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Jan Gruwez, Jacky Mortelmans & Stefaan Deboosere,
TREVI nv

Waste water minimization and water reuse in the automotive and textile industry

Due to environmental problems, recuperation of waste water has become more and more important. This paper presents two cases of waste water reuse. The first case describes the internal water recirculation in the automotive industry ; the second case is an example of end of pipe purification and water reuse in the textile industry. It is showed that both investments are economically beneficial. Pay-back periods of less than two years are realistic. It proves that waste water recuperation is affordable and cost effective in many cases.

WATER REUSE IN THE AUTOMOTIVE INDUSTRY

► Introduction

A lot of automotive processes, such as pretreatment installations (degreasing, phosphatation, passivation,...), electrocoat, wet sanding lines, carwash and spraybooths, require a high amount of deionized water. The continued increase in costs for water supply and waste water treatment makes that the last few years a lot of research was done to investigate the possibilities of water recuperation in this area. A good example is the internal reuse of the waste water coming from the wet sanding lines. For several years, the deionized water polluted with small paint particles was discharged to the physicochemical waste water treatment plant. It is now collected and separately treated by a recuperation unit from where it is recycled into the production process.

► Composition of the waste water flow

The waste water coming from the wet sanding lines can be defined as deionized water polluted with small paint particles. The average particle size is approximately 25 µm ; the maximum particle size is 125 µm. The pH value of the water is 6.0 to 6.5 ; the electrical conductivity varies between 10 µS/cm and 20 µS/cm. The content of suspended solids is in the range between 5 mg/l and 15 mg/l. The colour is light grey due to the presence of the electrocoat paint particles (containing lead).

► Description of the recuperation unit

All waste water from the wet sanding lines is discharged into a buffertank in order to reduce variations in flow and composition. The discharge pipe is equipped with a conductivity measurement for continuous registration of the electrical conductivity. A small amount of tap water is added to obtain a sufficient high alkalinity for coagulation. The tap water supply is controlled by a regulation valve, steered in function of the conductivity. The present setpoint value is 70 µS/cm.

The collected water is pumped over a continuously operating sand filter, based on the counterflow principle. The sand filter has a capacity of 30 m³/h and contains 7.5 ton of sand with a grain coarseness of 0.7 mm. The height of the sand bed is approximately 1.5 m. The filtration surface is 3 m² which results in a surface loading of 10 m/h. The water enters through an inlet distributor in the lower section of the filter. The feed pipe is equipped with a flow meter to control the dosage of a coagulant. It concerns a product based on poly aluminium chloride.

The water is filtered as it flows upward through the sand bed prior to discharge through the filtrate outlet at the top of the filter. The quality of the filtrate is continuously measured by means of a turbidity measurement, expressed in units called NTU's or Nephelometric Turbidity Units. It is calculated by measuring the dispersion of a light beam passed through a sample of water. The average turbidity is approximately 0.20 NTU. The filtrate is collected into a storage tank if the turbidity is lower than the alarm limit value (0.70 NTU). The water is returned to the buffer tank when the turbidity exceeds this setpoint value.

The sand containing the entrapped impurities is conveyed from the tapered bottem section by means of an airlift pump to the sand washer at the top. Cleaning of the the sand commences in the pump itself, where particles of dirt are separated from the sand grains by turbulent mixing action. The contaminated sand exits from the pump outlet into the washer labyrinth where it is washed by a small amount of filtrate. The wash water flow is adjusted on 3 m³/h. The impurities are discharged through the wash water outlet to a lamella separator for thickening. The settled sludge is finally pumped to the waste water treatment as waste sludge while the above liquid is recycled into the buffer tank in order to mimimize the water losses.

The heavier grains of sand are returned to the top of the sand bed. As a result, the sand bed is constant downward motion through the unit. The sand velocity is 2 mm/min to 3 mm/min and is adjustable by adaption of the air flow of the airlift pump. Filtration and sand washing both take place continuously, enabling the recuperation unit to remain in service without interruption. This means that the filtration time is maximized by eliminating the need to take the filter out of operation for backwashing.

The filtrate is then treated by a microfilter (1µm) and an ultraviolet disinfection unit. The dosage of the UV-filter is approximately 25 mJ/cm² which is sufficient high for a complete disinfection of the water.

The effluent is finally applied as feed water for the humidification of the spraybooths and some cooling towers. Four alternatives, namely tap water (existing situation on that moment), softened water, recuperated water and deionized water, were evaluated to determine the most effective water supply for those installations. It was determined that the recuperated water was the best alternative based on several criteria. The recovery ratio is now significant higher than the situation where tap water was supplied due to the fact that the conductivity of the recuperated water is much lower than the one of tap water.

The excess of water is pumped to the raw water tank of the deionized water plant for reuse as feed water for the production of fresh deionized water. This has a positive effect on the cycle time of the deionized water plant since the rather low conductivity of the recuperated water in comparison with pure tap water. The introduction of the recuperated water as feed water for the deionized water plant has resulted in a significant decrease of the frequency of regeneration of the cation and anion exchanger with respectively hydrochloric acid (HCl) and sodium hydroxide ($NaOH$).

A principle flow diagram of the complete recuperation plant is given in the figure below.

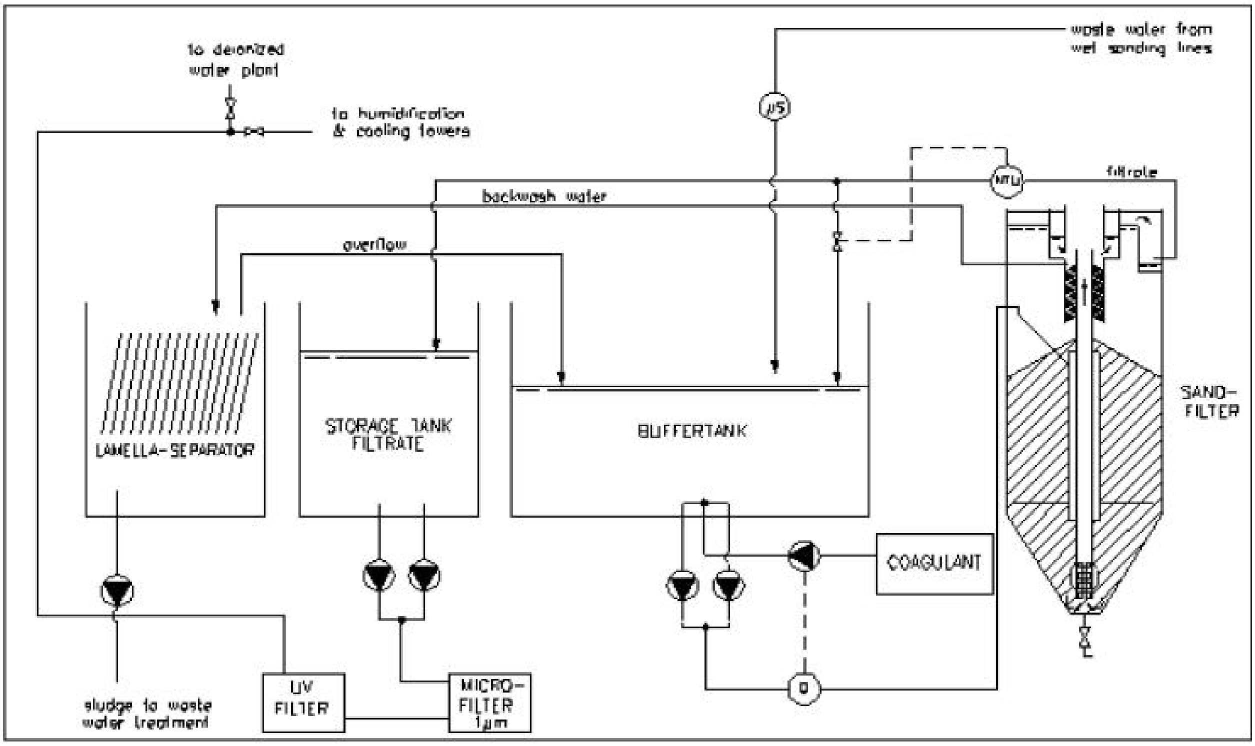

Figure 1. Principle flow diagram recuperation unit in automotive industry

► Economical balance

The daily amount of waste water treated by the described recuperation unit is 600 m³/day or 135000 m³/year. This has resulted in a decrease of the tap water consumption with 600 m³/day. The cost price of the recuperated water is estimated on 12,- BEF/m³ and is mainly caused by the replacement of the microfilters and the UV-lamp. Other costs are the dosage of the coagulant and the power consumption. Due to this low cost, the overall saving can be calculated on 43,- BEF/m³ or 5800000 BEF/year, taken into account the operating costs of the recuperation unit.

A second important saving is the reduction of the amount of industrial waste water since the complete waste water flow from the wet sanding lines was discharged to the waste water treatment plant before. The recuperation has resulted in a significant reduction of the operating costs in the physicochemical waste water treatment plant, estimated on 2700000,- BEF/year. In this saving is included the decrease of the consumption of chemicals (such as sulfuric acid, iron trichloride, sodium hydroxide and polymer) and the reduction of the waste sludge production.

Another advantage of the water recuperation is the lower hydraulic loading of the several waste water treatment plants by which more capacity is created for future projects (for instance an increase in production capacity).

The total saving can consequently be estimated on 8500000,- BEF/year for a total investment of approximately 15000000,- BEF. The pay-back period for this project was thus less than two years. It is generally expected that this pay-back period in the near future further shall increase due to the increasing cost prices for the purchase of tap water and the increasing costs related to waste water treatment.

WATER REUSE IN THE TEXTILE INDUSTRY

► Description

A similar project is now running in the textile industry. The average tap water consumption of this plant is 2000 m³/day. The daily amount of waste water is approximately 1650 m³/day and is treated over a biological waste water treatment since a few years. Recently the installation was enlarged with two continuously operating sand filters with a capacity of 30 m³/h each. The main goal of this adaption was to recycle about 60% of the Total amount of waste water and also to obtain a better water quality to reduce the costs related to the softening which is necessary because of the relative high hardness of the tap water in this region. A principle flow diagram of the waste water treatment plant, including the recuperation unit, is given in the undermentioned figure 2.

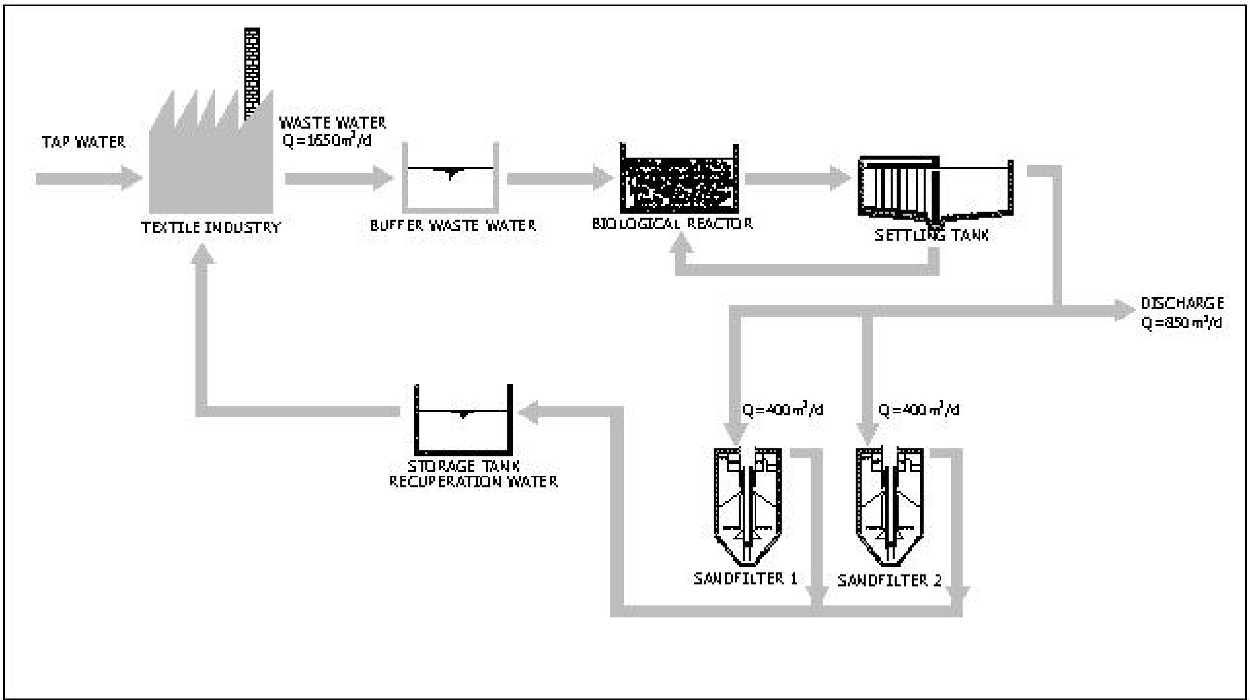

Figure 2. Principle flow diagram recuperation unit in textile industry

► Economical balance

The sand filtration has resulted in an extra removal of suspended solids, organic matter (C.O.D. and B.O.D.) and also in a further reduction of the colour. Approximately 800 m³/day of water is already reused on this moment. The present water saving can consequently be estimated on 180000 m³/year or 7920000,- BEF/year.

Other savings are a lower energy consumption and a significant decrease of the salt consumption for the regeneration of the softening filters, estimated on 500000,- BEF/year, respectively 1000000,- BEF/year. The water recovery has also resulted in a reduction of the environmental taxes with approximately 1000000,- BEF/year which brings the total saving of the water recuperation on 10500000,- BEF/year.

The total operating cost is estimated on 2750000,- BEF/year and exists of the consumption of electricity and chemicals (respectively 250000,- BEF/year and 1000000,- BEF/year), waste sludge production (1000000,- BEF/year) and manpower (500000,- BEF/year). The total investment for the recuperation plant was, including extension of piping system, 13000000,- BEF. The pay-back period for this project is thus less than two years.