

ECONOMIC EFFICIENCY OF AQUEOUS AND SOLVENT CLEANING

No cleaning solution is universally suited to all industrial metal cleaning tasks. When deciding on the right cleaning method for your application, various factors must be taken into consideration. Metal types, complexity of parts, contaminations and cleanliness requirements are just a few examples.

Metal cleaning is more than simply achieving the desired technical cleanliness in a consistent and reliable manner. An effective cleaning process should fulfill the cleaning needs in the most economical way.

In order to understand the real economic cost of cleaning, it is important to consider both the acquisition costs and the running costs.

The acquisition costs cover the price of the machine, installation and retrofitting. Operating costs include consumables such as solvents or cleaning agents/additives, electricity/water, process control and bath maintenance, floor space, waste disposal fees. Not to mention personnel costs in terms of working hours as well as efforts required for operational control and process monitoring.

By taking all cost parameters into account, the total cost per batch or the total cost per cleaned part can be determined. This can provide a much more informative and robust indicator on the cost efficiency of the selected cleaning system.

PRACTICAL EXAMPLE



Component to be cleaned	Extruded sleeves; made of aluminium slugs
Material	Aluminium
Contamination	Zinc stearate; auxiliary material for extrusion
Cleaning objective	No particles larger than 200 µm on the part

PRACTICAL EXAMPLE 1

ENERGY USAGE AND MEDIA CONSUMPTION

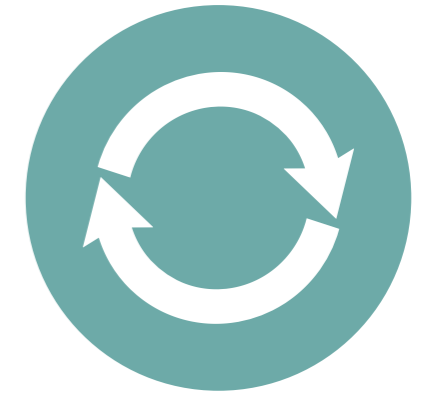
Batch system, aqueous cleaning



PRACTICAL EXAMPLE 2

ENERGY USAGE AND MEDIA CONSUMPTION

Solvent cleaning



Water-based cleaning

It takes place in a single-chamber cleaning system with two media tanks. An acidic cleaner (pH 5) is used. The use of ultrasound is required for this water-based cleaning application. The operating costs total **€4.48 per batch**.

Cost	Per Year	Per Cleaning Hour	Per Batch
Depreciation	€20,000	€9.62	€1.60
Calc. interest (8% of half of the acquisition price)	€6400	€3.08	€0.51
Cleaning agent	€1058.40	€0.51	€0.08
Energy	€11,232	€5.40	€0.90
Operating personnel	€10,000	€4.81	€0.80
Waste oil disposal	€624	€0.30	€0.05
Disposal of used cleaning solution	€79.2	€0.04	€0.01
Maintenance (1 per year)	€3500	€1.68	€0.28
In-house maintenance	€2860	€1.38	€0.23
Water exchange	€47.52	€0.02	€0.00
Water loss	€124.80	€0.06	€0.01
Running costs including personnel	€29,526	€14.20	€2.37
Total costs	€55,926	€26.89	€4.48
Running costs	€19,526	€9.39	€1.56

Cost calculation for aqueous cleaning plant (1 shift/day, 5 days/week)

Oil entry	0.2 L / Hour
Machine price ex. works	€160,000
Depreciation, linear	8 years
Operating personnel	€40,000 / Year
Personnel required for the plant operation	0.25 Employee
Cleaning hours	2080 per year
Batches per hour	6
Parts per batch	50
Electricity price	€0.15 / KW
Average energy consumption	36 KW
Number of bath exchange / year	12
Water volume per bath exchange	1020 L
Oil extracted by optional de-oiling	300 L
Cost of cleaning agent (concentrates)	€4.5 / L
Dosage of cleaning concentrates in water	4%
Required volume of cleaning concentrates	19.6 L
Water loss at 70°C / per hour	20 L / Hour
Cost of waste oil disposal	€1.5 / Kg
Personnel effort for own maintenance, bath maintenance etc.	1 Hour / Week
Cost for own maintenance	€55 / Hour
Water cost incl. waste water	€3 / m³
Disposal of used cleaning solution	€5 / m³

Source: Pero AG

Solvent cleaning

It takes place in a full vacuum single-chamber cleaning system with two media tanks. Perchloroethylene (PER) is used as a cleaning medium. Contrary to aqueous cleaning, the use of ultrasound is not required in this case. This results in shorter cycle times which are reflected in the operating cost calculations, with **cleaning cost per batch totaling €3.18**.

Cost (as of the 2nd Year)	Per Year	Per Cleaning Hour	Per Batch
Depreciation	€25,000	€12.02	€1.20
Calc. interest (8% of half of the acquisition price)	€8000	€3.85	€0.38
Energy	€10,399	€5	€0.50
Solvent loss	€242	€0.12	€0.01
Operating personnel	€10,000	€4.81	€0.48
Waste oil disposal	€657	€0.32	€0.03
Activated carbon exchange	€749	€0.36	€0.04
Maintenance (1 per year)	€3500	€1.68	€0.17
In-house maintenance	€2860	€1.38	€0.14
Bath exchange*	€4634	€2.23	€0.22
Running costs including personnel	€33,040	€15.88	€1.59
Total costs	€66,040	€31.75	€3.18
Running costs	€23,040	€11.08	€1.11

*The bath only needs to be replaced every two years (Per replacement: €9268).

Cost calculation for solvent cleaning plant (1 shift/day, 5 days/week)

Number of baths	2
Solvent type	PER
Oil entry	0.2 L / Hour
Machine price ex. works	€200,000
Depreciation, linear	8 years
Operating personnel	€40,000 / Year
Personnel required for the plant operation	0.25 Employee
Rest distillation required after	50 days
Cleaning hours	2080 per year
Operating hours	2101 per year
Batches per hour	10
Parts per batch	50
Electricity price	€0.15 / KW
Average energy consumption	33 KW
Cost for solvent first fill	€7474
Loss of solvent due to emissions	2g / Cycle
Loss of solvent due to oil discharge	0.026 Kg / Day
Cost for activated carbon exchange	€630
Activated carbon exchange / Year	1.19
Solvent cost	€5 / Kg
Solvent waste disposal	0.5 per year
Cost for solvent waste disposal	€1.2 / Kg
Cost for waste oil disposal	€1.5 / Kg
Cost for solvent bath exchange	€9268 / Exchange
Efforts required for own maintenance	1 Hour / Week
Cost for own maintenance	€55 / Hour

Source: Pero AG

RESULT:

In terms of energy consumption, cleaning with PER shows a bigger advantage. **It only consumes 3.3 KW per batch, compared to 6.0 KW per batch with aqueous cleaning.**

Conclusion: Considering the cleaning costs per batch of €4.48 vs €3.18, the choice falls on solvent cleaning due to its cost efficiency.

It should be noted that in this example, the oil entry as one of the main criteria accounts for a relatively small amount of just 0.2 L per hour (416 L per year). If the oil input would be 10 times higher, the cost difference between the two cleaning methods would be even more significant.

When multiplying the number of cleaning hours per year with the number of batches per hour and the number of parts cleaned per batch, the water-based cleaning system can clean 624,000 parts per year (2080 x 6 x 50). In contrast, the solvent plant can clean up to 1,040,000 parts (2080 x 10 x 10). This corresponds to a 40% higher cleaning capacity or material throughput with solvent cleaning.

Although the use of solvent already shows a cost benefit in this practical example, this general principle applies even more so: "the higher the oil input and the higher the material throughput, the more advantages solvent cleaning can offer".

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Finding the way to optimal cleaning application

To find the optimal solution for a cleaning application, it is necessary to carry out practical tests in commercial cleaning systems. The chosen medium must have the ability to meet the cleanliness requirements at a minimal cost.

In addition to the actual cleaning procedure, the entire production process (including the type of processing as well as transport/storage containers) should also be taken into account.

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