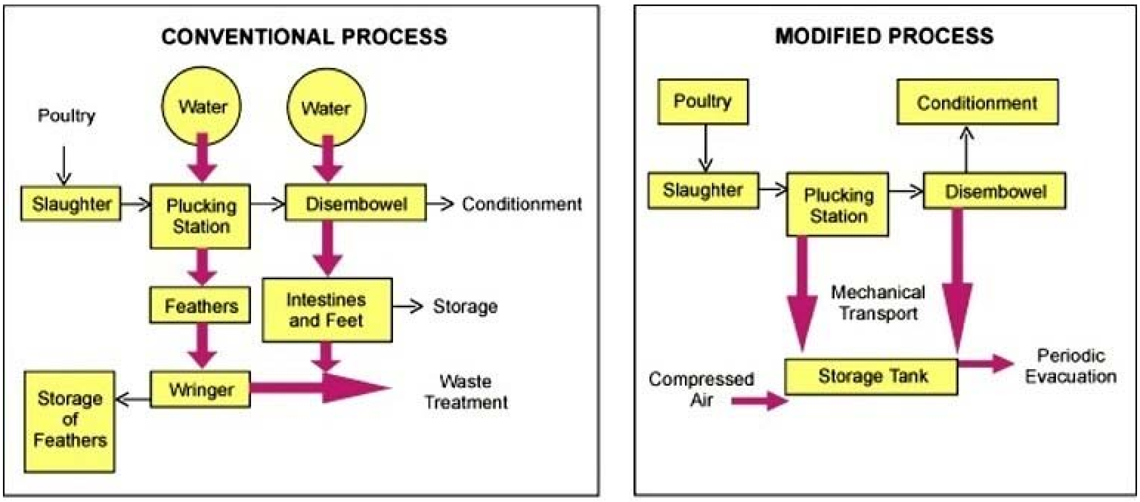

Figure 3. Conventional and modified transport systems in poultry farms

As can be seen from Table 3, the waste strength in terms of BOD, suspended solids and grease reduces to a great extent in the new process. The quantity of the water used also reduces significantly. A greater reduction in investment and annual cost can be achieved by adopting waste minimization technology in poultry industry.

Parameter (per ton of slaughtered poultry)	Old process	New process
Wastewater, m^3	20	11
BOD, kg	8	8
COD, kg	24	17
Suspended solids, kg	9	5
Grease, kg	2.5	1

Table 3. Waste minimization in poultry farms.

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Bibliography

Cleaner Production Worldwide, Volume II, (1995). UNEP. [This covers cleaner production case studies with economic evaluation.]

Huisingh D., and Baas L. W. (1991), *European Water Pollution Control*, **1**(1), 24–30.

Office of Technology Assessment, (1986). *Serious Reduction of Hazardous Waste*. OTA-ITE-317, Washington, D.C.

Riikonen, N. (1992). *Industrial Wastewater Source Control—An Inspection Guide*, Technomic Publishing Company, Inc., PA, USA. [Provides techniques to minimize wastewater generation in various industries.]

Theodore L., Dupont R. R., and Reynolds J., eds., *Pollution Prevention—Problems and Solutions*, Gordon and Breach Science Publishers S.A., Switzerland. [Contains worked examples on waste minimization.]

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, 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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S. Vigneswaran is currently a Professor and Head of Environmental Engineering Group in Faculty of Engineering, University of Technology, Sydney, Australia. He has been working on water and wastewater research since 1976. He has published over 175 technical papers and authored two books (both through CRC press, USA). He has established research links with the leading laboratories in France, Korea, Thailand and the USA. Also, he has been involved in number of consulting activities in this field in Australia, Indonesia, France, Korea and Thailand through various national and international agencies. Presently, Dr. Vigneswaran is coordinating the university key research strengths on “water and waste management in small communities”, one of the six key research centers funded by the university on competitive basis. His research in solid–liquid separation processes in water and wastewater treatment namely filtration, adsorption is recognized internationally and widely referred.