

<b>TOWEFO</b> Toward Effluent Zero	Partner <b>ENEA</b>	<b>Identification code</b> TM-108-010	<b>Rev.</b> 0	<b>Dis</b> CO	<b>Pag.</b> 1	<b>of</b> 32
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**ANNEX 6**  
**MODULES OF GENERAL FACILITIES**

<b>TOWEFO</b> Toward Effluent Zero	Partner <b>ENEA</b>	<b>Identification code</b> TM-108-010	<b>Rev.</b> 0	<b>Dis</b> CO	<b>Pag.</b> 2	<b>of</b> 32
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1	SOFTENING - FLAX/PES FABRIC .....	3
2	SOFTENING - VISCOSE FABRIC.....	5
3	FILTRATION - SILK YARN.....	7
4	SOFTENING - SILK YARN .....	9
5	DISINFECTION - SILK YARN .....	11
6	MEMBRANE ULTRA-FILTRATION - SILK YARN .....	13
7	JIGGER WASHING - SILK YARN .....	15
8	STORAGE OF WATER - VISCOSE FABRIC .....	17
9	RAPID FILTRATION - VISCOSE FABRIC.....	18
10	SOFTENING - VISCOSE FABRIC.....	19
11	CONDITIONING - VISCOSE FABRIC .....	21
12	MEMBRANE NANO-FILTRATION - VISCOSE FABRIC .....	23
13	EQUIPMENT WASHING - VISCOSE FABRIC.....	25
14	STORAGE OF WATER - SILK FABRIC .....	27
15	RAPID FILTRATION - SILK FABRIC.....	28
16	DE-IRONING - SILK FABRIC .....	29
17	SOFTENING - SILK FABRIC.....	31

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 3	of 32
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## 1 Softening – Flax/Pes fabric

<b>Name</b>	Softening	
<b>Sources</b>	Report LCA I06: TM-108-002	<b>E.2 Softening</b>
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	modern	
<b>Reference flow</b>	1000 l of water to softening	
<b>Equipment</b>	Ion exchange softener operating mode: batch number of run/yr: 153 run time (h): - regeneration cycle time (h) 2 processed water (m <sup>3</sup> /run): 485 processed water (m <sup>3</sup> /yr): 76251	
<b>Notes</b>	Production of chemicals considered: Sodium chloride	
<b>Procedural steps (flow-chart)</b>		
<b>Water: Public Network: 485 m<sup>3</sup>/run</b> 14,5 m <sup>3</sup> /h  <b>Water: Public Network: 4150 l</b>  <b>Water: Public Network: 37500 l</b> Brine (120 kg NaCl): 400 l  <b>Water: Public Network: 8300 l</b>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Softening</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Bed expansion t=10 min</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Regeneration tTOT=90 min (brine from 15 to 40)</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Washing t=20 min</div>	<b>Water: from Softening Treatment 485 m<sup>3</sup>/run</b> 14,5 m <sup>3</sup> /h  <b>Wastewater :4150 l</b> COD [mg/l] = 10 ; TSS [mg/l] = 0 .  <b>Wastewater: 37900 l</b> COD [mg/l] = 10 ; TSS [mg/l] = 0 .  <b>Wastewater : 8300 l</b> COD [mg/l] = 10 ; TSS [mg/l] = 0 .

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 4	of 32
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	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUTS</b>	(r) Coal (in ground)	kg	4,18E-03	
	(r) Natural Gas (in ground)	kg	2,69E-03	
	(r) Oil (in ground)	kg	2,39E-03	
	(r) Uranium (U, ore)	kg	8,66E-08	
	Water: Public Network	litre	1,00E+03	
	Water: Unspecified Origin	litre	5,70E-01	
	Water: Well	litre	0,00E+00	
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	5,65E-04	
	(a) Arsenic (As)	g	2,74E-06	
	(a) Benzene (C6H6)	g	1,49E-04	
	(a) Butane (n-C4H10)	g	4,50E-04	
	(a) Cadmium (Cd)	g	3,11E-06	
	(a) Carbon Dioxide (CO2, fossil)	g	2,11E+01	
	(a) Ethane (C2H6)	g	3,63E-03	
	(a) Ethylene (C2H4)	g	1,83E-03	
	(a) Formaldehyde (CH2O)	g	5,58E-05	
	(a) Heptane (C7H16)	g	4,27E-05	
	(a) Hexane (C6H14)	g	8,55E-05	
	(a) Hydrocarbons (except methane)	g	1,81E-02	
	(a) Hydrogen Chloride (HCl)	g	3,60E-03	
	(a) Lead (Pb)	g	1,12E-05	
	(a) Methane (CH4)	g	1,11E-01	
	(a) Nickel (Ni)	g	6,12E-05	
	(a) Nitrogen Oxides (NOx as NO2)	g	3,61E-02	
	(a) Nitrous Oxide (N2O)	g	2,43E-04	
	(a) Propane (C3H8)	g	1,01E-03	
	(a) Propylene (CH2CHCH3)	g	8,86E-05	
	(a) Sulphur Oxides (SOx as SO2)	g	1,46E-01	
	(a) Toluene (C6H5CH3)	g	6,77E-05	
	(a) Vanadium (V)	g	2,41E-04	
	(s) Arsenic (As)	g	2,17E-08	
	(s) Chromium (Cr III, Cr VI)	g	2,72E-07	
	(s) Zinc (Zn)	g	8,16E-07	
	(w) Ammonia (NH4+, NH3, as N)	g	1,41E-04	
	(w) Benzene (C6H6)	g	3,10E-05	
	(w) Cadmium (Cd++)	g	9,11E-08	
	(w) Chromium (Cr III)	g	5,71E-07	
	(w) Chromium (Cr III, Cr VI)	g	6,43E-07	
	(w) Oils (unspecified)	g	2,86E-04	
	Water: from Softening Treatment	litre	1,00E+03	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	9,28E-03
		E Fuel Energy	MJ	3,20E-01
E Non Renewable Energy		MJ	3,23E-01	
E Renewable Energy		MJ	5,67E-03	
E Total Primary Energy		MJ	3,30E-01	
Electricity		MJ elec	3,14E-02	
COD: to Wastewater Treatment Plant		kg	0,00E+00	
TSS: to Wastewater Treatment Plant		kg	0,00E+00	

## 2 Softening – Viscose fabric

<b>Name</b>	Softening	
<b>Sources</b>	Report LCA I02: TM-108-003	<b>E.1 Softening</b>
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	1000 l of water	
<b>Equipment</b>	Ion exchange softener operating mode: batch batch volume (lit.): - number of run/yr: 75 run time (h): 48 processed water (m3/run): 85 processed water (m3/yr): 6380	
<b>Notes</b>	Production of chemicals considered: Sodium chloride	
<b>Procedural steps (flow-chart)</b>		
<b>Water: Well</b> 85,07 m <sup>3</sup>  <b>Water: Well</b> 5610 l Sodium chloride ()= 990 kg.  <b>Water: Well</b> 3625 l	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Softening</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Regeneration t=75 min</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Washing t=15 min</div>	<b>Water: Well</b> 85,07 m <sup>3</sup>  <b>Wastewater:</b> 5610 l <i>COD [mg/l] = 50 ;</i> <i>TSS [mg/l] = 0 .</i>  <b>Wastewater:</b> 3625 l <i>COD [mg/l] = 50 ;</i> <i>TSS [mg/l] = 0 .</i>

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 6	of 32
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	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUTS</b>	(r) Coal (in ground)	kg	1,96E-01
	(r) Natural Gas (in ground)	kg	1,26E-01
	(r) Oil (in ground)	kg	1,12E-01
	(r) Uranium (U, ore)	kg	4,07E-06
	Water: Public Network	litre	0,00E+00
	Water: Unspecified Origin	litre	2,68E+01
	Water: Well	litre	1,00E+03
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	2,66E-02
	(a) Arsenic (As)	g	1,29E-04
	(a) Benzene (C6H6)	g	7,02E-03
	(a) Butene (1-CH3CH2CHCH2)	g	2,12E-02
	(a) Cadmium (Cd)	g	1,46E-04
	(a) Carbon Dioxide (CO2, fossil)	g	9,92E+02
	(a) Ethane (C2H6)	g	1,71E-01
	(a) Ethylene (C2H4)	g	8,61E-02
	(a) Formaldehyde (CH2O)	g	2,62E-03
	(a) Heptane (C7H16)	g	2,01E-03
	(a) Hexane (C6H14)	g	4,02E-03
	(a) Hydrocarbons (except methane)	g	8,50E-01
	(a) Hydrogen Chloride (HCl)	g	1,69E-01
	(a) Lead (Pb)	g	5,28E-04
	(a) Methane (CH4)	g	5,24E+00
	(a) Nickel (Ni)	g	2,88E-03
	(a) Nitrogen Oxides (NOx as NO2)	g	1,70E+00
	(a) Nitrous Oxide (N2O)	g	1,14E-02
	(a) Propane (C3H8)	g	4,76E-02
	(a) Propylene (CH2CHCH3)	g	4,17E-03
	(a) Sulphur Oxides (SOx as SO2)	g	6,88E+00
	(a) Toluene (C6H5CH3)	g	3,18E-03
	(a) Vanadium (V)	g	1,13E-02
	(s) Arsenic (As)	g	1,02E-06
	(s) Chromium (Cr III, Cr VI)	g	1,28E-05
	(s) Zinc (Zn)	g	3,84E-05
	(w) Ammonia (NH4+, NH3, as N)	g	6,63E-03
	(w) Benzene (C6H6)	g	1,46E-03
	(w) Cadmium (Cd++)	g	4,29E-06
	(w) Chromium (Cr III)	g	2,69E-05
	(w) Chromium (Cr III, Cr VI)	g	3,02E-05
	(w) Oils (unspecified)	g	1,35E-02
	Water: from Softening Treatment	litre	1,00E+03
	<b>REMINDERS</b>	E Feedstock Energy	MJ
E Fuel Energy		MJ	1,51E+01
E Non Renewable Energy		MJ	1,52E+01
E Renewable Energy		MJ	2,67E-01
E Total Primary Energy		MJ	1,55E+01
Electricity		MJ elec	1,48E+00
COD: to Wastewater Treatment Plant		Kg	0,00E+00
TSS: to Wastewater Treatment Plant		Kg	0,00E+00

### 3 Filtration – Silk yarn

<b>Name</b>	Filtration	
<b>Sources</b>	Report LCA I09: TM-108-004	<b>E.1 Filtration</b>
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	1000 lit of filtered water	
<b>Equipment</b>	Sand filter operating mode: continuous number of cycles/yr: 15 cycle time (h): 360 absorbed power (kW): 6 processed water (m3/h): 27,6 processed water (m3/yr): 291568	
<b>Notes</b>		
<b>Procedural steps (flow-chart)</b>		
<p><b>Water Untreated:</b> 27,6 m<sup>3</sup>/h</p> <p><b>Water from Filtration</b></p> <p><b>Compressed air</b></p> <p><b>Water from Filtration</b></p>	<pre> graph TD     A[Filtration] --- B[Bed expansion t=35 min]     B --- C[Backwashing t=105 min]     C --- D[Rinsing t=15 min]           </pre>	<p><b>Water from Filtration:</b> 27,6 m<sup>3</sup>/h</p> <p><b>Wastewater:</b> 9530,5 l.  <i>T [°C] = 15 ;</i>  <i>pH [-] = 7,6 ;</i>  <i>Conductivity [mS/cm] = 0,19 ;</i>  <i>COD [mg/l] = 10 ;</i>  <i>TSS [mg/l] = 10 .</i></p> <p><b>Wastewater:</b> 4084,5 l.  <i>T [°C] = 12 ;</i>  <i>pH [-] = 7,6 ;</i>  <i>Conductivity [mS/cm] = 0,19 ;</i>  <i>COD [mg/l] = 10 ;</i>  <i>TSS [mg/l] = 0 .</i></p>

TOWEFO Toward Effluent Zero	Partner  <b>ENEA</b>	Identification code  TM-108-010	Rev.  0	Dis  CO	Pag.  8	of  32
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	Flow	Units	Value	
<b>INPUTS</b>	(r) Coal (in ground)	kg	6,89E-05	
	(r) Iron (Fe, ore)	kg	5,86E-07	
	(r) Natural Gas (in ground)	kg	7,28E-05	
	(r) Oil (in ground)	kg	1,85E-04	
	(r) Uranium (U, ore)	kg	6,47E-12	
	Water: Untretated	l	1,00E+03	
	Water: Unspecified Origin	l	1,06E-02	
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	2,35E-05	
	(a) Arsenic (As)	g	1,16E-07	
	(a) Benzene (C6H6)	g	3,32E-06	
	(a) Butane (n-C4H10)	g	3,07E-05	
	(a) Cadmium (Cd)	g	2,36E-07	
	(a) Carbon Dioxide (CO2, fossil)	g	8,88E-01	
	(a) Carbon Monoxide (CO)	g	3,61E-04	
	(a) Ethane (C2H6)	g	2,50E-04	
	(a) Ethylene (C2H4)	g	4,00E-05	
	(a) Hydrocarbons (except methane)	g	1,28E-03	
	(a) Hydrocarbons (unspecified)	g	7,47E-07	
	(a) Hydrogen Chloride (HCl)	g	6,65E-05	
	(a) Lead (Pb)	g	5,02E-07	
	(a) Manganese (Mn)	g	4,09E-08	
	(a) Methane (CH4)	g	6,68E-03	
	(a) Nickel (Ni)	g	4,66E-06	
	(a) Nitrogen Oxides (NOx as NO2)	g	1,65E-03	
	(a) Nitrous Oxide (N2O)	g	1,31E-05	
	(a) Propane (C3H8)	g	6,29E-05	
	(a) Sulphur Oxides (SOx as SO2)	g	9,15E-03	
	(a) Toluene (C6H5CH3)	g	2,96E-06	
	(a) Vanadium (V)	g	1,86E-05	
	(s) Arsenic (As)	g	5,78E-10	
	(s) Chromium (Cr III, Cr VI)	g	7,23E-09	
	(s) Zinc (Zn)	g	2,17E-08	
	(w) Ammonia (NH4+, NH3, as N)	g	8,04E-06	
	(w) Benzene (C6H6)	g	2,38E-06	
	(w) Cadmium (Cd++)	g	6,36E-09	
	(w) Chromium (Cr III)	g	1,52E-08	
	(w) Chromium (Cr III, Cr VI)	g	4,40E-08	
	(w) COD (Chemical Oxygen Demand)	g	8,93E-06	
	(w) Nitrate (NO3-)	g	1,52E-06	
	(w) Nitrogenous Matter (unspecified, as N)	g	1,02E-05	
	(w) Oils (unspecified)	g	1,65E-05	
	Water: from Filtration	l	1,00E+03	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	6,03E-04
		E Fuel Energy	MJ	1,22E-02
		E Non Renewable Energy	MJ	1,18E-02
		E Renewable Energy	MJ	1,05E-03
		E Total Primary Energy	MJ	1,28E-02
		Electricity	MJ elec	8,23E-03



#### 4 Softening – Silk yarn

<b>Name</b>	Softening	
<b>Sources</b>	Report LCA I09: TM-108-004	<b>E.2 Softening</b>
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	1000 lit of softened water	
<b>Equipment</b>	Ion exchange softener operating mode: batch number of run/yr: 98 run time (h): 18 processed water (m3/run): 700 processed water (m3/yr): 205300	
<b>Notes</b>	Production of chemicals considered: Sodium Chloride	
<b>Procedural steps (flow-chart)</b>		
<pre> graph TD     A[Softening] --&gt; B[Bed expansion t=20 min]     B --&gt; C[Regeneration t=40 min]     C --&gt; D[Washing t=30 min]       </pre> <p><b>Water from Filtration:</b> 700 m<sup>3</sup></p> <p><b>Water from Softening:</b> 700 m<sup>3</sup></p> <p><b>Water from Softening:</b> 10000 l</p> <p><b>Wastewater:</b> 10000 l  <i>T [°C] = 13 ;</i>  <i>pH [-] = 7,6 ;</i>  <i>Conductivity [mS/cm] = 0,19 ;</i>  <i>COD [mg/l] = 10 ;</i>  <i>TSS [mg/l] = 0 .</i></p> <p><b>Water from Softening:</b> 4100 l      Sodium chloride = 817 kg</p> <p><b>Wastewater:</b> 4100 l  <i>T [°C] = 13 ;</i>  <i>pH [-] = 8 ;</i>  <i>Conductivity [mS/cm] = 4 ;</i>  <i>COD [mg/l] = 10 ;</i>  <i>TSS [mg/l] = 0 .</i></p> <p><b>Water from Softening:</b> 8000 l</p> <p><b>Wastewater:</b> 8000 l  <i>T [°C] = 15 ;</i>  <i>pH [-] = 7,9 ;</i>  <i>Conductivity [mS/cm] = 1 ;</i>  <i>COD [mg/l] = 10 ;</i>  <i>TSS [mg/l] = 0 .</i></p>		

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 10	of 32
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	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUTS</b>	(r) Coal (in ground)	kg	1,98E-02
	(r) Iron (Fe, ore)	kg	9,95E-05
	(r) Natural Gas (in ground)	kg	1,27E-02
	(r) Oil (in ground)	kg	1,23E-02
	(r) Uranium (U, ore)	kg	4,10E-07
	Water: from Filtration	l	1,00E+03
	Water: Unspecified Origin	l	3,11E+01
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	2,69E-03
	(a) Arsenic (As)	g	1,30E-05
	(a) Benzene (C6H6)	g	7,14E-04
	(a) Butane (n-C4H10)	g	2,20E-03
	(a) Cadmium (Cd)	g	1,48E-05
	(a) Carbon Dioxide (CO2, fossil)	g	1,03E+02
	(a) Carbon Monoxide (CO)	g	2,18E-01
	(a) Ethane (C2H6)	g	1,74E-02
	(a) Ethylene (C2H4)	g	8,67E-03
	(a) Hydrocarbons (except methane)	g	9,73E-02
	(a) Hydrocarbons (unspecified)	g	1,85E-04
	(a) Hydrogen Chloride (HCl)	g	1,70E-02
	(a) Lead (Pb)	g	5,33E-05
	(a) Manganese (Mn)	g	1,14E-05
	(a) Methane (CH4)	g	5,32E-01
	(a) Nickel (Ni)	g	2,91E-04
	(a) Nitrogen Oxides (NOx as NO2)	g	2,08E-01
	(a) Nitrous Oxide (N2O)	g	1,57E-03
	(a) Propane (C3H8)	g	4,87E-03
	(a) Sulphur Oxides (SOx as SO2)	g	6,97E-01
	(a) Toluene (C6H5CH3)	g	3,31E-04
	(a) Vanadium (V)	g	1,14E-03
	(s) Arsenic (As)	g	1,03E-07
	(s) Chromium (Cr III, Cr VI)	g	1,29E-06
	(s) Zinc (Zn)	g	3,87E-06
	(w) Ammonia (NH4+, NH3, as N)	g	7,50E-04
	(w) Benzene (C6H6)	g	1,59E-04
	(w) Cadmium (Cd++)	g	5,00E-07
	(w) Chromium (Cr III)	g	2,70E-06
	(w) Chromium (Cr III, Cr VI)	g	3,28E-06
	(w) COD (Chemical Oxygen Demand)	g	8,22E-04
	(w) Nitrate (NO3-)	g	1,19E-04
	(w) Nitrogenous Matter (unspecified, as N)	g	6,42E-04
	(w) Oils (unspecified)	g	1,44E-03
	Water: from Softening	l	1,00E+03
<b>REMINDERS</b>	E Feedstock Energy	MJ	4,47E-02
	E Fuel Energy	MJ	1,56E+00
	E Non Renewable Energy	MJ	1,57E+00
	E Renewable Energy	MJ	2,69E-02
	E Total Primary Energy	MJ	1,60E+00
	Electricity	MJ elec	1,49E-01

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 11	of 32
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## 5 Disinfection – Silk yarn

<b>Name</b>	Disinfection
<b>Sources</b>	Report LCA I09: TM-108-004 E.4 Disinfection
<b>Reference year</b>	2000
<b>Geographic reference</b>	Italy
<b>Technological level</b>	modern
<b>Reference flow</b>	1000 lit of disinfected water
<b>Equipment</b>	UV lamp operating mode: continuous working ours (h): 5280 absorbed power (kW): 1,14 processed water (m3/h): 37,65 processed water (m3/yr): 198800
<b>Notes</b>	
<b>Procedural steps (flow-chart)</b>	
<p>Water from Softening: 37,65 m<sup>3</sup>/h</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 10px; text-align: center;">Disinfection</div> </div> <p>Water from Disinfection: 37,65 m<sup>3</sup>/h</p>	

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 12	of 32
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	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUTS</b>	(r) Coal (in ground)	kg	1,93E-03
	(r) Iron (Fe, ore)	kg	1,64E-05
	(r) Natural Gas (in ground)	kg	2,04E-03
	(r) Oil (in ground)	kg	5,19E-03
	(r) Uranium (U, ore)	kg	1,82E-10
	Water: from Softening	l	1,00E+03
	Water: Unspecified Origin	l	2,96E-01
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	6,60E-04
	(a) Arsenic (As)	g	3,24E-06
	(a) Benzene (C6H6)	g	9,29E-05
	(a) Butane (n-C4H10)	g	8,60E-04
	(a) Cadmium (Cd)	g	6,63E-06
	(a) Carbon Dioxide (CO2, fossil)	g	2,49E+01
	(a) Carbon Monoxide (CO)	g	1,01E-02
	(a) Ethane (C2H6)	g	7,00E-03
	(a) Ethylene (C2H4)	g	1,12E-03
	(a) Hydrocarbons (except methane)	g	3,59E-02
	(a) Hydrocarbons (unspecified)	g	2,09E-05
	(a) Hydrogen Chloride (HCl)	g	1,86E-03
	(a) Lead (Pb)	g	1,41E-05
	(a) Manganese (Mn)	g	1,15E-06
	(a) Methane (CH4)	g	1,87E-01
	(a) Nickel (Ni)	g	1,31E-04
	(a) Nitrogen Oxides (NOx as NO2)	g	4,61E-02
	(a) Nitrous Oxide (N2O)	g	3,67E-04
	(a) Propane (C3H8)	g	1,76E-03
	(a) Sulphur Oxides (SOx as SO2)	g	2,56E-01
	(a) Toluene (C6H5CH3)	g	8,30E-05
	(a) Vanadium (V)	g	5,21E-04
	(s) Arsenic (As)	g	1,62E-08
	(s) Chromium (Cr III, Cr VI)	g	2,02E-07
	(s) Zinc (Zn)	g	6,08E-07
	(w) Ammonia (NH4+, NH3, as N)	g	2,25E-04
	(w) Benzene (C6H6)	g	6,67E-05
	(w) Cadmium (Cd++)	g	1,78E-07
	(w) Chromium (Cr III)	g	4,26E-07
	(w) Chromium (Cr III, Cr VI)	g	1,23E-06
	(w) COD (Chemical Oxygen Demand)	g	2,50E-04
	(w) Nitrate (NO3-)	g	4,26E-05
	(w) Nitrogenous Matter (unspecified, as N)	g	2,86E-04
(w) Oils (unspecified)	g	4,63E-04	
	Water: from Disinfection	l	1,00E+03
<b>REMINDERS</b>	E Feedstock Energy	MJ	1,69E-02
	E Fuel Energy	MJ	3,43E-01
	E Non Renewable Energy	MJ	3,30E-01
	E Renewable Energy	MJ	2,94E-02
	E Total Primary Energy	MJ	3,60E-01
	Electricity	MJ elec	2,31E-01

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 13	of 32
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## 6 Membrane ultra-filtration – Silk yarn

<b>Name</b>	Membrane ultra-filtration	
<b>Sources</b>	Report LCA I09: TM-108-004 <b>E.5 Membrane ultra-filtration</b>	
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	modern	
<b>Reference flow</b>	1000 lit of water to membrane ultra-filtration	
<b>Equipment</b>	Membrane system operating mode: batch number of run/yr: 375 run time (h): 13,5 absorbed power (kW): 5 processed water (m3/run): 15 processed water (m3/yr): 5625	
<b>Notes</b>	Production of chemicals considered: Caustic soda	
<b>Procedural steps (flow-chart)</b>		
<p>Wastewater to Membrane ultra-filtration: 15000 l</p> <p>Water from Disinfection: 500 l</p> <p>Cationic detergent = 0,5 % vol.;</p> <p>Caustic soda (10016) = 2 g/l.</p>	<pre> graph TD     A[Ultra-filtration] --- B[Backwashing t=120 min]           </pre>	<p>Concentrate to sericin recovery: 1875 l</p> <p><b>Wastewater:</b> 13125 l  <math>T [^{\circ}C] = 80</math> ;  <math>pH [-] = 6,81</math> ;  <math>Conductivity [mS/cm] = 0,702</math> ;  <math>COD [mg/l] = 8227</math> ;  <math>TSS [mg/l] = 0</math> .</p> <p><b>Wastewater:</b> 500 l  <math>T [^{\circ}C] = 30</math> ;  <math>pH [-] = 8,7</math> ;  <math>Conductivity [mS/cm] = 0,103</math> ;  <math>COD [mg/l] = 500</math> ;  <math>TSS [mg/l] = 150</math> .</p>

	Flow	Units	Value
<b>INPUTS</b>	(r) Coal (in ground)	kg	3,01E-01
	(r) Iron (Fe, ore)	kg	2,54E-03
	(r) Natural Gas (in ground)	kg	3,18E-01
	(r) Oil (in ground)	kg	8,04E-01
	(r) Uranium (U, ore)	kg	9,25E-07
	Waste Water: to Membrane ultra-filtration	l	1,00E+03
Water: from Disinfection	l	1,12E+01	
Water: Unspecified Origin	l	4,03E+00	
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	1,02E-01
	(a) Arsenic (As)	g	5,02E-04
	(a) Benzene (C6H6)	g	1,44E-02
	(a) Butane (n-C4H10)	g	1,33E-01
	(a) Cadmium (Cd)	g	1,02E-03
	(a) Carbon Dioxide (CO2, fossil)	g	3,87E+03
	(a) Carbon Monoxide (CO)	g	1,58E+00
	(a) Ethane (C2H6)	g	1,08E+00
	(a) Ethylene (C2H4)	g	1,73E-01
	(a) Hydrocarbons (except methane)	g	5,55E+00
	(a) Hydrocarbons (unspecified)	g	3,01E-02
	(a) Hydrogen Chloride (HCl)	g	3,15E-01
	(a) Lead (Pb)	g	2,19E-03
	(a) Manganese (Mn)	g	1,77E-04
	(a) Methane (CH4)	g	2,90E+01
	(a) Nickel (Ni)	g	2,02E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	7,24E+00
	(a) Nitrous Oxide (N2O)	g	5,68E-02
	(a) Propane (C3H8)	g	2,73E-01
	(a) Sulphur Oxides (SOx as SO2)	g	3,98E+01
	(a) Toluene (C6H5CH3)	g	1,28E-02
	(a) Vanadium (V)	g	8,05E-02
	(s) Arsenic (As)	g	2,50E-06
	(s) Chromium (Cr III, Cr VI)	g	3,13E-05
	(s) Zinc (Zn)	g	9,41E-05
	(w) Ammonia (NH4+, NH3, as N)	g	3,49E-02
	(w) Benzene (C6H6)	g	1,03E-02
	(w) Cadmium (Cd++)	g	2,76E-05
	(w) Chromium (Cr III)	g	6,58E-05
	(w) Chromium (Cr III, Cr VI)	g	1,90E-04
	(w) COD (Chemical Oxygen Demand)	g	3,89E-02
	(w) Nitrate (NO3-)	g	6,60E-03
	(w) Nitrogenous Matter (unspecified, as N)	g	4,43E-02
	(w) Oils (unspecified)	g	7,16E-02
	Concentrate to Sericin recovery	l	1,25E+02
	Wastewater	l	8,86E+02
<b>REMINDERS</b>	E Feedstock Energy	MJ	2,61E+00
	E Fuel Energy	MJ	5,35E+01
	E Non Renewable Energy	MJ	5,15E+01
	E Renewable Energy	MJ	4,56E+00
	E Total Primary Energy	MJ	5,61E+01
	Electricity	MJ elec	3,60E+01
	COD: to Wastewater Treatment Plant	kg	7,20E-03
	TSS: to Wastewater Treatment Plant	kg	1,68E-06



TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 16	of 32
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	Flow	Units	Value
<b>INPUTS</b>	(r) Coal (in ground)	kg	1,69E+00
	(r) Iron (Fe, ore)	kg	4,19E-02
	(r) Natural Gas (in ground)	kg	7,82E+00
	(r) Oil (in ground)	kg	3,09E+00
	(r) Uranium (U, ore)	kg	1,44E-05
	Water from Disinfection	l	8,00E+02
	Water from Filtration	l	4,00E+02
<b>OUTPUTS</b>	Water: Unspecified Origin	l	3,42E+01
	(a) Alkane (unspecified)	g	1,14E+00
	(a) Arsenic (As)	g	1,92E-03
	(a) Benzene (C6H6)	g	1,70E-01
	(a) Butane (n-C4H10)	g	7,12E-01
	(a) Cadmium (Cd)	g	3,78E-03
	(a) Carbon Dioxide (CO2, fossil)	g	3,16E+04
	(a) Ethane (C2H6)	g	4,80E+00
	(a) Ethylene (C2H4)	g	3,93E+00
	(a) Hexane (C6H14)	g	1,10E-01
	(a) Hydrocarbons (except methane)	g	2,47E+01
	(a) Hydrocarbons (unspecified)	g	1,94E+00
	(a) Hydrogen Chloride (HCl)	g	1,19E+00
	(a) Lead (Pb)	g	8,45E-03
	(a) Methane (CH4)	g	1,27E+02
	(a) Nickel (Ni)	g	7,44E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	3,89E+01
	(a) Nitrous Oxide (N2O)	g	4,16E-01
	(a) Propane (C3H8)	g	1,26E+00
	(a) Sulphur Oxides (SOx as SO2)	g	1,56E+02
	(a) Vanadium (V)	g	2,96E-01
	(s) Arsenic (As)	g	6,41E-05
	(s) Chromium (Cr III, Cr VI)	g	8,03E-04
	(s) Zinc (Zn)	g	2,41E-03
	(w) Ammonia (NH4+, NH3, as N)	g	1,41E-01
	(w) Benzene (C6H6)	g	4,08E-02
	(w) Cadmium (Cd++)	g	1,15E-04
	(w) Chromium (Cr III)	g	1,69E-03
	(w) Chromium (Cr III, Cr VI)	g	7,37E-04
	(w) Nitrate (NO3-)	g	2,72E-02
	(w) Nitrogenous Matter (unspecified, as N)	g	1,70E-01
	(w) Oils (unspecified)	g	5,49E-01
	Wastewater	l	1,20E+03
	<b>REMINDERS</b>	E Feedstock Energy	MJ
E Fuel Energy		MJ	4,90E+02
E Non Renewable Energy		MJ	4,83E+02
E Renewable Energy		MJ	1,71E+01
E Total Primary Energy		MJ	5,00E+02
Electricity		MJ elec	1,32E+02
COD: to Wastewater Treatment Plant		kg	2,75E-01
TSS: to to Wastewater Treatment Plant		kg	1,72E-02



TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 17	of 32
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## 8 Storage of water – Viscose fabric

<b>Name</b>	Storage of water
<b>Sources</b>	Report LCA I04: TM-108-005
<b>Reference year</b>	2000
<b>Geographic reference</b>	Italy
<b>Technological level</b>	average
<b>Reference flow</b>	1000 lit of stored water

	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUTS</b>	Well water	l	3,53E+02
	Water from Rapid filtration	l	6,05E+02
	Water from Membrane ultra-filtration	l	4,16E+01
<b>OUTPUTS</b>	Water from Storage	l	1,00E+03

## 9 Rapid Filtration – Viscose fabric

<b>Name</b>	Rapid filtration	
<b>Sources</b>	Report LCA I04: TM-108-005	<b>E.1 Rapid Filtration</b>
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	1000 lit of filtered water	
<b>Equipment</b>	Sand filter operating mode: batch number of run/yr: 420 run time (h): 184 numebr of backwashing/yr: 420 backwashing time (h;min): 0,35 processes water (m3/yr): 16706	
<b>Notes</b>		
<b>Procedural steps (flow-chart)</b>		
Industrial water: 546 m <sup>3</sup> (Water flow 68 m <sup>3</sup> /h)	<div style="border: 1px solid black; padding: 5px; width: 100px; margin: 0 auto;">Filtration</div>	Water from Rapid filtration: 546 m <sup>3</sup>
Water from Storage: 28142 l	<div style="border: 1px solid black; padding: 5px; width: 100px; margin: 0 auto;">Backwashing t=25 min</div>	Wastewater: 28142 l. COD [mg/l]=100 TSS [mg/l]=10
Water from Storage: 11365 l	<div style="border: 1px solid black; padding: 5px; width: 100px; margin: 0 auto;">Rinsing t=10 min</div>	Wastewater:11365 l COD [mg/l]=50 TSS [mg/l]=5

	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUTS</b>	Industrial water	l	1,00E+03
	Water: from Storage	l	7,29E+01
<b>OUTPUTS</b>	Water: from Rapid filtration	l	1,00E+03
	Wastewater	l	7,29E+01
<b>REMINDERS</b>	COD	kg	6,25E-03
	TSS	kg	6,25E-04

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 19	of 32
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## 10 Softening – Viscose fabric

<b>Name</b>	Softening	
<b>Sources</b>	Report LCA I04: TM-108-005	<b>E.2 Softening</b>
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	1000 lit of softened water	
<b>Equipment</b>	Softener operating mode: batch number of run/yr: 315 run time (h): 11 absorbed power (kW): 6,5 regeneration cycle time: 2 processes water (m3/yr) 862	
<b>Notes</b>	Production of regenerating agent is excluded because of lack of data.	
<b>Procedural steps (flow-chart)</b>		
<b>Water from Storage:</b> 596 m <sup>3</sup> (Water flow 56 m <sup>3</sup> /h)	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Softening</div>	<b>Water from Softening:</b> 596 m <sup>3</sup>
<b>Water from Storage:</b> 913 l	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Backwashing t= 40 min</div>	<b>Wastewater:</b> 913 l COD [mg/l]=150 TSS [mg/l]=15
<b>Water from Storage:</b> 1369 l  Regenerating agent = 587 kg. (30% solution brine)	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Regeneration t=60 min</div>	<b>Wastewater:</b> 1369 l COD [mg/l]=100 TSS [mg/l]=10
<b>Water from Storage:</b> 456 l	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Rinsing t= 20 min</div>	<b>Wastewater:</b> 456 l COD [mg/l]=50 TSS [mg/l]=5

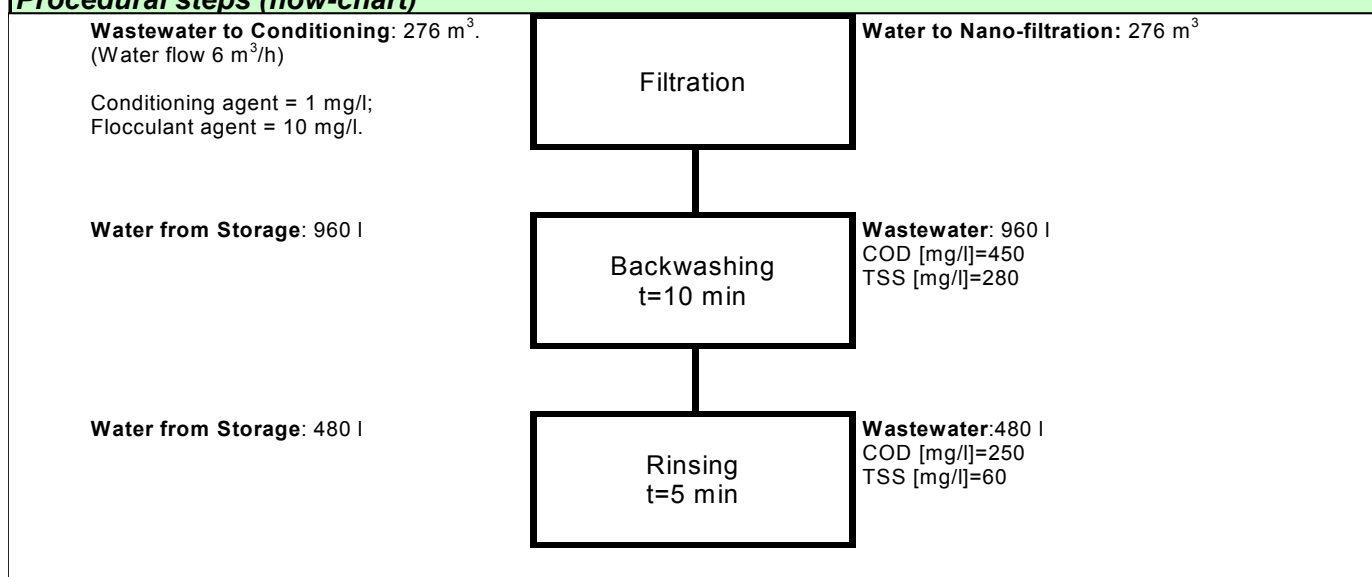
	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	1,78E-04	
	(r) Natural Gas (in ground)	kg	2,25E-02	
	(r) Oil (in ground)	kg	3,30E-02	
	(r) Uranium (U, ore)	kg	4,73E-07	
	Water from Storage	l	1,00E+03	
<b>OUTPUTS</b>	Water: Unspecified Origin	l	3,20E+00	
	(a) Alkane (unspecified)	g	5,61E-03	
	(a) Arsenic (As)	g	2,73E-05	
	(a) Butane (n-C4H10)	g	5,76E-03	
	(a) Cadmium (Cd)	g	4,24E-05	
	(a) Carbon Dioxide (CO2, fossil)	g	2,10E+02	
	(a) Ethane (C2H6)	g	4,67E-02	
	(a) Ethylene (C2H4)	g	1,43E-02	
	(a) Hydrocarbons (except methane)	g	2,93E-04	
	(a) Hydrogen Chloride (HCl)	g	2,68E-02	
	(a) Lead (Pb)	g	1,15E-04	
	(a) Methane (CH4)	g	1,33E+00	
	(a) Nickel (Ni)	g	8,35E-04	
	(a) Nitrogen Oxides (NOx as NO2)	g	3,74E-01	
	(a) Propane (C3H8)	g	1,23E-02	
	(a) Sulphur Oxides (SOx as SO2)	g	1,78E+00	
	(a) Vanadium (V)	g	3,31E-03	
	(s) Arsenic (As)	g	1,80E-07	
	(s) Chromium (Cr III, Cr VI)	g	2,26E-06	
	(s) Zinc (Zn)	g	6,79E-06	
	(w) Ammonia (NH4+, NH3, as N)	g	1,63E-03	
	(w) Benzene (C6H6)	g	4,25E-04	
	(w) Cadmium (Cd++)	g	1,18E-06	
	(w) Chromium (Cr III)	g	4,75E-06	
	(w) Chromium (Cr III, Cr VI)	g	8,25E-06	
	(w) COD (Chemical Oxygen Demand)	g	1,74E-03	
	(w) Nitrate (NO3-)	g	3,01E-04	
	(w) Nitrogenous Matter (unspecified, as N)	g	1,81E-03	
	(w) Oils (unspecified)	g	3,34E-03	
	Water: from Softening	l	1,00E+03	
	Wastewater	l	4,59E+00	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	1,15E-01
		E Fuel Energy	MJ	3,06E+00
E Non Renewable Energy		MJ	3,03E+00	
E Renewable Energy		MJ	1,44E-01	
E Total Primary Energy		MJ	3,18E+00	
Electricity		MJ elec	1,06E+00	
COD: to Wastewater Treatment Plant		Kg	4,97E-04	
TSS: to Wastewater Treatment Plant		Kg	4,97E-05	

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 21	of 32
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## 11 Conditioning – Viscose fabric

<b>Name</b>	Conditioning
<b>Sources</b>	Report LCA I04: TM-108-005 E.4 Conditionig
<b>Reference year</b>	2000
<b>Geographic reference</b>	Italy
<b>Technological level</b>	modern
<b>Reference flow</b>	1000 lit of water to conditioning
<b>Equipment</b>	Sand filter operating mode: batch number of run/yr: 70 run time (h): 48 absorbed power (kW): 6,75 number of backwashing/yr: 70 backwashing time (h:m): 0,15 processed water (m3/yr) 101
<b>Notes</b>	Note: Production of conditioning agent and flocculant agent are excluded because of lack of data.

### Procedural steps (flow-chart)



TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 22	of 32
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	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	6,36E-04	
	(r) Natural Gas (in ground)	kg	7,90E-02	
	(r) Oil (in ground)	kg	2,01E-01	
	(r) Uranium (U, ore)	kg	7,03E-09	
	Wastewater to Conditioning	l	1,00E+03	
	Water from Storage	l	5,22E+00	
	Water: Unspecified Origin	l	9,95E-01	
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	2,55E-02	
	(a) Arsenic (As)	g	1,26E-04	
	(a) Butane (n-C4H10)	g	3,33E-02	
	(a) Cadmium (Cd)	g	2,57E-04	
	(a) Carbon Dioxide (CO2, fossil)	g	9,64E+02	
	(a) Ethane (C2H6)	g	2,71E-01	
	(a) Ethylene (C2H4)	g	4,34E-02	
	(a) Hydrocarbons (except methane)	g	1,39E+00	
	(a) Hydrogen Chloride (HCl)	g	7,22E-02	
	(a) Lead (Pb)	g	5,44E-04	
	(a) Methane (CH4)	g	7,25E+00	
	(a) Nickel (Ni)	g	5,05E-03	
	(a) Nitrogen Oxides (NOx as NO2)	g	1,79E+00	
	(a) Propane (C3H8)	g	6,83E-02	
	(a) Sulphur Oxides (SOx as SO2)	g	9,92E+00	
	(a) Vanadium (V)	g	2,02E-02	
	(s) Arsenic (As)	g	6,26E-07	
	(s) Chromium (Cr III, Cr VI)	g	7,85E-06	
	(s) Zinc (Zn)	g	2,35E-05	
	(w) Ammonia (NH4+, NH3, as N)	g	8,72E-03	
	(w) Benzene (C6H6)	g	2,58E-03	
	(w) Cadmium (Cd++)	g	6,90E-06	
	(w) Chromium (Cr III)	g	1,65E-05	
	(w) Chromium (Cr III, Cr VI)	g	4,76E-05	
	(w) COD (Chemical Oxygen Demand)	g	9,69E-03	
	(w) Nitrate (NO3-)	g	1,65E-03	
	(w) Nitrogenous Matter (unspecified, as N)	g	1,11E-02	
	(w) Oils (unspecified)	g	1,79E-02	
	Water to Membrane nano-filtration	l	5,22E+00	
	Wastewater	l	1,00E+03	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	6,54E-01
		E Fuel Energy	MJ	1,33E+01
		E Non Renewable Energy	MJ	1,28E+01
E Renewable Energy		MJ	1,14E+00	
E Total Primary Energy		MJ	1,39E+01	
Electricity		MJ elec	8,93E+00	
COD: to Wastewater Treatment Plant		kg	1,99E-03	
TSS: to Wastewater Treatment Plant		kg	1,07E-03	

## 12 Membrane Nano-Filtration – Viscose fabric

<b>Name</b>	Membrane separation	
<b>Sources</b>	Report LCA I04: TM-108-005	<b>E.5 Membrane Nano-Filtration</b>
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	modern	
<b>Reference flow</b>	1000 lit of water to membrane nano-filtration	
<b>Equipment</b>	Membrane system operating mode: batch number of run/yr: 104 run time (h): 32 number of washing/yr: 104 washing time (h;min) 0,23 absorbed power (kW): 26 processed water (m3/yr) 230	
<b>Notes</b>	Production of sodium hypochlorite is excluded because of lack of data.	
<b>Procedural steps (flow-chart)</b>		
<b>Water to Nano-filtration:</b> 186 m <sup>3</sup> (Water flow 6 m <sup>3</sup> /h)	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Nano-filtration</div>	<b>Water to Storage:</b> 150 m <sup>3</sup>  <b>Wastewater (concentrate):</b> 36 m <sup>3</sup> COD [mg/l]=405 TSS [mg/l]=40
<b>Water from Storage:</b> 1453 l  Sodium hypochlorite = 2 g/l	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Chemical washing t=15 min</div>	<b>Wastewater:</b> 1453 l COD [mg/l]=300 TSS [mg/l]=25
<b>Water from Storage:</b> 768 l	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Rinsing t=8 min</div>	<b>Wastewater:</b> 768 l COD [mg/l]=150 TSS [mg/l]=20

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 24	of 32
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	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	6,71E-04	
	(r) Natural Gas (in ground)	kg	8,33E-02	
	(r) Oil (in ground)	kg	2,12E-01	
	(r) Uranium (U, ore)	kg	7,41E-09	
	Water to Membrane nano-filtration	l	1,00E+03	
	Water from Storage	l	1,17E+01	
	Water: Unspecified Origin	l	1,05E+00	
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	2,69E-02	
	(a) Arsenic (As)	g	1,33E-04	
	(a) Butane (n-C4H10)	g	3,51E-02	
	(a) Cadmium (Cd)	g	2,71E-04	
	(a) Carbon Dioxide (CO2, fossil)	g	1,02E+03	
	(a) Ethane (C2H6)	g	2,86E-01	
	(a) Ethylene (C2H4)	g	4,57E-02	
	(a) Hydrocarbons (except methane)	g	1,47E+00	
	(a) Hydrogen Chloride (HCl)	g	7,61E-02	
	(a) Lead (Pb)	g	5,74E-04	
	(a) Methane (CH4)	g	7,65E+00	
	(a) Nickel (Ni)	g	5,33E-03	
	(a) Nitrogen Oxides (NOx as NO2)	g	1,88E+00	
	(a) Propane (C3H8)	g	7,20E-02	
	(a) Sulphur Oxides (SOx as SO2)	g	1,05E+01	
	(a) Vanadium (V)	g	2,13E-02	
	(s) Arsenic (As)	g	6,61E-07	
	(s) Chromium (Cr III, Cr VI)	g	8,27E-06	
	(s) Zinc (Zn)	g	2,48E-05	
	(w) Ammonia (NH4+, NH3, as N)	g	9,20E-03	
	(w) Benzene (C6H6)	g	2,73E-03	
	(w) Cadmium (Cd++)	g	7,29E-06	
	(w) Chromium (Cr III)	g	1,75E-05	
	(w) Chromium (Cr III, Cr VI)	g	5,02E-05	
	(w) COD (Chemical Oxygen Demand)	g	1,02E-02	
	(w) Nitrate (NO3-)	g	1,74E-03	
	(w) Nitrogenous Matter (unspecified, as N)	g	1,17E-02	
	(w) Oils (unspecified)	g	1,89E-02	
	Water: from Membrane nano-filtration	l	8,03E+02	
	Wastewater	l	2,09E+02	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	6,90E-01
		E Fuel Energy	MJ	1,40E+01
		E Non Renewable Energy	MJ	1,35E+01
E Renewable Energy		MJ	1,20E+00	
E Total Primary Energy		MJ	1,47E+01	
Electricity		MJ elec	9,43E+00	
COD: to Wastewater Treatment Plant		Kg	8,28E-02	
TSS: to Wastewater Treatment Plant		Kg	8,16E-03	





<b>TOWEFO</b> Toward Effluent Zero	Partner <b>ENEA</b>	<b>Identification code</b> TM-108-010	<b>Rev.</b> 0	<b>Dis</b> CO	<b>Pag.</b> 26	<b>of</b> 32
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	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	2,73E-01	
	(r) Natural Gas (in ground)	kg	5,57E+01	
	(r) Oil (in ground)	kg	2,25E+00	
	(r) Uranium (U, ore)	kg	1,35E-04	
	Water from Softening	l	8,00E+02	
	Water from Storage	l	1,80E+03	
	Water: Unspecified Origin	l	1,16E+02	
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	6,56E+00	
	(a) Arsenic (As)	g	1,82E-03	
	(a) Benzene (C6H6)	g	1,09E+00	
	(a) Butane (n-C4H10)	g	2,10E+00	
	(a) Cadmium (Cd)	g	2,30E-03	
	(a) Carbon Dioxide (CO2, fossil)	g	1,48E+05	
	(a) Ethane (C2H6)	g	9,04E+00	
	(a) Ethylene (C2H4)	g	2,76E+01	
	(a) Hexane (C6H14)	g	6,83E-02	
	(a) Hydrocarbons (except methane)	g	4,59E+01	
	(a) Hydrogen Chloride (HCl)	g	1,91E+00	
	(a) Lead (Pb)	g	1,89E-02	
	(a) Methane (CH4)	g	2,17E+02	
	(a) Nickel (Ni)	g	4,54E-02	
	(a) Nitrogen Oxides (NOx as NO2)	g	1,01E+02	
	(a) Nitrous Oxide (N2O)	g	8,37E-01	
	(a) Propane (C3H8)	g	2,68E+00	
	(a) Sulphur Oxides (SOx as SO2)	g	1,39E+02	
	(a) Toluene (C6H5CH3)	g	4,89E-01	
	(a) Vanadium (V)	g	1,72E-01	
	(s) Arsenic (As)	g	4,61E-04	
	(s) Chromium (Cr III, Cr VI)	g	5,77E-03	
	(s) Zinc (Zn)	g	1,73E-02	
	(w) Ammonia (NH4+, NH3, as N)	g	1,43E-01	
	(w) Benzene (C6H6)	g	3,90E-02	
	(w) Cadmium (Cd++)	g	1,56E-04	
	(w) Chromium (Cr III)	g	1,21E-02	
	(w) Chromium (Cr III, Cr VI)	g	6,05E-04	
	(w) COD (Chemical Oxygen Demand)	g	1,90E+00	
	(w) Nitrate (NO3-)	g	3,29E-02	
	(w) Nitrogenous Matter (unspecified, as N)	g	1,38E-01	
	(w) Oils (unspecified)	g	2,49E+00	
	Wastewater	l	2,60E+03	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	1,58E+01
		E Fuel Energy	MJ	2,49E+03
E Non Renewable Energy		MJ	2,49E+03	
E Renewable Energy		MJ	1,56E+01	
E Total Primary Energy		MJ	2,50E+03	
Electricity		MJ elec	1,00E+02	
COD to Wastewater Treatment Plant		kg	1,16E+00	
TSS to Wastewater Treatment Plant		kg	6,00E-02	

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 27	of 32
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#### 14 Storage of water – Silk fabric

<b>Name</b>	Storage of water
<b>Sources</b>	Report LCA I15: TM-108-006
<b>Reference year</b>	2001
<b>Geographic reference</b>	Italy
<b>Technological level</b>	average
<b>Reference flow</b>	1000 lit of stored water

	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUTS</b>	Water from De-Ironing	l	6,11E+02
	Water from Rapid filtration	l	3,89E+02
<b>OUTPUTS</b>	Water from Storage	l	1,00E+03

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 28	of 32
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## 15 Rapid filtration – Silk fabric

<b>Name</b>	Rapid filtration	
<b>Sources</b>	Report LCA I15: TM-108-006	
<b>Reference year</b>	2001	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	1000 lit of filtered water	
<b>Equipment</b>	Sand filter operating mode: batch number of run/yr: 29 run time (h): 184 numebr of backwashing/yr: 88 backwashing time (h;min): 0,35 processes water (m3/yr): 351380	
<b>Procedural steps (flow-chart)</b>		
Industrial water: 12117 m <sup>3</sup> (Water flow 66 m <sup>3</sup> /h)	<div style="border: 1px solid black; padding: 10px; width: fit-content; margin: 0 auto;">         Filtration       </div>	Water from Filtration: 12117 m <sup>3</sup>
Water from Filtration: 27356 l	<b>Backwashing:</b>  <div style="border: 1px solid black; padding: 10px; width: fit-content; margin: 0 auto;">         Backwashing          t=25 min       </div>	Wastewater: 27356 l COD [mg/l]=100; TSS [mg/l]=10.
Water from Filtration: 10942 l	<div style="border: 1px solid black; padding: 10px; width: fit-content; margin: 0 auto;">         Rinsing          t=10 min       </div>	Wastewater: 10942 l COD [mg/l]=50 TSS [mg/l]=5

	Flow	Units	Value
<b>INPUTS</b>	Water: Industrial	l	1,00E+03
	Water: from Filtration	l	3,16E+00
<b>OUTPUTS</b>	Water: from Rapid filtration	l	1,00E+03
	Wastewater	l	3,16E+00
<b>REMINDERS</b>	COD	kg	2,71E-04
	TSS	kg	2,71E-05

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 29	of 32
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## 16 De-Ironing – Silk fabric

<b>Name</b>	Iron Removal	
<b>Sources</b>	Report LCA I15: TM-108-006	<b>E.2 De-ironing</b>
<b>Reference year</b>	2001	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	modern	
<b>Reference flow</b>	1000 lit of water to de-ironing	
<b>Equipment</b>	De-Ironer operating mode: batch number of run/yr: 44 run time (h,m): 122,00 number of regeneration/yr: 44 regeneration cycle time (h,m) 2,00 absorbed power (kW): 28 processed water (m3/yr) 224004	
<b>Procedural steps (flow-chart)</b>		
Well water: 5091 m <sup>3</sup> (Water flow 42 m <sup>3</sup> /h)	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Softening</div>	Water from De-ironing: 5091 m <sup>3</sup>
Water from Storage: 389 l	<b>Regeneration:</b>  <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> Backwashing  t= 40 min   Regeneration  t= 60 min   Rinsing  t= 20 min </div>	Wastewater: 389 l COD [mg/l]=150 TSS [mg/l]=15  Wastewater: 583 l COD [mg/l]=100 TSS [mg/l]=10  Wastewater: 194 l COD [mg/l]=50 TSS [mg/l]=5
Water from Storage: 583 l Regenerating agent = 250 kg. (solution 30% brine)		
Water from Storage: 194 l		

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 30	of 32
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	Flow	Units	Value	
<b>INPUT</b>	(r) Iron (Fe, ore)	kg	3,63E-04	
	(r) Natural Gas (in ground)	kg	4,51E-02	
	(r) Oil (in ground)	kg	1,15E-01	
	(r) Uranium (U, ore)	kg	4,01E-09	
	Water: Well	litre	1,00E+03	
	Water: from Storage	litre	2,32E-01	
	Water: Unspecified Origin	litre	5,68E-01	
<b>OUTPUT</b>	(a) Aldehyde (unspecified)	g	2,89E-06	
	(a) Alkane (unspecified)	g	1,46E-02	
	(a) Ammonia (NH3)	g	1,53E-04	
	(a) Arsenic (As)	g	7,17E-05	
	(a) Benzene (C6H6)	g	2,05E-03	
	(a) Butane (n-C4H10)	g	1,90E-02	
	(a) Cadmium (Cd)	g	1,46E-04	
	(a) Carbon Dioxide (CO2, fossil)	g	5,50E+02	
	(a) Ethane (C2H6)	g	1,55E-01	
	(a) Ethylene (C2H4)	g	2,47E-02	
	(a) Hydrocarbons (except methane)	g	7,93E-01	
	(a) Hydrogen Chloride (HCl)	g	4,12E-02	
	(a) Lead (Pb)	g	3,11E-04	
	(a) Methane (CH4)	g	4,14E+00	
	(a) Nickel (Ni)	g	2,88E-03	
	(a) Nitrogen Oxides (NOx as NO2)	g	1,02E+00	
	(a) Propane (C3H8)	g	3,90E-02	
	(a) Sulphur Oxides (SOx as SO2)	g	5,66E+00	
	(a) Vanadium (V)	g	1,15E-02	
	(s) Arsenic (As)	g	3,58E-07	
	(s) Chromium (Cr III, Cr VI)	g	4,49E-06	
	(s) Zinc (Zn)	g	1,35E-05	
	(w) Ammonia (NH4+, NH3, as N)	g	4,98E-03	
	(w) COD (Chemical Oxygen Demand)	g	5,53E-03	
	(w) Nitrate (NO3-)	g	9,42E-04	
	(w) Nitrogenous Matter (unspecified, as N)	g	6,32E-03	
	Water from De-Ironing	litre	1,00E+03	
	Wastewater	litre	2,32E-01	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	3,73E-01
		E Fuel Energy	MJ	7,57E+00
		E Non Renewable Energy	MJ	7,30E+00
		E Renewable Energy	MJ	6,49E-01
		E Total Primary Energy	MJ	7,95E+00
Electricity		MJ elec	5,10E+00	
COD to Wastewater Treatment Plant		Kg	2,50E-05	
TSS to Wastewater Treatment Plant		kg	2,50E-06	

TOWEFO Toward Effluent Zero	Partner <b>ENEA</b>	Identification code TM-108-010	Rev. 0	Dis CO	Pag. 31	of 32
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## 17 Softening – Silk fabric

<b>Name</b>	Softening	
<b>Sources</b>	Report LCA I15: TM-108-006	<b>E.3 Softening</b>
<b>Reference year</b>	2001	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	modern	
<b>Reference flow</b>	1000 lit of water to softening	
<b>Equipment</b>	Softening operating mode: batch number of run/yr: 394 run time (h,m): 14,00 regeneration cycle time (h,m): 2,00 absorbed power (kW): 8 processed water (m3/yr): 155929	
<b>Notes</b>	Production of chemicals considered: Sodium chloride	
<b>Procedural steps (flow-chart)</b>		
<b>Water from Storage:</b> 450 m <sup>3</sup> (Water flow 33 m <sup>3</sup> /h)	<div style="border: 1px solid black; padding: 10px; width: fit-content; margin: 0 auto;">Softening</div>	<b>Water from Softening:</b> 450 m <sup>3</sup>
<b>Regeneration:</b>		
<b>Water from Storage:</b> 404 l  <b>Water from Storage:</b> 607 l Regenerating agent = 260 kg. (30% solution brine)	<div style="border: 1px solid black; padding: 10px; width: fit-content; margin: 0 auto;">           Backwashing            t= 40 min             Regeneration            t=60 min             Rinsing            t= 20 min         </div>	<b>Wastewater:</b> 404 l COD [mg/l]=150 TSS [mg/l]=15  <b>Wastewater:</b> 607 l COD [mg/l]=100 TSS [mg/l]=10  <b>Wastewater:</b> 202 l COD [mg/l]=50 TSS [mg/l]=5

<b>TOWEFO</b> Toward Effluent Zero	Partner <b>ENEA</b>	<b>Identification code</b> TM-108-010	<b>Rev.</b> 0	<b>Dis</b> CO	<b>Pag.</b> 32	<b>of</b> 32
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	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUT</b>	(r) Iron (Fe, ore)	kg	2,05E-04	
	(r) Natural Gas (in ground)	kg	2,58E-02	
	(r) Oil (in ground)	kg	5,90E-02	
	(r) Uranium (U, ore)	kg	2,31E-07	
	Water: from Storage	litre	1,00E+03	
	Water: Unspecified Origin	litre	1,77E+00	
<b>OUTPUT</b>	(a) Aldehyde (unspecified)	g	1,28E-01	
	(a) Alkane (unspecified)	g	7,60E-03	
	(a) Ammonia (NH3)	g	1,47E+00	
	(a) Arsenic (As)	g	3,68E-05	
	(a) Benzene (C6H6)	g	1,29E-03	
	(a) Butane (n-C4H10)	g	9,41E-03	
	(a) Cadmium (Cd)	g	6,87E-05	
	(a) Carbon Dioxide (CO2, fossil)	g	3,00E+02	
	(a) Ethane (C2H6)	g	7,46E-02	
	(a) Ethylene (C2H4)	g	1,51E-02	
	(a) Hydrocarbons (except methane)	g	4,40E-01	
	(a) Hydrogen Chloride (HCl)	g	2,65E-02	
	(a) Lead (Pb)	g	1,58E-04	
	(a) Methane (CH4)	g	2,02E+00	
	(a) Nickel (Ni)	g	1,35E-03	
	(a) Nitrogen Oxides (NOx as NO2)	g	7,23E-01	
	(a) Propane (C3H8)	g	1,91E-02	
	(a) Sulphur Oxides (SOx as SO2)	g	2,74E+00	
	(a) Vanadium (V)	g	5,38E-03	
	(s) Arsenic (As)	g	2,06E-07	
	(s) Chromium (Cr III, Cr VI)	g	2,57E-06	
	(s) Zinc (Zn)	g	7,71E-06	
	(w) Ammonia (NH4+, NH3, as N)	g	2,88E-03	
	(w) COD (Chemical Oxygen Demand)	g	3,47E-03	
	(w) Nitrate (NO3-)	g	4,54E-04	
	(w) Nitrogenous Matter (unspecified, as N)	g	3,06E-03	
	Wastewater	litre	1,74E+01	
	Water from Softening	litre	9,97E+02	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	1,82E-01
		E Fuel Energy	MJ	4,19E+00
		E Non Renewable Energy	MJ	4,09E+00
		E Renewable Energy	MJ	2,81E-01
E Total Primary Energy		MJ	4,37E+00	
Electricity		MJ elec	2,18E+00	
COD to Wastewater Treatment Plant		Kg	3,32E-04	
TSS to Wastewater Treatment Plant		kg	3,32E-05	