WASATEX PROJECT

The WASATEX project uses an innovative combination of well-tested technologies in the wastewater treatment, with the aim of producing a water with such characteristics as to be suitable for its re-using in the industrial production cycle.

For the industrial development of this project was chosen the textile production plant of Benetton Group in Osijek- Croatia (Benetton Tekstil Croatia), which currently recycle only 5-10% of treated water in industrial processes. The existing water treatment plant was built more than 10 years ago and is constituted by a biological unit with a classic final clarifier, designed to treat the wastewater from the textile plant and discharging them into the sewer. The water needed for industrial processes is completely pumped out from the well, about 1.600 m^3/day.

The new additional units, that treat only a part of the total effluent as per request of Textile Company, allow recycling up to 90% of the water treated with the Wasatex project; this technology can be applied in all textile processes or similar industries. The amount of water pumped from the well is less than 65% (equivalent to a reduction of approximately 1.020 m^3/day), allowing a remarkable water saving, a cost saving of water extraction and its discharge and the cost reduction of primary water treatments (softening and iron removal filters).
This solution also allows to reduce the environmental impact, due to a lower consumption of natural resources to heat the incoming water (because the recycled water has a temperature of about 30 °C against to 15 °C of the well water), with a consequent reduction of CO_2 emissions and a cost saving of fuel.

		Actual situation	With technology	Δ
DATA				
Working time	days/year	300		
Dye House discharged water	m³/day	1.200	1.200	
Technological Water	m³/day	400	100	
Total flow to be depurated	m³/day	1.600	1.300	-300
Flow treated with wasatex technology	**m³/day**	**0**	**735**	
Recovered water from depuration plant (for washing operations)	m³/day	0	300	
Recovered water from depuration plant (for dyeing operations)	m³/day	0	378	
Recovered water from depuration plant (as NaCl brine)	m³/day	0	21,0	
Recirculated water from OX back to biological tanks	m³/day	0	21,0	
Total recovered water	m³/day	0	720	
Discharged water	m³/day	1.600	580	-1.020

Based on the final requests of Benetton Tekstil regarding the total volume of water to be recycled and its characteristics, the new treatment units have been defined, in order to realize a recycling system, which produces water of different quality and cost, with the aim to reach an advantageous ratio of cost/benefit and the environmental sustainability.

The wastewater of a textile factory essentially contain organic load (COD and BOD_5), salts (chlorides, sulfates, hardness) and dye molecules. The currently biological process effectively removes COD, BOD_5, surfactants, oils and fats, nitrogen, phosphorus and suspended solids with the linked concentration of colloids and also it is partially operative with the color. It does not remove inorganic components such as hardness, alkalinity, silica, chlorides, sulfates and heavy metals.
To use the outlet water from the biological unit, it is necessary to perform other treatments to remove suspended solids, color, hardness and alkalinity and reach the chemical-physical water characteristics suitable for the

processes of washing and fabrics' rinsing. The total removal of the salinity is instead necessary to make the final water also suitable for the processes of dyeing and finishing.
Therefore, the implementation of the existing biological system involves the following systems:

1. Membrane Bioreactor (MBR), able to separate completely suspended solids, biomass, bacteria and microbes present in the oxidation basin. The output water is very clear (NTU <1) and contains a very low concentration of organic matter, a fraction of color and the inlet salinity.
2. Resin filter, for the removal of the residual color, COD and surfactants.
3. Softener filter and Decarbonating tower, to remove the hardness of calcium and magnesium and the alkalinity.
4. Reverse osmosis (RO), to eliminate the soluble salts such as sulfates, chlorides, in addition to the residual COD, silica, alkalinity, etc.
5. Nanofiltration (NF) to treat the RO's rejections and separate monovalent salts, such as Sodium Chloride, from other compounds contained in solution, obtaining a brine (NaCl) that can be reused either as a saline agent to the dye baths, both for the regeneration of the softening filters.
6. OX system, to destroy and then remove the complex molecules with high molecular weight, such as COD and color, concentrated in NF's rejection, through radical group OH –.

The characteristics of the water, produced and reused in the factory, are:

PLANT UNIT	**U.M.**	***Bio outlet***	***Filters outlet***	***RO Permeate***	***Brine (NF permeate)***
Daily flow rate	m^3/day	1.300	735	378	21
Daily discharged flow rate	m^3/day	565	0	0	0
Daily recyclad flow rate	m^3/day	0	300	378	21
COD	ppm	85	< 50	0	150
BOD_5	ppm	10,0	< 5	0,0	45
TDS	ppm	2.700	2.700	65	32.000
pH		7,2	6,5	5,7	7,3
Temperature	°C	35	35	35	35
Colour	Pt/Co	100	30	0	60-80
Phosphorous	ppm	0,10	0,10	0,00	0,4
Surfactants	ppm	0,5	0,1	0,0	0,5
SS	ppm	50	0	0	0
Total Hardness	ppm $CaCO_3$	350	20	0	60
Alkalinity	ppm $CaCO_3$	620	40	2	390
Cl^-	ppm	1.000	1.000	35	16.400
SO_4^{2-}	ppm	400	400	2	200
Iron	ppm	0,50	0,13	0,03	0,78
Silica	ppm	25	15	1	225

The water, coming out from the decarbonating tower, after the biological treatments, filtration with MBR, color removal through RF and hardness reduction through SF, has the necessary characteristics to be used in washing operations after treatment of soaping. The reused water is about 300 m^3/day.
The water, coming out from the RO, has a quality so high that it can be reused for preparing the dyeing baths, for the execution of the bleaching and in all those industrial processes where are required parameters with very low limits of salinity and hardness. This characteristic allows obtaining technically more stable colors, superior light fastness, better yields of the dye, less use of sequestering agents and chemical agents in baths of dyeing and finishing. Furthermore, the operation of bleaching is much more efficient and stable over time, since alkali salts are not deposited on the fiber, and also a reduction in the use of the optical bleached is reached.
The permeate produced by the RO membranes, as well as being excellent from the qualitative point of view, also guarantees the stability and repeatability of its characteristics over time; this avoids problems of color reproducibility and uniformity during the whole year, which are usually caused by seasonal variations of the primary water (summer-winter).

The permeate of the RO is characterized by a very low salinity and a concentration of silica and hardness equal to zero, so it can also be used to feed the boiler for the steam production, reducing the consumption of chemical agents.
The brine, coming out from the NF (permeate) that treats the RO's rejections, can be used in the regeneration of the softener filters or like a saline agent for dyeing baths.

For this specific case, it was not necessary to provide new areas for the implementation of the system. It was possible to use a current warehouse for the section of filters, RO and NF; resize the current equalization tank to obtain tanks for MBR and the storage of treated water; and build a new technical room close to the existing tanks, as shown in the following figure.

In addition, the normal production of the factory will not be interrupted or affected during the revamping of plant and the assembling of Wasatex units, because it will set up a temporary bypass of the equalization tank that will allow the normal operation of existing biological plant.

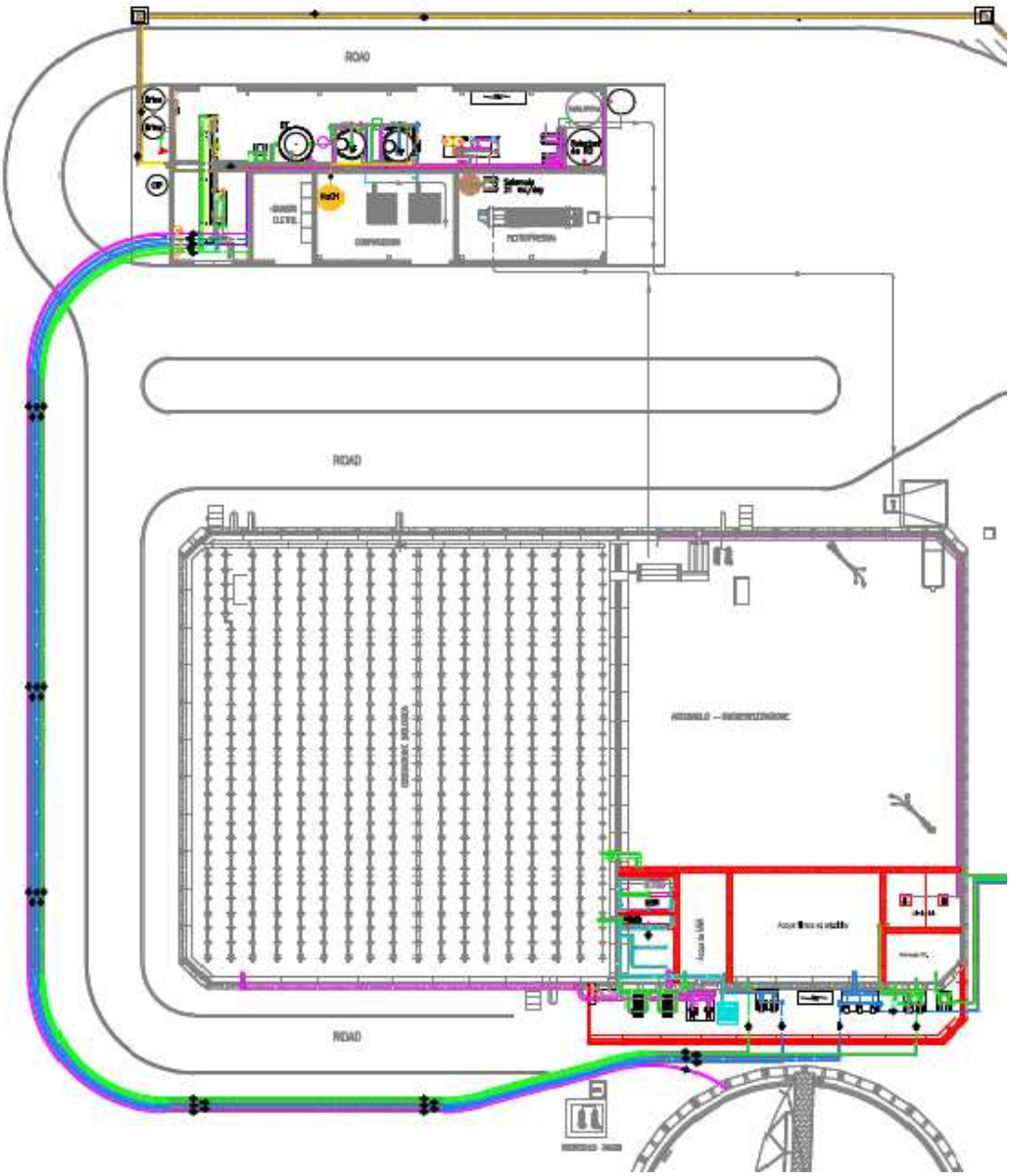

Figure 1: Plant's layout: new civil works in red; new machineries and equipment in different colors; existing plant in gray

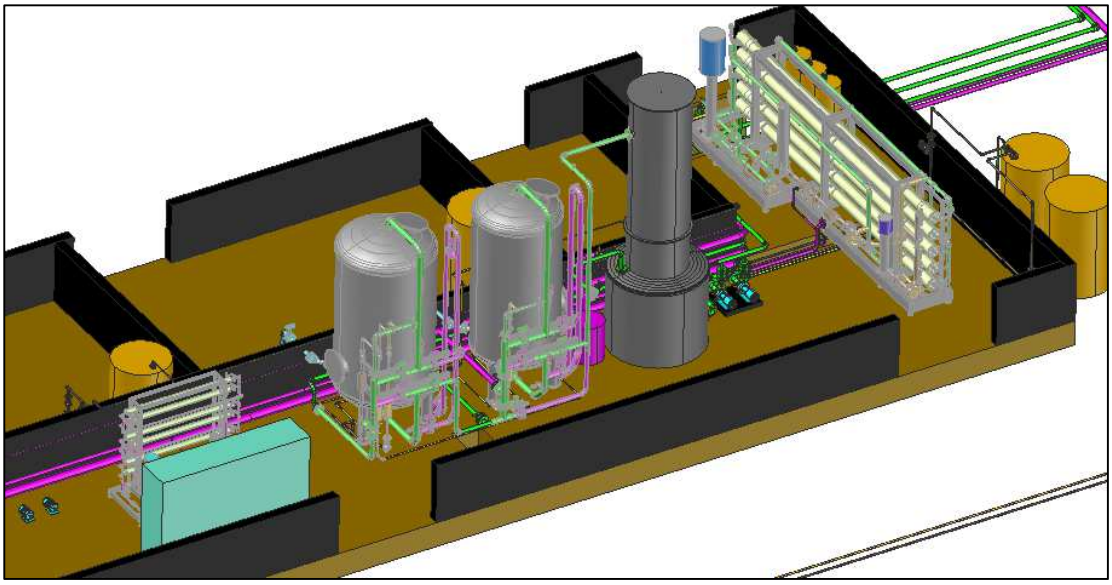

Figure 2: 3D view of filters, RO and NF systems

The Wasatex project is ENVIRONMENTALY SUSTAINABLE, it can produce water, reusable in industrial processes, reducing the consumption of water resources, the fuel consumption related to heating water and reducing CO_2 emissions.

		Actual situation	With technology	Δ
SAVING OF INCOMING WATER				
Water incoming to the factory to be pre-treated	m³/day	1.600	580	-1.020

Considering the recycled water has an average temperature of 30 °C, against a temperature of 15 °C of the well water, there will get an energy saving since the industrial boiler will heat the water up to the operating temperature, starting from a temperature of 30 °C instead of 15 °C.

		Actual situation	With technology	Δ
POWER SAVINGS				
Heat to supply to increase incoming water temperature from 15°C to 30°C	Kcal/day	24.000.000	8.700.000	-15.300.000
Natural gas calorific power	Kcal/lt	8.350		
Natural gas needed	Nm³/day	2.874	1.042	-1.832

Considering that CO_2 emissions due to burned natural gas is equal to 2.276 g/Nm^3 and that there is a reduction of natural gas consumption of 1.832 Nm^3/day, CO_2 emissions can be reduced of about 4.170 kgCO_2/day, amounted to <u>1.251 tons CO_2/year.</u>

The recycling of the treated water is also ECONOMICALLY FAVOURABLE, in fact in this case it can be reached a cost savings related to plant management of almost 400.000 €/year, basing the calculations on the following data:

Working days per year	300 gg/anno	Cost of pretreatment of well water	0,16 €/m³
Cost of well water	0,24 €/m³	Cost of natural gas	0,473 €/Nm³
Cost of water discharge	0,65 /m³	Cost of plant O&M	0,45 €/m³

		Actual situation	With technology	Δ
YEARLY NET SAVING				
Total management cost	€/year	0	203.152	203.152
Total water saving cost	€/year	504.000	182.700	-321.300
Total power saving cost	€/year	407.856	147.848	-260.008
Total brine saving cost	€/year	12.705	4.528	-8.177
YEARLY NET SAVING COST	*€/year*	*924.561,29*	*538.227,38*	*-386.333,91*

Therefore, the Wasatex project involves improvements both in terms of technical - economical, both in terms of ecological and social (reduction of environmental impact), consolidating the company's eco-friendly image in a world increasingly focused on compliance and environmental protection.