

<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> 50
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**ANNEX 3**  
**MODULES OF TEXTILES DYEING PROCESS**

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## 1 Light disperse dyeing – Flax/Pes fabric

<b>Name</b>	Dyeing
<b>Sources</b>	Report LCA I06: TM-108-002 <b>G.1.1 Light disperse dyeing</b>
<b>Reference year</b>	2000
<b>Geographic reference</b>	Italy
<b>Technological level</b>	modern
<b>Reference flow</b>	100 kg of flax/pes fabric
<b>Equipment</b>	Torpedo operating mode: batch bath volume (m <sup>3</sup> ): 0,8 run time (h): 4 N. of run/year 271 absorbed power (kW): 11,2 processed fabric per run (kg): 54 processed fabric (kg/yr): 14555
<b>Notes</b>	Production of chemicals considered: Acetic acid, Dyestuff
<b>Procedural steps (flow-chart)</b>	
<p>Water: from Softening Treatment: equip. volume</p> <p>Acetic acid (2006)= 1 g/l; Carrier (2036)= 1 g/l;</p> <p>Disperse dyestuffs &lt; 0,05%</p> <p>Steam</p> <p>Water: from Softening Treatment: equip. volume</p>	<pre> graph TD     Bath["Bath T=110-120-130°C; t=30 min. Indirect heating"] --&gt; Discharge1["Discharge"]     Discharge1 --&gt; Washing["Washing"]     Washing --&gt; Discharge2["Discharge"]           </pre> <p><b>Wastewater:</b> equip. volume COD [mg/l] = 1500. TSS [mg/l] = 35</p> <p><b>Wastewater:</b> equip. volume COD [mg/l] = 450. TSS [mg/l] = 10</p>

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	Flow	Units	Value	
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	7,65E-01	
	(r) Natural Gas (in ground)	kg	1,54E+02	
	(r) Oil (in ground)	kg	1,63E+01	
	(r) Uranium (U, ore)	kg	2,94E-04	
	Flax/Pes fabric: to Dyeing Flax	kg	1,00E+02	
	Water: Public Network	litre	0,00E+00	
	Water: Unspecified Origin	litre	2,84E+02	
	Water: Well	litre	0,00E+00	
	Water: from Softening Treatment	litre	2,96E+03	
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	1,92E+01	
	(a) Ammonia (NH3)	g	7,20E-01	
	(a) Arsenic (As)	g	1,12E-02	
	(a) Benzene (C6H6)	g	2,83E+00	
	(a) Butane (n-C4H10)	g	7,35E+00	
	(a) Cadmium (Cd)	g	1,97E-02	
	(a) Carbon Dioxide (CO2, fossil)	g	4,41E+05	
	(a) Ethane (C2H6)	g	3,85E+01	
	(a) Ethylene (C2H4)	g	7,66E+01	
	(a) Hexane (C6H14)	g	5,60E-01	
	(a) Hydrocarbons (except methane)	g	1,90E+02	
	(a) Hydrocarbons (unspecified)	g	7,26E+00	
	(a) Hydrogen Chloride (HCl)	g	8,32E+00	
	(a) Lead (Pb)	g	5,12E-02	
	(a) Methane (CH4)	g	9,50E+02	
	(a) Nickel (Ni)	g	3,89E-01	
	(a) Nitrogen Oxides (NOx as NO2)	g	3,35E+02	
	(a) Nitrous Oxide (N2O)	g	1,92E+00	
	(a) Propane (C3H8)	g	1,07E+01	
	(a) Sulphur Oxides (SOx as SO2)	g	8,61E+02	
	(a) Toluene (C6H5CH3)	g	1,48E+00	
	(a) Vanadium (V)	g	1,53E+00	
	(s) Arsenic (As)	g	1,28E-03	
	(s) Chromium (Cr III, Cr VI)	g	1,60E-02	
	(s) Zinc (Zn)	g	4,80E-02	
	(w) Ammonia (NH4+, NH3, as N)	g	8,18E-01	
	(w) Benzene (C6H6)	g	2,38E-01	
	(w) Cadmium (Cd++)	g	7,83E-04	
	(w) Chromium (Cr III)	g	3,35E-02	
	(w) Nitrogenous Matter (unspecified, as N)	g	9,78E-01	
	(w) Oils (unspecified)	g	7,65E+00	
	Flax/Pes fabric: to Dyeing Pes	kg	1,00E+02	
	Wastewater	litre	2,96E+03	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	1,08E+02
		E Fuel Energy	MJ	7,27E+03
E Non Renewable Energy		MJ	7,28E+03	
E Renewable Energy		MJ	9,98E+01	
E Total Primary Energy		MJ	7,38E+03	
Electricity		MJ elec	4,35E+02	
COD: to Wastewater Treatment Plant		kg	2,89E+00	
TSS: to Wastewater Treatment Plant		kg	6,67E-02	

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## 2 Dark disperse dyeing – Flax/Pes fabric

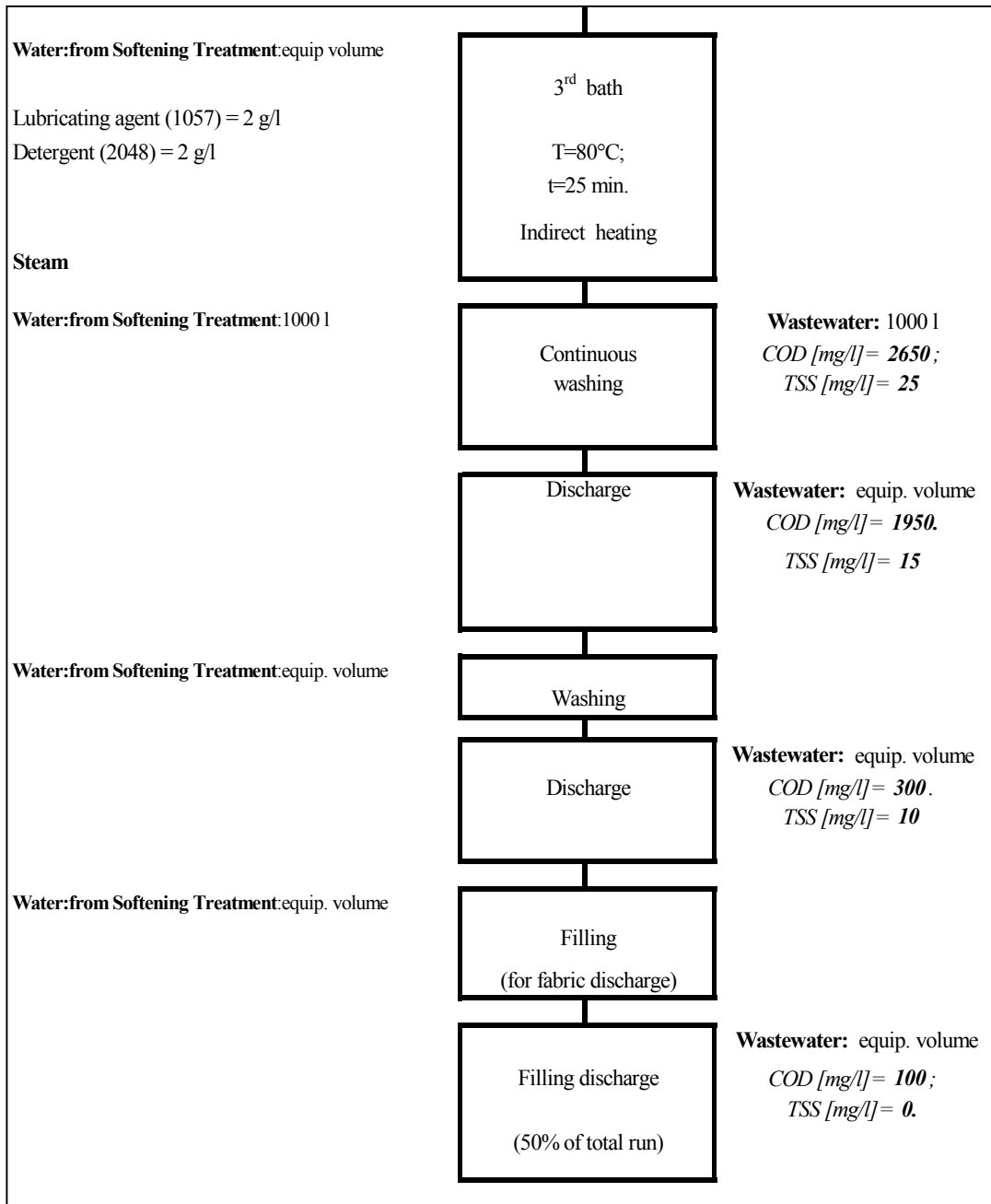
<b>Name</b>	Dyeing														
<b>Sources</b>	Report LCA I06: TM-108-002 <b>G.3.1 Dark disperse dyeing</b>														
<b>Reference year</b>	2000														
<b>Geographic reference</b>	Italy														
<b>Technological level</b>	modern														
<b>Reference flow</b>	100 kg of flax/pes fabric														
<b>Equipment</b>	<p>Torpedo</p> <table> <tr> <td>operating mode:</td> <td>batch</td> </tr> <tr> <td>bath volume (m3):</td> <td>2,5</td> </tr> <tr> <td>run time (h):</td> <td>4,5</td> </tr> <tr> <td>N.of run/year</td> <td>31</td> </tr> <tr> <td>absorbed power (kW):</td> <td>22</td> </tr> <tr> <td>processed fabric per run (kg):</td> <td>75</td> </tr> <tr> <td>processed fabric (kg/yr):</td> <td>2340</td> </tr> </table>	operating mode:	batch	bath volume (m3):	2,5	run time (h):	4,5	N.of run/year	31	absorbed power (kW):	22	processed fabric per run (kg):	75	processed fabric (kg/yr):	2340
operating mode:	batch														
bath volume (m3):	2,5														
run time (h):	4,5														
N.of run/year	31														
absorbed power (kW):	22														
processed fabric per run (kg):	75														
processed fabric (kg/yr):	2340														
<b>Notes</b>	Production of chemicals considered: Acetic acid, Dyestuffs														
<b>Procedural steps (flow-chart)</b>															
<p><b>Water:</b>from Softening Treatment:equip volume</p> <p>Acetic acid (2006)=1 g/l; Carrier (2068)=1 g/l; Disperse dyestuffs&gt;1% Reducing agent (2067)= 3 g/l.</p> <p><b>Steam</b></p>	<pre> graph TD     Bath["Bath T=110°C; t=30 min. Indirect heating"] --&gt; Discharge1["Discharge"]     Discharge1 --&gt; Washing["Washing"]     Washing --&gt; Discharge2["Discharge"]   </pre> <p><b>Wastewater:</b> equip. volume <i>COD [mg/l]= 1750.</i> <i>TSS [mg/l]= 85</i></p> <p><b>Wastewater:</b> equip. volume <i>COD [mg/l]= 400.</i> <i>TSS [mg/l]= 10</i></p>														

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	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	1,29E+00	
	(r) Natural Gas (in ground)	kg	2,60E+02	
	(r) Oil (in ground)	kg	2,67E+01	
	(r) Uranium (U, ore)	kg	4,99E-04	
	Flax/Pes fabric: to Dyeing Flax	kg	1,00E+02	
	Water: Public Network	litre	0,00E+00	
	Water: Unspecified Origin	litre	4,75E+02	
	Water: Well	litre	0,00E+00	
	Water: from Softening Treatment	litre	6,67E+03	
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	3,24E+01	
	(a) Arsenic (As)	g	1,80E-02	
	(a) Benzene (C6H6)	g	4,75E+00	
	(a) Butane (n-C4H10)	g	1,22E+01	
	(a) Cadmium (Cd)	g	3,15E-02	
	(a) Carbon Dioxide (CO2, fossil)	g	7,39E+05	
	(a) Ethane (C2H6)	g	6,32E+01	
	(a) Ethylene (C2H4)	g	1,29E+02	
	(a) Hexane (C6H14)	g	8,98E-01	
	(a) Hydrocarbons (except methane)	g	3,14E+02	
	(a) Hydrocarbons (unspecified)	g	1,63E+01	
	(a) Hydrogen Chloride (HCl)	g	1,36E+01	
	(a) Lead (Pb)	g	8,28E-02	
	(a) Methane (CH4)	g	1,56E+03	
	(a) Nickel (Ni)	g	6,22E-01	
	(a) Nitrogen Oxides (NOx as NO2)	g	5,54E+02	
	(a) Nitrous Oxide (N2O)	g	3,15E+00	
	(a) Propane (C3H8)	g	1,76E+01	
	(a) Sulphur Oxides (SOx as SO2)	g	1,39E+03	
	(a) Toluene (C6H5CH3)	g	2,48E+00	
	(a) Vanadium (V)	g	2,44E+00	
	(s) Arsenic (As)	g	2,15E-03	
	(s) Chromium (Cr III, Cr VI)	g	2,69E-02	
	(s) Zinc (Zn)	g	8,08E-02	
	(w) Ammonia (NH4+, NH3, as N)	g	1,36E+00	
	(w) Benzene (C6H6)	g	3,91E-01	
	(w) Cadmium (Cd++)	g	1,31E-03	
	(w) Chromium (Cr III)	g	5,65E-02	
	(w) Nitrogenous Matter (unspecified, as N)	g	1,63E+00	
	(w) Oils (unspecified)	g	1,28E+01	
	Flax/Pes fabric: to Dyeing Pes	kg	1,00E+02	
	Wastewater	litre	6,67E+03	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	1,97E+02
		E Fuel Energy	MJ	1,22E+04
		E Non Renewable Energy	MJ	1,22E+04
		E Renewable Energy	MJ	1,61E+02
E Total Primary Energy		MJ	1,24E+04	
Electricity		MJ elec	7,04E+02	
COD: to Wastewater Treatment Plant		kg	7,17E+00	
TSS: to Wastewater Treatment Plant		kg	3,16E-01	

### 3 Light reactive dyeing – Flax/Pes fabric

<b>Name</b>	Dyeing														
<b>Sources</b>	Report LCA I06: TM-108-002 <b>G.7.2 Light reactive dyeing</b>														
<b>Reference year</b>	2000														
<b>Geographic reference</b>	Italy														
<b>Technological level</b>	modern														
<b>Reference flow</b>	100 kg of flax/pes fabric														
<b>Equipment</b>	<p>Overflow</p> <table> <tr> <td>operating mode:</td> <td>batch</td> </tr> <tr> <td>bath volume (m3):</td> <td>4</td> </tr> <tr> <td>run time (h):</td> <td>6,5</td> </tr> <tr> <td>N.of run/year</td> <td>79</td> </tr> <tr> <td>absorbed power (kW):</td> <td>9,35</td> </tr> <tr> <td>processed fabric per run (kg):</td> <td>42</td> </tr> <tr> <td>processed fabric (kg/yr):</td> <td>3314</td> </tr> </table>	operating mode:	batch	bath volume (m3):	4	run time (h):	6,5	N.of run/year	79	absorbed power (kW):	9,35	processed fabric per run (kg):	42	processed fabric (kg/yr):	3314
operating mode:	batch														
bath volume (m3):	4														
run time (h):	6,5														
N.of run/year	79														
absorbed power (kW):	9,35														
processed fabric per run (kg):	42														
processed fabric (kg/yr):	3314														
<b>Notes</b>	Production of chemicals considered: Acetic acid, Soda solvay, Sodium sulphate, Reactive dyestuff														
<b>Procedural steps (flow-chart)</b>															
<p><b>Water: from Softening Treatment: equip volume</b></p> <p>Sodium sulphate (2008) = 50 g/l Soda solvay (1016) = 3 g/l Detergent (2046) = 0,5 g/l Dispersant agent (2058) = 0,5 g/l Lubricating agent (1057) = 2 g/l</p> <p>Reactive dyestuffs &lt; 0,05%</p> <p><b>Steam</b></p>	<pre> graph TD     A["1st bath T=60°C; t=90 min. Indirect heating"] --&gt; B["Discharge"]     B --&gt; C["2nd bath T=50°C; t=10 min. Indirect heating"]     C --&gt; D["Discharge"]     </pre> <p><b>Wastewater: equip. volume</b> COD [mg/l] = 750. TSS [mg/l] = 21</p>														
<p><b>Water: from Softening Treatment: equip volume</b></p> <p>Acetic acid (2006) = 1 g/l</p> <p><b>Steam</b></p>	<p><b>Wastewater: equip. volume</b> COD [mg/l] = 1050. TSS [mg/l] = 12</p>														





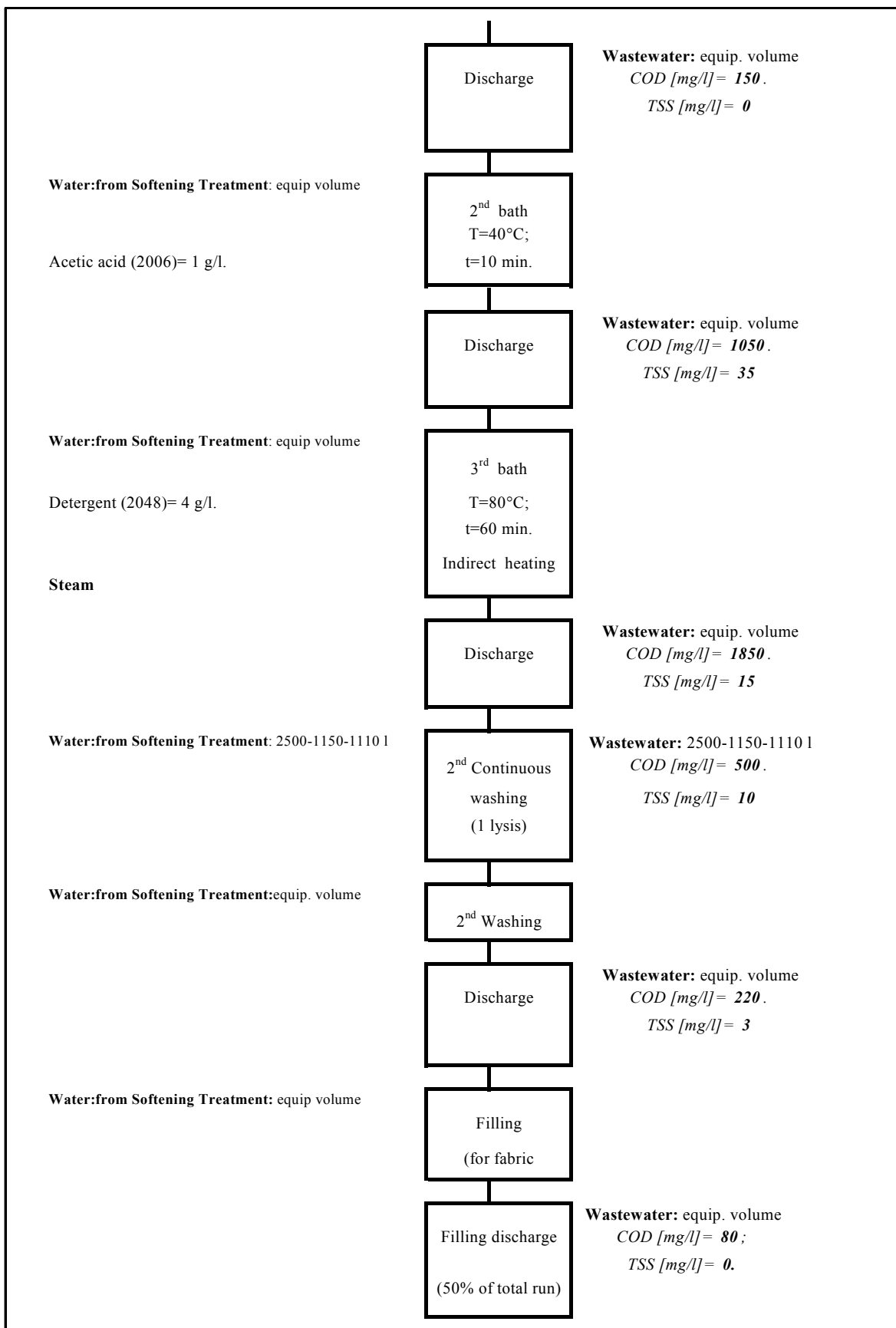
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	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUT</b>	(r) Natural Gas (in ground)	kg	4,15E+02	
	(r) Oil (in ground)	kg	1,42E+02	
	(r) Potassium Chloride (KCl, as K2O, in ground)	kg	2,15E+01	
	(r) Uranium (U, ore)	kg	1,21E-03	
	Flax/Pes fabric: to Dyeing Pes	kg	1,00E+02	
	Water: Public Network	litre	1,18E+03	
	Water: Unspecified Origin	litre	2,09E+03	
	Water: Well	litre	1,72E-02	
	Water: from Softening Treatment	litre	5,00E+04	
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	4,20E+01	
	(a) Ammonia (NH3)	g	3,46E+01	
	(a) Arsenic (As)	g	5,57E-02	
	(a) Butane (n-C4H10)	g	2,42E+01	
	(a) Cadmium (Cd)	g	1,22E-01	
	(a) Carbon Dioxide (CO2, fossil)	g	1,19E+06	
	(a) Ethane (C2H6)	g	1,60E+02	
	(a) Ethylene (C2H4)	g	1,42E+02	
	(a) Heptane (C7H16)	g	1,80E+00	
	(a) Hexane (C6H14)	g	3,60E+00	
	(a) Hydrocarbons (except methane)	g	8,56E+02	
	(a) Hydrocarbons (unspecified)	g	6,55E+02	
	(a) Methane (CH4)	g	4,42E+03	
	(a) Nickel (Ni)	g	2,40E+00	
	(a) Nitrogen Oxides (NOx as NO2)	g	1,93E+03	
	(a) Nitrous Oxide (N2O)	g	1,41E+01	
	(a) Propane (C3H8)	g	4,16E+01	
	(a) Sulphur Oxides (SOx as SO2)	g	1,23E+04	
	(a) Toluene (C6H5CH3)	g	3,64E+00	
	(a) Vanadium (V)	g	9,54E+00	
	(s) Arsenic (As)	g	2,35E-03	
	(s) Chromium (Cr III, Cr VI)	g	2,94E-02	
	(s) Zinc (Zn)	g	8,82E-02	
	(w) Ammonia (NH4+, NH3, as N)	g	5,03E+00	
	(w) Benzene (C6H6)	g	1,40E+00	
	(w) Cadmium (Cd++)	g	4,14E-03	
	(w) Chromate (CrO4--)	g	1,96E-01	
	(w) Chromium (Cr III)	g	6,17E-02	
	(w) Chromium (Cr III, Cr VI)	g	2,56E-02	
	(w) Nitrogenous Matter (unspecified, as N)	g	7,73E+00	
	(w) Oils (unspecified)	g	1,98E+01	
	Flax/Pes fabric: to Finishing	kg	1,00E+02	
	Wastewater	litre	5,00E+04	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	2,90E+02
		E Fuel Energy	MJ	2,42E+04
		E Non Renewable Energy	MJ	2,43E+04
		E Renewable Energy	MJ	2,52E+02
		E Total Primary Energy	MJ	2,45E+04
		Electricity	MJ elec	1,51E+03
		COD: to Wastewater Treatment Plant	kg	4,58E+01
		TSS: to Wastewater Treatment Plant	kg	7,07E-01

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#### 4 Dark reactive dyeing- Flax/Pes

<b>Name</b>	Dyeing
<b>Sources</b>	Report LCA I06: TM-108-002 <b>G.8.1 Dark reactive dyeing Jigger</b>
<b>Reference year</b>	2000
<b>Geographic reference</b>	Italy
<b>Technological level</b>	modern
<b>Reference flow</b>	100 kg of flax/pes fabric
<b>Equipment</b>	Jigger operating mode: batch bath volume (lit.): 0,6 run time (h): 7 N. of run/year 57 absorbed power (kW): 22,4 processed fabric per run (kg): 53 processed fabric (kg/yr): 3051
<b>Notes</b>	Production of chemicals considered: Acetic acid, Sodium sulphate, Soda solvay, Reactive dyestuff
<b>Procedural steps (flow-chart)</b>	
<p><b>Water:</b>from Softening Treatment: equip volume</p> <p>Detergent (2046)= 1 g/l; Dispersant agent (2058)= 1 g/l; Sodium sulphate (2008)= 50 g/l; Soda Solvay (1016)= 3 g/l; Reactive dyestuffs&gt;0,05%.</p> <p><b>Steam</b></p> <p><b>Water:</b>from Softening Treatment: 2500-1150-1110 l</p> <p><b>Water:</b>from Softening Treatment:equip. volume</p>	



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	Flow	Units	Value	
<b>INPUTS</b>	(r) Coal (in ground)	kg	2,30E+01	
	(r) Natural Gas (in ground)	kg	6,80E+01	
	(r) Oil (in ground)	kg	6,47E+01	
	(r) Potassium Chloride (KCl, as K2O, in ground)	kg	2,56E+00	
	(r) Uranium (U, ore)	kg	1,45E-04	
	Flax/Pes fabric: to Dyeing Pes	kg	1,00E+02	
	Water: Public Network	litre	1,40E+02	
	Water: Unspecified Origin	litre	4,85E+02	
	Water: Well	litre	2,05E-03	
	Water: from Softening Treatment	litre	1,10E+04	
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	1,11E+01	
	(a) Ammonia (NH3)	g	4,18E+00	
	(a) Arsenic (As)	g	3,65E-02	
	(a) Butane (n-C4H10)	g	1,08E+01	
	(a) Cadmium (Cd)	g	7,54E-02	
	(a) Carbon Dioxide (CO2, fossil)	g	3,70E+05	
	(a) Ethane (C2H6)	g	8,34E+01	
	(a) Ethylene (C2H4)	g	2,72E+01	
	(a) Heptane (C7H16)	g	1,07E+00	
	(a) Hexane (C6H14)	g	2,14E+00	
	(a) Hydrocarbons (except methane)	g	4,32E+02	
	(a) Hydrocarbons (unspecified)	g	7,80E+01	
	(a) Methane (CH4)	g	2,25E+03	
	(a) Nickel (Ni)	g	1,49E+00	
	(a) Nitrogen Oxides (NOx as NO2)	g	6,55E+02	
	(a) Nitrous Oxide (N2O)	g	5,07E+00	
	(a) Propane (C3H8)	g	2,12E+01	
	(a) Propylene (CH2CHCH3)	g	4,56E-01	
	(a) Sulphur Oxides (SOx as SO2)	g	3,82E+03	
	(a) Toluene (C6H5CH3)	g	1,20E+00	
	(a) Vanadium (V)	g	5,92E+00	
	(s) Arsenic (As)	g	4,28E-04	
	(s) Chromium (Cr III, Cr VI)	g	5,36E-03	
	(s) Zinc (Zn)	g	1,61E-02	
	(w) Ammonia (NH4+, NH3, as N)	g	2,67E+00	
	(w) Benzene (C6H6)	g	7,80E-01	
	(w) Cadmium (Cd++)	g	2,13E-03	
	(w) Chromate (CrO4--)	g	2,33E-02	
	(w) Chromium (Cr III)	g	1,12E-02	
	(w) Chromium (Cr III, Cr VI)	g	1,43E-02	
	(w) Nitrogenous Matter (unspecified, as N)	g	3,55E+00	
	(w) Oils (unspecified)	g	6,62E+00	
	Flax/Pes fabric: to Finishing	kg	1,00E+02	
	Wastewater	litre	1,10E+04	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	1,90E+02
		E Fuel Energy	MJ	6,03E+03
		E Non Renewable Energy	MJ	5,92E+03
		E Renewable Energy	MJ	3,00E+02
		E Total Primary Energy	MJ	6,22E+03
		Electricity	MJ elec	1,80E+03
COD: to Wastewater Treatment Plant		kg	2,19E+00	
TSS: to Wastewater Treatment Plant		kg	8,92E-02	

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## 5 Light acid dyeing – Silk yarn

<b>Name</b>	Light Acid Dyeing	
<b>Sources</b>	PIDACS I09	G.4.2 Silk light acid dyeing
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of silk yarn	
<b>Equipment</b>	Autoclave operating mode: batch bath volume (m3): 0,65 run time (h): 1 N. of run/year 211 absorbed power (kW): 5 processed fabric per run (kg): 90 processed fabric (kg/yr): 8422	
<b>Notes</b>	Production of chemicals considered: Acetic acid	
<b>Procedural steps (flow-chart)</b>		
<b>Water from Disinfection:</b> equip. volume  Acid buffer = 0,7 g/l Equalizing agent = 0,75% Antifoaming agent = 0,5 g/l Sequestering agent = 0,8 g/l Acid dyestuffs < 0,5%  <b>Steam</b>  <b>Water from Disinfection:</b> equip. volume  <b>Water from Filtration:</b> equip. volume  <b>Water from Disinfection:</b> equip. volume  Acetic acid = 1 g/l	1 <sup>st</sup> bath T=80°C; t=40 min.  Indirect heating  Discharge  1 <sup>st</sup> washing  Discharge  2 <sup>nd</sup> washing  Discharge  2 <sup>nd</sup> bath  Discharge	<b>Wastewater:</b> equip. volume  COD [mg/l]= 461 TSS [mg/l]= 16  <b>Wastewater:</b> equip. volume  COD [mg/l]= 206 TSS [mg/l]= 10  <b>Wastewater:</b> equip. volume  COD [mg/l]= 143 TSS [mg/l]= 10  <b>Wastewater:</b> equip. volume  COD [mg/l]= 622 TSS [mg/l]= 25

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	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	1,18E-01	
	(r) Natural Gas (in ground)	kg	2,38E+01	
	(r) Oil (in ground)	kg	3,27E+00	
	(r) Uranium (U, ore)	kg	4,95E-05	
	Silk yarn	kg	1,00E+02	
	Water from Disinfection	l	4,88E+03	
	Water from Filtration	l	1,63E+03	
<b>OUTPUTS</b>	Water: Unspecified Origin	l	6,21E+01	
	(a) Alkane (unspecified)	g	3,19E+00	
	(a) Arsenic (As)	g	1,76E-03	
	(a) Benzene (C6H6)	g	4,44E-01	
	(a) Butane (n-C4H10)	g	1,14E+00	
	(a) Cadmium (Cd)	g	3,07E-03	
	(a) Carbon Dioxide (CO2, fossil)	g	6,85E+04	
	(a) Ethane (C2H6)	g	6,11E+00	
	(a) Ethylene (C2H4)	g	1,18E+01	
	(a) Hydrocarbons (except methane)	g	3,45E+01	
	(a) Hydrocarbons (unspecified)	g	7,87E+00	
	(a) Hydrogen Chloride (HCl)	g	1,34E+00	
	(a) Lead (Pb)	g	8,05E-03	
	(a) Methane (CH4)	g	1,50E+02	
	(a) Nickel (Ni)	g	6,05E-02	
	(a) Nitrogen Oxides (NOx as NO2)	g	5,32E+01	
	(a) Nitrous Oxide (N2O)	g	3,07E-01	
	(a) Propane (C3H8)	g	1,66E+00	
	(a) Sulphur Oxides (SOx as SO2)	g	1,34E+02	
	(a) Vanadium (V)	g	2,38E-01	
	(s) Arsenic (As)	g	1,97E-04	
	(s) Chromium (Cr III, Cr VI)	g	2,46E-03	
	(s) Zinc (Zn)	g	7,40E-03	
	(w) Ammonia (NH4+, NH3, as N)	g	1,91E-01	
	(w) Benzene (C6H6)	g	4,64E-02	
	(w) Cadmium (Cd++)	g	1,72E-04	
	(w) Chromium (Cr III)	g	5,17E-03	
	(w) Chromium (Cr III, Cr VI)	g	8,03E-04	
	(w) COD (Chemical Oxygen Demand)	g	7,73E+00	
	(w) Nitrate (NO3-)	g	1,53E-01	
	(w) Nitrogenous Matter (unspecified, as N)	g	2,44E-01	
	(w) Oils (unspecified)	g	1,24E+00	
	Silk yarn	kg	1,00E+02	
	Wastewater	l	6,50E+03	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	4,93E+01
		E Fuel Energy	MJ	1,12E+03
E Non Renewable Energy		MJ	1,16E+03	
E Renewable Energy		MJ	1,54E+01	
E Total Primary Energy		MJ	1,17E+03	
Electricity		MJ elec	1,12E+02	
COD: to Wastewater Treatment Plant		kg	2,33E+00	
TSS: to Wastewater Treatment Plant		kg	9,91E-02	

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## 6 Medium acid dyeing – Silk yarn

<b>Name</b>	Medium Acid Dyeing	
<b>Sources</b>	PIDACS I09	G.5.2 Silk medium acid dyeing
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of silk yarn	
<b>Equipment</b>	Autoclave operating mode: batch bath volume (m3): 0,65 run time (h): 1 N.of run/year 156 absorbed power (kW): 5 processed fabric per run (kg): 40 processed fabric (kg/yr): 6239	
<b>Notes</b>	Production of chemicals considered: Acetic acid	
<b>Procedural steps (flow-chart)</b>		
<b>Water from Disinfection:</b> equip volume  Acid buffer = 1 g/l Equalizing agent = 0,75% Antifoaming agent = 0,5 g/l Sequestering agent = 0,8 g/l 0,5% < Acid dyestuffs < 1,5%  <b>Steam</b>          <b>Water from Disinfection:</b> equip. volume          <b>Water from Filtration:</b> equip. volume          <b>Water from Disinfection:</b> equip. volume  Acetic acid = 1 g/l.	1 <sup>st</sup> bath T=80°C; t=40 min.  Indirect heating  Discharge  1 <sup>st</sup> washing  Discharge  2 <sup>nd</sup> washing  Discharge  2 <sup>nd</sup> bath  Discharge	<b>Wastewater:</b> equip. volume  COD [mg/l]= 1350 TSS [mg/l]= 27  <b>Wastewater:</b> equip. volume  COD [mg/l]= 310 TSS [mg/l]= 10  <b>Wastewater:</b> equip. volume  COD [mg/l]= 120 TSS [mg/l]= 10  <b>Wastewater:</b> equip. volume  COD [mg/l]= 1500 TSS [mg/l]= 25

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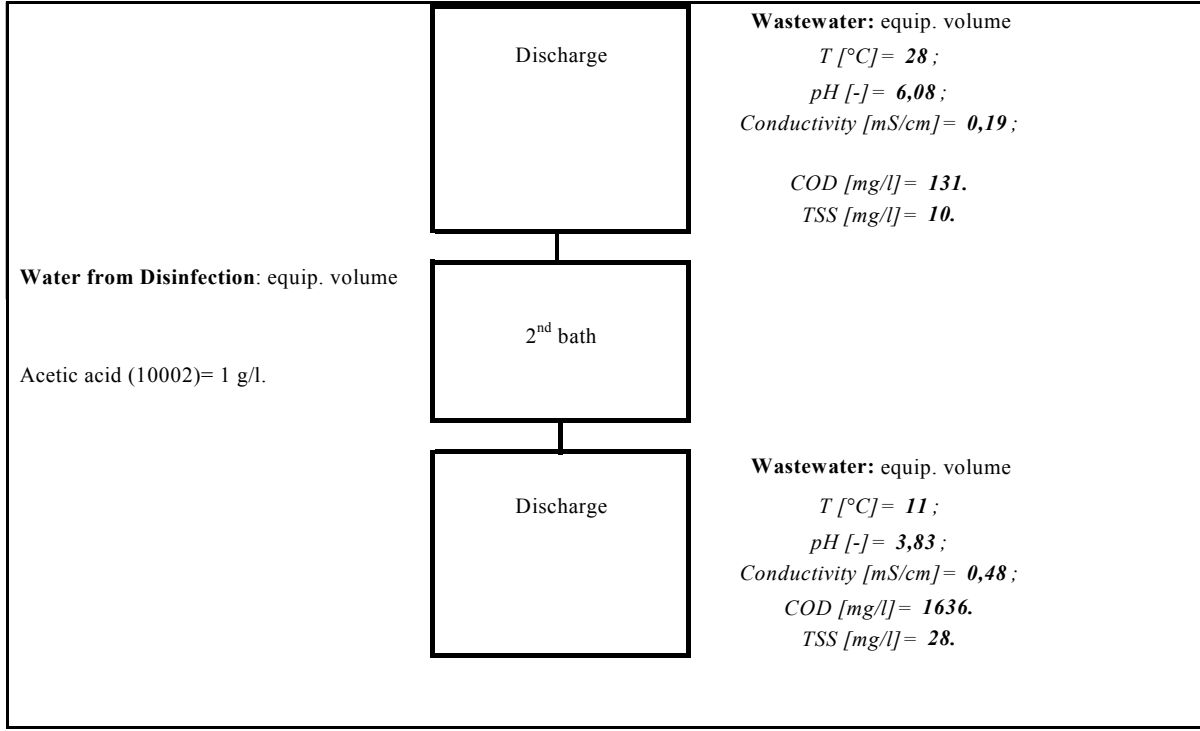
	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	1,18E-01
	(r) Natural Gas (in ground)	kg	2,38E+01
	(r) Oil (in ground)	kg	3,28E+00
	(r) Uranium (U, ore)	kg	4,95E-05
	Silk yarn	kg	1,00E+02
	Water from Disinfection	l	4,88E+03
	Water from Filtration	l	1,63E+03
	Water: Unspecified Origin	l	6,21E+01
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	3,19E+00
	(a) Arsenic (As)	g	1,76E-03
	(a) Benzene (C6H6)	g	4,44E-01
	(a) Butane (n-C4H10)	g	1,14E+00
	(a) Cadmium (Cd)	g	3,07E-03
	(a) Carbon Dioxide (CO2, fossil)	g	6,85E+04
	(a) Ethane (C2H6)	g	6,11E+00
	(a) Ethylene (C2H4)	g	1,18E+01
	(a) Hydrocarbons (except methane)	g	3,45E+01
	(a) Hydrocarbons (unspecified)	g	7,87E+00
	(a) Hydrogen Chloride (HCl)	g	1,34E+00
	(a) Lead (Pb)	g	8,05E-03
	(a) Methane (CH4)	g	1,50E+02
	(a) Nickel (Ni)	g	6,05E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	5,34E+01
	(a) Nitrous Oxide (N2O)	g	3,09E-01
	(a) Propane (C3H8)	g	1,66E+00
	(a) Sulphur Oxides (SOx as SO2)	g	1,34E+02
	(a) Vanadium (V)	g	2,38E-01
	(s) Arsenic (As)	g	1,97E-04
	(s) Chromium (Cr III, Cr VI)	g	2,46E-03
	(s) Zinc (Zn)	g	7,40E-03
	(w) Ammonia (NH4+, NH3, as N)	g	1,91E-01
	(w) Benzene (C6H6)	g	4,64E-02
	(w) Cadmium (Cd++)	g	1,73E-04
	(w) Chromium (Cr III)	g	5,17E-03
	(w) Chromium (Cr III, Cr VI)	g	8,04E-04
	(w) COD (Chemical Oxygen Demand)	g	7,73E+00
	(w) Nitrate (NO3-)	g	1,53E-01
	(w) Nitrogenous Matter (unspecified, as N)	g	2,44E-01
	(w) Oils (unspecified)	g	1,24E+00
	Silk yarn	kg	1,00E+02
	Wastewater	l	6,50E+03
	<b>REMINDERS</b>	E Feedstock Energy	MJ
E Fuel Energy		MJ	1,12E+03
E Non Renewable Energy		MJ	1,16E+03
E Renewable Energy		MJ	1,54E+01
E Total Primary Energy		MJ	1,17E+03
Electricity		MJ elec	1,12E+02
COD: to Wastewater Treatment Plant		kg	5,33E+00
TSS: to Wastewater Treatment Plant		kg	1,17E-01



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## 7 Dark acid dyeing –Silk yarn

<b>Name</b>	Silk dark acid dyeing	
<b>Sources</b>	Report LCA I09: TM-108-004	<b>G.6.2 Dark acid dyeing</b>
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of silk yarn	
<b>Equipment</b>	Autoclave operating mode: batch bath volume (m3): 0,65 run time (h): 1,1 N.of run/year 413 absorbed power (kW): 5 processed fabric per run (kg): 40 processed fabric (kg/yr): 16533	
<b>Notes</b>	Production of chemicals considered: Acetic acid	
<b>Procedural steps (flow-chart)</b>		
<p><b>Water from Disinfection:</b>equip volume</p> <p>Acid buffer (10178)= 1,5 g/l;          Equalizing agent (10029)= 0,75%;          Antifoaming agent (10404)= 0,5 g/l;          Sequestering agent (10263)= 0,8 g/l;          Acid dyestuffs &gt; 1,5%</p> <p><b>Steam</b></p>	<div style="border: 1px solid black; padding: 5px; text-align: center;"> <p>1<sup>st</sup> bath</p> <p>T=80°C; t=40 min.</p> <p>Indirect heating</p> </div>	
	↓	
	<div style="border: 1px solid black; padding: 5px; text-align: center;"> <p>Discharge</p> </div>	<p><b>Wastewater:</b> equip. volume</p> <p><math>T [^{\circ}C] = 78</math> ;  <math>pH [-] = 4,96</math> ;  <math>Conductivity [mS/cm] = 1,11</math> ;  <math>COD [mg/l] = 2067</math>.  <math>TSS [mg/l] = 35</math>.</p>
	↓	
<p><b>Water from Disinfection:</b> equip. volume</p>	<div style="border: 1px solid black; padding: 5px; text-align: center;"> <p>1<sup>st</sup> washing</p> </div>	
	↓	
	<div style="border: 1px solid black; padding: 5px; text-align: center;"> <p>Discharge</p> </div>	<p><b>Wastewater:</b> equip. volume</p> <p><math>T [^{\circ}C] = 43</math> ;  <math>pH [-] = 6,53</math> ;  <math>Conductivity [mS/cm] = 0,24</math> ;  <math>COD [mg/l] = 426</math>.  <math>TSS [mg/l] = 15</math>.</p>
	↓	
<p><b>Water from Filtration:</b> equip. volume</p>	<div style="border: 1px solid black; padding: 5px; text-align: center;"> <p>2<sup>nd</sup> washing</p> </div>	



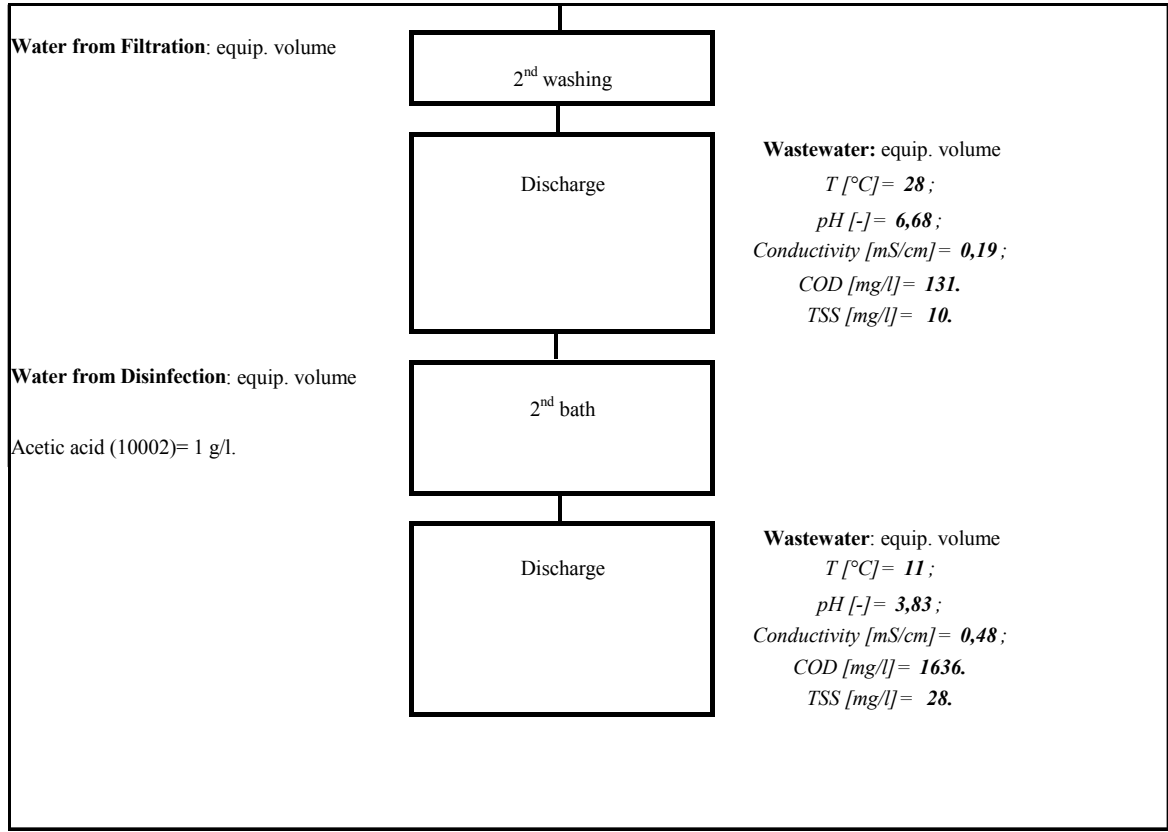
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	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUTS</b>	(r) Coal (in ground)	kg	1,60E+00
	(r) Iron (Fe, ore)	kg	1,19E-01
	(r) Natural Gas (in ground)	kg	2,39E+01
	(r) Oil (in ground)	kg	3,49E+00
	(r) Uranium (U, ore)	kg	4,95E-05
	Silk yarn: to Dyeing	kg	1,00E+02
	Water: from Disinfection	l	4,88E+03
	Water: from Filtration	l	1,63E+03
	Water: Unspecified Origin	l	6,32E+01
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	3,22E+00
	(a) Arsenic (As)	g	1,90E-03
	(a) Benzene (C6H6)	g	4,48E-01
	(a) Butane (n-C4H10)	g	1,18E+00
	(a) Cadmium (Cd)	g	3,34E-03
	(a) Carbon Dioxide (CO2, fossil)	g	6,96E+04
	(a) Carbon Monoxide (CO)	g	4,17E+01
	(a) Ethane (C2H6)	g	6,40E+00
	(a) Ethylene (C2H4)	g	1,19E+01
	(a) Hydrocarbons (except methane)	g	3,60E+01
	(a) Hydrocarbons (unspecified)	g	7,87E+00
	(a) Hydrogen Chloride (HCl)	g	1,42E+00
	(a) Lead (Pb)	g	8,63E-03
	(a) Manganese (Mn)	g	6,05E-03
	(a) Methane (CH4)	g	1,58E+02
	(a) Nickel (Ni)	g	6,59E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	5,53E+01
	(a) Nitrous Oxide (N2O)	g	3,24E-01
	(a) Propane (C3H8)	g	1,73E+00
	(a) Sulphur Oxides (SOx as SO2)	g	1,45E+02
	(a) Toluene (C6H5CH3)	g	2,40E-01
	(a) Vanadium (V)	g	2,59E-01
	(s) Arsenic (As)	g	1,98E-04
	(s) Chromium (Cr III, Cr VI)	g	2,47E-03
	(s) Zinc (Zn)	g	7,42E-03
	(w) Ammonia (NH4+, NH3, as N)	g	2,00E-01
	(w) Benzene (C6H6)	g	4,92E-02
	(w) Cadmium (Cd++)	g	1,80E-04
	(w) Chromium (Cr III)	g	5,19E-03
	(w) Chromium (Cr III, Cr VI)	g	8,55E-04
	(w) COD (Chemical Oxygen Demand)	g	7,74E+00
	(w) Nitrate (NO3-)	g	1,55E-01
	(w) Nitrogenous Matter (unspecified, as N)	g	2,55E-01
(w) Oils (unspecified)	g	1,26E+00	
Silk yarn: to Finishing	kg	1,00E+02	
Wastewater	l	6,50E+03	
<b>REMINDERS</b>	E Feedstock Energy	MJ	5,00E+01
	E Fuel Energy	MJ	1,14E+03
	E Non Renewable Energy	MJ	1,17E+03
	E Renewable Energy	MJ	1,66E+01
	E Total Primary Energy	MJ	1,19E+03
	Electricity	MJ elec	1,22E+02
	COD: to Wastewater Treatment Plant	kg	6,92E+03
	TSS: to Wastewater Treatment Plant	kg	1,43E+02

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## 8 Dark acid dyeing –Charged silk yarn

<b>Name</b>	Charged silk dark acid dyeing	
<b>Sources</b>	Report LCA I09: TM-108-004	<b>G.6.3 Dark acid dyeing</b>
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of charged silk yarn	
<b>Equipment</b>	Autoclave operating mode: batch bath volume (m3): 0,65 run time (h): 1,1 N.of run/year 125 absorbed power (kW): 5 processed fabric per run (kg): 40 processed fabric (kg/yr): 4994	
<b>Notes</b>	Production of chemicals considered: Acetic acid	
<b>Procedural steps (flow-chart)</b>		
<p><b>Water from Disinfection:</b> equip. volume</p> <p>Acid buffer (10178)= 1,5 g/l;  Equalizing agent (10029)= 0,75%;  Antifoaming agent (10404)= 0,5 g/l;  Sequestering agent (10263)= 0,8 g/l;  Acid dyestuffs &gt; 1,5%</p> <p><b>Steam</b></p>	<div style="border: 1px solid black; padding: 5px; text-align: center;"> 1<sup>st</sup> bath  T=90°C;  t=40 min.    Indirect heating </div>	
	↓	
	<div style="border: 1px solid black; padding: 5px; text-align: center;"> Discharge </div>	<b>Wastewater:</b> equip. volume <i>T [°C] = 78 ;</i> <i>pH [-] = 4,95 ;</i> <i>Conductivity [mS/cm] = 1,11 ;</i> <i>COD [mg/l] = 2067 .</i> <i>TSS [mg/l] = 35 .</i>
	↓	
<p><b>Water from Disinfection:</b> equip. volume</p>	<div style="border: 1px solid black; padding: 5px; text-align: center;"> 1<sup>st</sup> washing </div>	
	↓	
	<div style="border: 1px solid black; padding: 5px; text-align: center;"> Discharge </div>	<b>Wastewater:</b> : equip. volume <i>T [°C] = 43 ;</i> <i>pH [-] = 6,53 ;</i> <i>Conductivity [mS/cm] = 0,24 ;</i> <i>COD [mg/l] = 426 .</i> <i>TSS [mg/l] = 15 .</i>



	Flow	Units	Value
<b>INPUTS</b>	(r) Coal (in ground)	kg	1,71E+00
	(r) Iron (Fe, ore)	kg	1,39E-01
	(r) Natural Gas (in ground)	kg	2,81E+01
	(r) Oil (in ground)	kg	3,53E+00
	(r) Uranium (U, ore)	kg	5,76E-05
	Silk yarn: to Dyeing	kg	1,00E+02
	Water: from Disinfection	l	4,88E+03
Water: from Filtration	l	1,63E+03	
Water: Unspecified Origin	l	7,17E+01	
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	3,70E+00
	(a) Arsenic (As)	g	1,96E-03
	(a) Benzene (C6H6)	g	5,19E-01
	(a) Butane (n-C4H10)	g	1,32E+00
	(a) Cadmium (Cd)	g	3,38E-03
	(a) Carbon Dioxide (CO2, fossil)	g	8,00E+04
	(a) Carbon Monoxide (CO)	g	4,80E+01
	(a) Ethane (C2H6)	g	6,93E+00
	(a) Ethylene (C2H4)	g	1,39E+01
	(a) Hydrocarbons (except methane)	g	3,84E+01
	(a) Hydrocarbons (unspecified)	g	7,87E+00
	(a) Hydrogen Chloride (HCl)	g	1,51E+00
	(a) Lead (Pb)	g	8,97E-03
	(a) Manganese (Mn)	g	7,04E-03
	(a) Methane (CH4)	g	1,70E+02
	(a) Nickel (Ni)	g	6,67E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	6,11E+01
	(a) Nitrous Oxide (N2O)	g	3,50E-01
	(a) Propane (C3H8)	g	1,90E+00
	(a) Sulphur Oxides (SOx as SO2)	g	1,49E+02
	(a) Toluene (C6H5CH3)	g	2,75E-01
	(a) Vanadium (V)	g	2,62E-01
	(s) Arsenic (As)	g	2,32E-04
	(s) Chromium (Cr III, Cr VI)	g	2,90E-03
	(s) Zinc (Zn)	g	8,72E-03
	(w) Ammonia (NH4+, NH3, as N)	g	2,04E-01
	(w) Benzene (C6H6)	g	5,04E-02
	(w) Cadmium (Cd++)	g	1,87E-04
	(w) Chromium (Cr III)	g	6,10E-03
	(w) Chromium (Cr III, Cr VI)	g	8,67E-04
	(w) COD (Chemical Oxygen Demand)	g	7,80E+00
	(w) Nitrate (NO3-)	g	1,57E-01
	(w) Nitrogenous Matter (unspecified, as N)	g	2,58E-01
(w) Oils (unspecified)	g	1,44E+00	
Silk yarn: to Finishing	kg	1,00E+02	
Wastewater	l	6,50E+03	
<b>REMINDERS</b>	E Feedstock Energy	MJ	5,07E+01
	E Fuel Energy	MJ	1,31E+03
	E Non Renewable Energy	MJ	1,35E+03
	E Renewable Energy	MJ	1,71E+01
	E Total Primary Energy	MJ	1,36E+03
	Electricity	MJ elec	1,25E+02
	COD: to Wastewater Treatment Plant	kg	6,92E+00
	TSS: to Wastewater Treatment Plant	kg	1,43E-01

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## 9 Dark acid dyeing- Silk yarn

<b>Name</b>	Dark acid dyeing in jigger	
<b>Sources</b>	PIDACS I09 G.12.1 Fabric dark acid dyeing in overflow	
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of silk yarn	
<b>Equipment</b>	Jigger operating mode: batch bath volume (m3): 0,4 run time (h): 1,42 N.of run/year 272 absorbed power (kW): 5 processed fabric per run (kg): 27 processed fabric (kg/yr): 7354	
<b>Notes</b>	Production of chemicals considered: Sodium sulphate	
<b>Procedural steps (flow-chart)</b>		
<b>Water from Disinfection:</b> equip volume  Equalizing agent = 0,5%; Sequestering agent = 2 g/l; Sequestering agent = 2 g/l; Sodium sulphate = 10 g/l Acid dyestuffs > 1,5 %  <b>Steam</b>   <b>Water from Disinfection:</b> 600 l   <b>Water from Disinfection:</b> 600 l   <b>Water from Filtration:</b> 600 l   <b>Water from Filtration:</b> 600 l   <b>Water from Filtration:</b> 600 l	Bath  T=80°C; t=60 min.  Indirect heating  Discharge  1 <sup>st</sup> continuous washing  2 <sup>nd</sup> continuous washing  3 <sup>rd</sup> continuous washing  4 <sup>th</sup> continuous washing  5 <sup>th</sup> continuous washing	<b>Wastewater:</b> equip. volume  COD [mg/l]= 1856 TSS [mg/l]= 84 <b>Wastewater:</b> 600 l  COD [mg/l]= 308 TSS [mg/l]= 10 <b>Wastewater:</b> 600 l  COD [mg/l]= 104 TSS [mg/l]= 22 <b>Wastewater:</b> 600 l  COD [mg/l]= 51 TSS [mg/l]= 10 <b>Wastewater:</b> 600 l  COD [mg/l]= 17 TSS [mg/l]= 13 <b>Wastewater:</b> 600 l  COD [mg/l]= 20 TSS [mg/l]= 10

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	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUTS</b>	(r) Coal (in ground)	kg	2,24E+00
	(r) Iron (Fe, ore)	kg	1,15E-01
	(r) Natural Gas (in ground)	kg	2,27E+01
	(r) Oil (in ground)	kg	4,73E+00
	(r) Uranium (U, ore)	kg	4,08E-05
	Silk yarn	kg	1,00E+02
	Water from Disinfection	l	3,70E+03
	Water from Filtration	l	8,89E+03
	Water: Unspecified Origin	l	6,53E+01
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	2,99E+00
	(a) Arsenic (As)	g	3,13E-03
	(a) Benzene (C6H6)	g	4,41E-01
	(a) Butane (n-C4H10)	g	1,45E+00
	(a) Cadmium (Cd)	g	5,96E-03
	(a) Carbon Dioxide (CO2, fossil)	g	7,40E+04
	(a) Ethane (C2H6)	g	8,77E+00
	(a) Ethylene (C2H4)	g	1,13E+01
	(a) Hexane (C6H14)	g	1,70E-01
	(a) Hydrocarbons (except methane)	g	4,38E+01
	(a) Hydrocarbons (unspecified)	g	2,42E-02
	(a) Hydrogen Chloride (HCl)	g	2,06E+00
	(a) Lead (Pb)	g	1,39E-02
	(a) Methane (CH4)	g	2,23E+02
	(a) Nickel (Ni)	g	1,17E-01
	(a) Nitrogen Oxides (NOx as NO2)	g	7,07E+01
	(a) Nitrous Oxide (N2O)	g	4,64E-01
	(a) Propane (C3H8)	g	2,35E+00
	(a) Sulphur Oxides (SOx as SO2)	g	2,45E+02
	(a) Vanadium (V)	g	4,65E-01
	(s) Arsenic (As)	g	1,87E-04
	(s) Chromium (Cr III, Cr VI)	g	2,34E-03
	(s) Zinc (Zn)	g	7,03E-03
	(w) Ammonia (NH4+, NH3, as N)	g	2,18E-01
	(w) Benzene (C6H6)	g	6,48E-02
	(w) Cadmium (Cd++)	g	1,91E-04
	(w) Chromium (Cr III)	g	4,91E-03
	(w) Chromium (Cr III, Cr VI)	g	1,14E-03
	(w) Nitrate (NO3-)	g	4,39E-02
	(w) Nitrogenous Matter (unspecified, as N)	g	2,62E-01
	(w) Oils (unspecified)	g	1,29E+00
	Silk yarn	kg	1,00E+02
	Wastewater	l	1,26E+04
<b>REMINDEERS</b>	E Feedstock Energy	MJ	1,85E+01
	E Fuel Energy	MJ	1,19E+03
	E Non Renewable Energy	MJ	1,18E+03
	E Renewable Energy	MJ	2,82E+01
	E Total Primary Energy	MJ	1,21E+03
	Electricity	MJ elec	2,14E+02
	COD: to Wastewater Treatment Plant	kg	3,86E+00
	TSS: to Wastewater Treatment Plant	kg	2,69E-01



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## 10 Direct dyeing – Viscose fabric

<b>Name</b>	Dark Direct Dyeing in Pad-Steam	
<b>Sources</b>	Report LCA I04: TM-108-005 G.3.1 Dark dirct dyeing in pad steam	
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of viscose fabric	
<b>Equipment</b>	Pad-steam operating mode: continuous cycle time (h:m): 2,3 n. of cycle/year: 202 absorbed power (kW): 92 processed fabric per hour (kg/h): 462 processed fabric (kg/yr): 206523	
<b>Notes</b>	Production of anti-reducing agent, direct dyestuffs and soaping agent are excluded because of lack of data.	
<b>Procedural steps (flow-chart)</b>		
<b>Water from Softening:</b> 50 l <b>Reintegration :</b> 160 l/h Anti-reducing agent =6 g/l Direct dyestuffs>1.5%  <b>Steam</b>  <b>Water from Softening:</b> 180 l/h Soaping agent = 15 g/l  <b>Steam</b>  <b>Water from Storage:</b> 8400 l  <b>Water from Storage:</b> 7000 l/h  <b>Water from Storage:</b> 50 l  <b>Water from Storage:</b> 50 l <b>Reintegration :</b> 130 l/h	Dyeing bath  T=60°C  Indirect heating  Steaming  T=80°C  Indirect heating  Filling  Rinsing  Discharge  Neutralization  Filling	<b>Wastewater:</b> 50 l COD [mg/l]= 5600 TSS [mg/l]= 180  <b>Wastewater:</b> 180 l/h COD [mg/l]= 150 TSS [mg/l]= 30  <b>Wastewater:</b> 7000 l/h COD [mg/l]= 100 TSS [mg/l]= 20  <b>Wastewater:</b> 8400 l COD [mg/l]= 880 TSS [mg/l]= 33  <b>Wastewater:</b> 50 l COD [mg/l]= 50 TSS [mg/l]= 10  <b>Wastewater:</b> 50 l COD [mg/l]= 100 TSS [mg/l]= 10

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	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUTS</b>	(r) Coal (in ground)	kg	1,38E+00	
	(r) Iron (Fe, ore)	kg	2,63E-02	
	(r) Natural Gas (in ground)	kg	4,54E+00	
	(r) Oil (in ground)	kg	3,48E+00	
	(r) Uranium (U, ore)	kg	8,14E-06	
	Viscose fabric to: Dyeing	kg	1,00E+02	
	Water: from Softening Treatment	l	8,43E+01	
	Water from Storage	l	1,53E+03	
<b>OUTPUTS</b>	Water: Unspecified Origin	l	2,27E+01	
	(a) Alkane (unspecified)	g	8,06E-01	
	(a) Arsenic (As)	g	2,20E-03	
	(a) Butane (n-C4H10)	g	6,77E-01	
	(a) Cadmium (Cd)	g	4,40E-03	
	(a) Carbon Dioxide (CO2, fossil)	g	2,46E+04	
	(a) Ethane (C2H6)	g	5,04E+00	
	(a) Ethylene (C2H4)	g	2,32E+00	
	(a) Hydrocarbons (except methane)	g	2,62E+01	
	(a) Hydrogen Chloride (HCl)	g	1,31E+00	
	(a) Lead (Pb)	g	1,18E-02	
	(a) Methane (CH4)	g	1,33E+02	
	(a) Nickel (Ni)	g	8,67E-02	
	(a) Nitrogen Oxides (NOx as NO2)	g	3,57E+01	
	(a) Propane (C3H8)	g	1,29E+00	
	(a) Sulphur Oxides (SOx as SO2)	g	1,72E+02	
	(a) Vanadium (V)	g	3,45E-01	
	(s) Arsenic (As)	g	3,71E-05	
	(s) Chromium (Cr III, Cr VI)	g	4,65E-04	
	(s) Zinc (Zn)	g	1,40E-03	
	(w) Ammonia (NH4+, NH3, as N)	g	1,55E-01	
	(w) Benzene (C6H6)	g	4,54E-02	
	(w) Cadmium (Cd++)	g	1,25E-04	
	(w) Chromium (Cr III)	g	8,31E-04	
	(w) Chromium (Cr III, Cr VI)	g	1,83E-08	
	(w) COD (Chemical Oxygen Demand)	g	2,19E-01	
	(w) Nitrate (NO3-)	g	2,92E-02	
	(w) Nitrogenous Matter (unspecified, as N)	g	1,94E-01	
	(w) Oils (unspecified)	g	4,43E-01	
	Viscose fabric to: Soaping	kg	1,00E+02	
	Wastewater	l	1,56E+03	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	1,18E+01
		E Fuel Energy	MJ	3,64E+02
E Non Renewable Energy		MJ	3,56E+02	
E Renewable Energy		MJ	1,98E+01	
E Total Primary Energy		MJ	3,76E+02	
Electricity		MJ elec	1,55E+02	
COD to Wastewater Treatment Plant		Kg	8,57E-01	
TSS to Wastewater Treatment Plant		Kg	4,39E-02	

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## 11 Dark direct dyeing – Viscose fabric

<b>Name</b>	Dark Direct Dyeing in Jigger	
<b>Sources</b>	Report LCA I04: TM-108-005 <b>G.3.2 Dark direct dyeing</b>	
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of viscose fabric	
<b>Equipment</b>	jigger operating mode: batch bath volume (m3): 0,8 run time (h:m): 4,3 n. of run/year 532 absorbed power (kW): 6,9 processed fabric per run (kg): 350 processed fabric (kg/yr): 186052	
<b>Notes</b>	Production of equalizing agent is excluded because of lack of data.	
<b>Procedural steps (flow-chart)</b>		
<p><b>Water from Softening:</b> equip volume Equalizing agent = 2 g/l 0,5% &lt; Direct dyestuffs &lt; 1,5%</p> <p><b>Steam</b></p>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> <p style="text-align: center;">Bath</p> <p style="text-align: center;">T=60°C</p> <p style="text-align: center;">t=30 min.</p> <p style="text-align: center;">Indirect heating</p> </div>	
	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> <p style="text-align: center;">Discharge</p> </div>	<p><b>Wastewater:</b> equip. volume COD [mg/l]= 7920 TSS [mg/l]= 60</p>
<p><b>Water from Storage:</b> 3700 l-2400 l-1800 l</p>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> <p style="text-align: center;">Continuous rinsing</p> <p style="text-align: center;">t=30 min</p> </div>	<p><b>Wastewater to Conditioning:</b> 3700 l-2400 l-1800 l COD [mg/l]= 179 TSS [mg/l]= 25</p>

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	Flow	Units	Value
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	5,68E-02
	(r) Natural Gas (in ground)	kg	1,13E+01
	(r) Oil (in ground)	kg	1,64E+00
	(r) Uranium (U, ore)	kg	2,10E-05
	Viscose fabric to: Dyeing	kg	1,00E+02
	Water from Storage	l	2,29E+03
	Water from Softening Treatmet	l	2,28E+02
	Water: Unspecified Origin	l	2,58E+01
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	1,44E+00
	(a) Arsenic (As)	g	1,11E-03
	(a) Butane (n-C4H10)	g	6,14E-01
	(a) Cadmium (Cd)	g	2,05E-03
	(a) Carbon Dioxide (CO2, fossil)	g	3,43E+04
	(a) Ethane (C2H6)	g	3,44E+00
	(a) Ethylene (C2H4)	g	5,63E+00
	(a) Hydrocarbons (except methane)	g	1,72E+01
	(a) Hydrogen Chloride (HCl)	g	7,73E-01
	(a) Lead (Pb)	g	6,55E-03
	(a) Methane (CH4)	g	8,62E+01
	(a) Nickel (Ni)	g	4,04E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	2,90E+01
	(a) Propane (C3H8)	g	9,40E-01
	(a) Sulphur Oxides (SOx as SO2)	g	8,64E+01
	(a) Vanadium (V)	g	1,59E-01
	(s) Arsenic (As)	g	9,37E-05
	(s) Chromium (Cr III, Cr VI)	g	1,17E-03
	(s) Zinc (Zn)	g	3,52E-03
	(w) Ammonia (NH4+, NH3, as N)	g	7,77E-02
	(w) Benzene (C6H6)	g	2,31E-02
	(w) Cadmium (Cd++)	g	7,13E-05
	(w) Chromium (Cr III)	g	2,46E-03
	(w) Chromium (Cr III, Cr VI)	g	3,99E-04
	(w) COD (Chemical Oxygen Demand)	g	2,40E-01
	(w) Nitrate (NO3-)	g	1,60E-02
	(w) Nitrogenous Matter (unspecified, as N)	g	9,32E-02
	(w) Oils (unspecified)	g	5,93E-01
	Viscose fabric to: Soaping	kg	1,00E+02
	Wastewater to Conditioning	l	2,09E+03
	Wastewater	l	2,09E+02
	<b>REMINDERS</b>	E Feedstock Energy	MJ
E Fuel Energy		MJ	5,58E+02
E Non Renewable Energy		MJ	5,55E+02
E Renewable Energy		MJ	9,99E+00
E Total Primary Energy		MJ	5,65E+02
Electricity		MJ elec	7,49E+01
COD to Wastewater Treatment Plant or to Conditioning		kg	2,03E+00
TSS to Wastewater Treatment Plant or to Conditioning		kg	6,48E-02



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	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	5,52E-02
	(r) Natural Gas (in ground)	kg	1,11E+01
	(r) Oil (in ground)	kg	1,15E+00
	(r) Uranium (U, ore)	kg	2,10E-05
	Mix acetate fabric	kg	1,00E+02
	Water from Softening Treatment	l	2,29E+02
	Water from Storage	l	1,06E+03
	Water: Unspecified Origin	l	2,34E+01
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	1,37E+00
	(a) Arsenic (As)	g	7,95E-04
	(a) Benzene (C6H6)	g	2,28E-01
	(a) Butane (n-C4H10)	g	5,31E-01
	(a) Cadmium (Cd)	g	1,40E-03
	(a) Carbon Dioxide (CO2, fossil)	g	3,19E+04
	(a) Ethane (C2H6)	g	2,76E+00
	(a) Ethylene (C2H4)	g	5,53E+00
	(a) Hexane (C6H14)	g	4,13E-02
	(a) Hydrocarbons (except methane)	g	1,40E+01
	(a) Hydrogen Chloride (HCl)	g	5,90E-01
	(a) Lead (Pb)	g	6,22E-03
	(a) Methane (CH4)	g	6,79E+01
	(a) Nickel (Ni)	g	2,77E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	2,48E+01
	(a) Nitrous Oxide (N2O)	g	1,53E-01
	(a) Propane (C3H8)	g	7,69E-01
	(a) Sulphur Oxides (SOx as SO2)	g	6,14E+01
	(a) Toluene (C6H5CH3)	g	1,06E-01
	(a) Vanadium (V)	g	1,09E-01
	(s) Arsenic (As)	g	9,21E-05
	(s) Chromium (Cr III, Cr VI)	g	1,15E-03
	(s) Zinc (Zn)	g	3,46E-03
	(w) Ammonia (NH4+, NH3, as N)	g	5,72E-02
	(w) Benzene (C6H6)	g	1,68E-02
	(w) Cadmium (Cd++)	g	5,51E-05
	(w) Chromium (Cr III)	g	2,42E-03
	(w) Chromium (Cr III, Cr VI)	g	2,83E-04
	(w) COD (Chemical Oxygen Demand)	g	2,18E-01
	(w) Nitrate (NO3-)	g	1,19E-02
	(w) Nitrogenous Matter (unspecified, as N)	g	6,70E-02
	(w) Oils (unspecified)	g	5,49E-01
	Mix acetate fabric	kg	1,00E+02
	Wastewater	l	1,29E+03
<b>REMINDERS</b>	E Feedstock Energy	MJ	5,18E+00
	E Fuel Energy	MJ	5,26E+02
	E Non Renewable Energy	MJ	5,24E+02
	E Renewable Energy	MJ	7,12E+00
	E Total Primary Energy	MJ	5,31E+02
	Electricity	MJ elec	5,23E+01
	COD to Wastewater Treatment Plant	kg	1,95E+00
	TSS to Wastewater Treatment Plant	kg	4,01E-02

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### 13 Light reactive dyeing- Mix acetate, bemberg or viscose fabric

<b>Name</b>	Light Reactive Dyeing in Jigger	
<b>Sources</b>	PIDACS I04	G.10.1 Light reactive dyeing in jigger
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of mix acetate, bemberg or viscose fabric	
<b>Equipment</b>	Jigger operating mode batch bath volume (m3): 0,8 run time (h,m): 4,30 n. of run/year 520 absorbed power (kW): 6,9 processed fabric per run (kg): 350 processed fabric (kg/yr): 182139	
<b>Notes</b>	Productions of reactive dyestuffs and soaping agent are excluded because of lack of data	
<b>Procedural steps (flow-chart)</b>		
<p><b>Water from Softening:</b> equip volume Caustic soda = 3 g/l; Sodium sulphate = 10 g/l; Reactive dyestuffs &lt; 0,5%;</p> <p><b>Steam</b></p> <p><b>Water from Storage:</b> 1300 l</p> <p><b>Water from Storage:</b> equip volume Acetic acid = 4 g/l</p> <p><b>Water from Storage:</b> equip volume Soaping agent = 1 g/l</p> <p><b>Steam</b></p> <p><b>Water from Storage:</b> equip volume Soaping agent = 1 g/l</p> <p><b>Steam</b></p> <p><b>Water from Storage:</b> 1400 l</p>	<p><b>Bath</b> T=60°C; t= 150 min.</p> <p>Indirect heating</p> <p>Discharge</p> <p>Continuous rinsing t=30 min</p> <p>Acid bath</p> <p>Discharge</p> <p>1<sup>st</sup> soaping bath (10% of run) T=60°C T=30 min</p> <p>Indirect heating</p> <p>Discharge</p> <p>2<sup>nd</sup> soaping bath (5% of run) T=60°C T=30 min</p> <p>Indirect heating</p> <p>Discharge</p> <p>Continuous rinsing t=30 min</p>	<p><b>Wastewater:</b> equip. volume COD [mg/l]= 4000 TSS [mg/l]= 180</p> <p><b>Wastewater:</b> 1300 l COD [mg/l]= 300 TSS [mg/l]= 25</p> <p><b>Wastewater:</b> equip. volume COD [mg/l]= 2000 TSS [mg/l]=125</p> <p><b>Wastewater:</b> equip. volume COD [mg/l]= 1800 TSS [mg/l]=67</p> <p><b>Wastewater:</b> equip. volume COD [mg/l]= 1000 TSS [mg/l]=38</p> <p><b>Wastewater:</b> 1400 l COD [mg/l]= 100 TSS [mg/l]= 10</p>

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	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	6,49E-02
	(r) Natural Gas (in ground)	kg	1,30E+01
	(r) Oil (in ground)	kg	2,25E+00
	(r) Uranium (U, ore)	kg	2,82E-05
	Fabric	kg	1,00E+02
	Water from Softening Treatment	l	2,29E+02
	Water from Storage	l	1,46E+03
	Water: Unspecified Origin	l	3,15E+01
<b>OUTPUTS</b>	(a) Alkane (unspecified)	g	1,78E+00
	(a) Arsenic (As)	g	1,20E-03
	(a) Benzene (C6H6)	g	3,06E-01
	(a) Butane (n-C4H10)	g	6,84E-01
	(a) Cadmium (Cd)	g	2,14E-03
	(a) Carbon Dioxide (CO2, fossil)	g	3,91E+04
	(a) Ethane (C2H6)	g	3,83E+00
	(a) Ethylene (C2H4)	g	6,47E+00
	(a) Hydrocarbons (except methane)	g	2,30E+01
	(a) Hydrocarbons (unspecified)	g	4,45E+00
	(a) Hydrogen Chloride (HCl)	g	8,74E-01
	(a) Lead (Pb)	g	1,14E-02
	(a) Methane (CH4)	g	9,53E+01
	(a) Nickel (Ni)	g	4,22E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	3,38E+01
	(a) Nitrous Oxide (N2O)	g	2,25E-01
	(a) Propane (C3H8)	g	1,03E+00
	(a) Sulphur Oxides (SOx as SO2)	g	9,12E+01
	(a) Vanadium (V)	g	1,66E-01
	(s) Arsenic (As)	g	1,07E-04
	(s) Chromium (Cr III, Cr VI)	g	1,34E-03
	(s) Zinc (Zn)	g	4,04E-03
	(w) Ammonia (NH4+, NH3, as N)	g	1,29E-01
	(w) Benzene (C6H6)	g	3,12E-02
	(w) Cadmium (Cd++)	g	1,13E-04
	(w) Chromium (Cr III)	g	2,82E-03
	(w) Chromium (Cr III, Cr VI)	g	5,49E-04
	(w) COD (Chemical Oxygen Demand)	g	4,37E+00
	(w) Nitrite (NO2-)	g	4,84E-05
	(w) Nitrogenous Matter (unspecified, as N)	g	1,64E-01
	(w) Oils (unspecified)	g	7,12E-01
	Fabric	kg	1,00E+02
Wastewater	l	1,69E+03	
<b>REMINDERS</b>	E Feedstock Energy	MJ	2,87E+01
	E Fuel Energy	MJ	6,35E+02
	E Non Renewable Energy	MJ	6,53E+02
	E Renewable Energy	MJ	1,05E+01
	E Total Primary Energy	MJ	6,64E+02
	Electricity	MJ elec	7,75E+01
	COD to Wastewater Treatment Plant	kg	2,16E+00
	TSS to Wastewater Treatment Plant	kg	1,07E-01



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## 14 Medium reactive dyeing- Mix acetate, bemberg or viscose fabric

<b>Name</b>	Medium Reactive Dyeing in Jigger	
<b>Sources</b>	PIDACS I04	G.11.1 Medium reactive dyeing in jigger
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of mix acetate, bemberg or viscose fabric	
<b>Equipment</b>	Jigger operating mode batch bath volume (m3): 0,8 run time (h,m): 4,30 n. of run/year 520 absorbed power (kW): 6,9 processed fabric per run (kg): 350 processed fabric (kg/yr): 182139	
<b>Notes</b>	Productions of reactive dyestuffs and soaping agent are excluded because of lack of data	
<b>Procedural steps (flow-chart)</b>		
<b>Water from Softening:</b> equip volume Caustic soda = 3 g/l; Sodium sulphate = 10 g/l; 0,5% <Reactive dyestuffs<1,5% ;  <b>Steam</b>  <b>Water from Storage:</b> 3700 l  <b>Water from Storage:</b> equip volume Acetic acid = 4 g/l  <b>Water from Storage:</b> equip volume Soaping agent = 1 g/l  <b>Steam</b>  <b>Water from Storage:</b> equip volume Soaping agent = 1 g/l  <b>Steam</b>  <b>Water from Storage:</b> 3700 l	Bath T=60°C; t= 150 min.  Indirect heating  Discharge  Continuous rinsing t=30 min  Acid bath  Discharge  1 <sup>st</sup> soaping bath (10% of run) T=60°C T=30 min  Indirect heating  Discharge  2 <sup>nd</sup> soaping bath (5% of run) T=60°C T=30 min  Indirect heating  Discharge  Continuous rinsing t=30 min	<b>Wastewater:</b> equip. volume COD [mg/l]= 7500 TSS [mg/l]= 345  <b>Wastewater:</b> 3700 l COD [mg/l]= 380 TSS [mg/l]= 41  <b>Wastewater:</b> equip. volume COD [mg/l]= 2050 TSS [mg/l]=133  <b>Wastewater:</b> equip. volume COD [mg/l]= 1870 TSS [mg/l]=67  <b>Wastewater:</b> equip. volume COD [mg/l]= 930 TSS [mg/l]=38  <b>Wastewater:</b> 3700 l COD [mg/l]= 100 TSS [mg/l]= 10

	Flow	Units	Value
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	6,49E-02
	(r) Natural Gas (in ground)	kg	1,30E+01
	(r) Oil (in ground)	kg	2,26E+00
	(r) Uranium (U, ore)	kg	2,82E-05
	Fabric	kg	1,00E+02
	Water from Softening Treatment	l	2,29E+02
	Water from Storage	l	2,80E+03
<b>OUTPUTS</b>	Water: Unspecified Origin	l	3,16E+01
	(a) Alkane (unspecified)	g	1,78E+00
	(a) Arsenic (As)	g	1,20E-03
	(a) Benzene (C6H6)	g	3,13E-01
	(a) Butane (n-C4H10)	g	6,85E-01
	(a) Cadmium (Cd)	g	2,14E-03
	(a) Carbon Dioxide (CO2, fossil)	g	3,91E+04
	(a) Ethane (C2H6)	g	3,83E+00
	(a) Ethylene (C2H4)	g	6,47E+00
	(a) Hydrocarbons (except methane)	g	2,32E+01
	(a) Hydrocarbons (unspecified)	g	4,45E+00
	(a) Hydrogen Chloride (HCl)	g	8,74E-01
	(a) Lead (Pb)	g	1,22E-02
	(a) Methane (CH4)	g	9,54E+01
	(a) Nickel (Ni)	g	4,22E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	3,41E+01
	(a) Nitrous Oxide (N2O)	g	2,30E-01
	(a) Propane (C3H8)	g	1,03E+00
	(a) Sulphur Oxides (SOx as SO2)	g	9,13E+01
	(a) Vanadium (V)	g	1,66E-01
	(s) Arsenic (As)	g	1,07E-04
	(s) Chromium (Cr III, Cr VI)	g	1,34E-03
	(s) Zinc (Zn)	g	4,04E-03
	(w) Ammonia (NH4+, NH3, as N)	g	1,30E-01
	(w) Benzene (C6H6)	g	3,14E-02
	(w) Cadmium (Cd++)	g	1,14E-04
	(w) Chromium (Cr III)	g	2,82E-03
	(w) Chromium (Cr III, Cr VI)	g	5,52E-04
	(w) COD (Chemical Oxygen Demand)	g	4,37E+00
	(w) Nitrite (NO2-)	g	4,84E-05
	(w) Nitrogenous Matter (unspecified, as N)	g	1,66E-01
	(w) Oils (unspecified)	g	7,13E-01
	Fabric	kg	1,00E+02
Wastewater	l	3,03E+03	
<b>REMINDERS</b>	E Feedstock Energy	MJ	2,87E+01
	E Fuel Energy	MJ	6,35E+02
	E Non Renewable Energy	MJ	6,54E+02
	E Renewable Energy	MJ	1,05E+01
	E Total Primary Energy	MJ	6,64E+02
	Electricity	MJ elec	7,75E+01
	COD to Wastewater Treatment Plant	kg	3,33E+00
	TSS to Wastewater Treatment Plant	kg	1,87E-01

## 15 Dark reactive dyeing – Viscose fabric

<b>Name</b>	Dark reactive dyeing in jigger	
<b>Sources</b>	Report LCA I04: TM-108-005 G.12.1 Dark reactive dyeing	
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of viscose fabric	
<b>Equipment</b>	Jigger operating mode: batch bath volume (m3): 0,8 run time (h,m): 4,30 n. of run/year 536 absorbed power (kW): 6,9 processed fabric per run(kg): 350 processed fabric (kg/yr): 187658	
<b>Notes</b>	Production of chemicals considered: Caustic soda, Acetic acid	
<b>Procedural steps (flow-chart)</b>		
<b>Water from Softening:</b> equip volume Caustic soda = 3 g/l Sodium sulphate = 10 g/l Reactive dyestuffs < 1,5%  <b>Steam</b>	Bath T=60°C t= 150 min. Indirect heating	
	Discharge	<b>Wastewater:</b> equip. volume COD [mg/l]= 9800 TSS [mg/l]= 345
<b>Water from Storage:</b> 8000 l-6000 l-4000 l	Continuous rinsing t=30 min	<b>Wastewater:</b> 8000 l-6000 l-4000 l COD [mg/l]= 500 TSS [mg/l]= 41
<b>Water from Storage:</b> equip volume Acetic acid = 4 g/l	Acid bath	
	Discharge	<b>Wastewater:</b> equip. volume COD [mg/l]= 2450 TSS [mg/l]=133
<b>Water from Storage:</b> equip volume Soaping agent = 1 g/l  <b>Steam</b>	1 <sup>st</sup> soaping bath (10% of run) T=60°C T=30 min Indirect heating	
	Discharge	<b>Wastewater:</b> equip. volume COD [mg/l]= 2080 TSS [mg/l]=67
<b>Water from Storage:</b> equip volume Soaping agent = 1 g/l  <b>Steam</b>	2 <sup>nd</sup> soaping bath (5% of run) T=60°C T=30 min Indirect heating	
	Discharge	<b>Wastewater:</b> equip. volume COD [mg/l]= 1300 TSS [mg/l]=38
<b>Water from Storage:</b> 8000 l-6000 l-4000 l	Continuous rinsing t=30 min	<b>Wastewater:</b> 8000 l-6000 l-4000 l COD [mg/l]= 120 TSS [mg/l]= 10

	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	1,61E-01	
	(r) Natural Gas (in ground)	kg	3,29E+01	
	(r) Oil (in ground)	kg	2,43E+00	
	(r) Uranium (U, ore)	kg	6,69E-05	
	Viscose fabric to: Dyeing	kg	1,00E+02	
	Water from Storage	l	5,26E+03	
	Water from Softening Treatment	l	2,29E+02	
<b>OUTPUTS</b>	Water: Unspecified Origin	l	6,51E+01	
	(a) Alkane (unspecified)	g	4,07E+00	
	(a) Arsenic (As)	g	1,49E-03	
	(a) Butane (n-C4H10)	g	1,35E+00	
	(a) Cadmium (Cd)	g	2,33E-03	
	(a) Carbon Dioxide (CO2, fossil)	g	8,89E+04	
	(a) Ethane (C2H6)	g	6,38E+00	
	(a) Ethylene (C2H4)	g	1,63E+01	
	(a) Hydrocarbons (except methane)	g	3,47E+01	
	(a) Hydrogen Chloride (HCl)	g	1,29E+00	
	(a) Lead (Pb)	g	1,39E-02	
	(a) Methane (CH4)	g	1,53E+02	
	(a) Nickel (Ni)	g	4,60E-02	
	(a) Nitrogen Oxides (NOx as NO2)	g	6,17E+01	
	(a) Propane (C3H8)	g	1,81E+00	
	(a) Sulphur Oxides (SOx as SO2)	g	1,12E+02	
	(a) Vanadium (V)	g	1,79E-01	
	(s) Arsenic (As)	g	2,72E-04	
	(s) Chromium (Cr III, Cr VI)	g	3,40E-03	
	(s) Zinc (Zn)	g	1,02E-02	
	(w) Ammonia (NH4+, NH3, as N)	g	1,47E-01	
	(w) Benzene (C6H6)	g	3,74E-02	
	(w) Cadmium (Cd++)	g	1,46E-04	
	(w) Chromium (Cr III)	g	7,15E-03	
	(w) Chromium (Cr III, Cr VI)	g	6,12E-04	
	(w) COD (Chemical Oxygen Demand)	g	4,67E+00	
	(w) Nitrate (NO3-)	g	9,54E-02	
	(w) Nitrogenous Matter (unspecified, as N)	g	1,78E-01	
	(w) Oils (unspecified)	g	1,56E+00	
	Viscose fabric to: Soaping	kg	1,00E+02	
	Wastewater	l	5,27E+03	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	3,22E+01
		E Fuel Energy	MJ	1,48E+03
E Non Renewable Energy		MJ	1,50E+03	
E Renewable Energy		MJ	1,30E+01	
E Total Primary Energy		MJ	1,51E+03	
Electricity		MJ elec	9,09E+01	
COD to Wastewater Treatment Plant		kg	4,99E+00	
TSS to Wastewater Treatment Plant		kg	2,50E-01	

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## 16 Soaping – Viscose fabric

<b>Name</b>	Soaping	
<b>Sources</b>	Report LCA I04: TM-108-005	<b>G.13.1 Soaping</b>
<b>Reference year</b>	2000	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of viscose fabric	
<b>Equipment</b>	Pad-steam operating mode: continuous Cycle time (h): 2,15 n. of cycle/year 2018 absorbed power (kW): 92 processed fabric per hour (kg/yr): 462 processed fabric (kg/yr): 2062340	
<b>Notes</b>		
<b>Procedural steps (flow-chart)</b>		
<b>Water from Softening:</b> 1000 l <b>Reintegration :</b> 300 l/h  Soaping agent = 1 g/l  <b>Water from Softening:</b> 1000 l/h Soaping agent = 1 g/l  <b>Steam</b>  <b>Water from Storage:</b> 5800 l  <b>Water from Storage:</b> 4000 l/h  <b>Water from Storage:</b> 50 l	Dyeing bath  Steaming T=60°C Indirect heating  Filling  Rinsing  Discharge  Neutralisation	<b>Wastewater:</b> 1000 l COD [mg/l]= 890 TSS [mg/l]= 150  <b>Wastewater:</b> 1000 l/h COD [mg/l]= 1520 TSS [mg/l]= 335  <b>Wastewater:</b> 4000 l/h COD [mg/l]= 750 TSS [mg/l]= 20  <b>Wastewater:</b> 5800 l COD [mg/l]= 400 TSS [mg/l]= 10  <b>Wastewater:</b> 50 l COD [mg/l]= 50 TSS [mg/l]= 10

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	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUTS</b>	(r) Iron (Fe, ore)	kg	5,89E-02	
	(r) Natural Gas (in ground)	kg	1,14E+01	
	(r) Oil (in ground)	kg	3,14E+00	
	(r) Uranium (U, ore)	kg	2,13E-05	
	Viscose fabric to: Soaping	kg	1,00E+02	
	Water from Storage	l	1,45E+03	
	Water from Softening Treatment	l	4,98E+02	
<b>OUTPUTS</b>	Water: Unspecified Origin	l	3,24E+01	
	(a) Alkane (unspecified)	g	1,56E+00	
	(a) Arsenic (As)	g	2,06E-03	
	(a) Butane (n-C4H10)	g	8,46E-01	
	(a) Cadmium (Cd)	g	3,99E-03	
	(a) Carbon Dioxide (CO2, fossil)	g	4,01E+04	
	(a) Ethane (C2H6)	g	5,42E+00	
	(a) Ethylene (C2H4)	g	5,69E+00	
	(a) Hydrocarbons (except methane)	g	2,71E+01	
	(a) Hydrogen Chloride (HCl)	g	1,32E+00	
	(a) Lead (Pb)	g	9,58E-03	
	(a) Methane (CH4)	g	1,40E+02	
	(a) Nickel (Ni)	g	7,86E-02	
	(a) Nitrogen Oxides (NOx as NO2)	g	4,14E+01	
	(a) Propane (C3H8)	g	1,44E+00	
	(a) Sulphur Oxides (SOx as SO2)	g	1,61E+02	
	(a) Vanadium (V)	g	3,12E-01	
	(s) Arsenic (As)	g	9,38E-05	
	(s) Chromium (Cr III, Cr VI)	g	1,17E-03	
	(s) Zinc (Zn)	g	3,52E-03	
	(w) Ammonia (NH4+, NH3, as N)	g	1,42E-01	
	(w) Benzene (C6H6)	g	4,23E-02	
	(w) Cadmium (Cd++)	g	1,22E-04	
	(w) Chromium (Cr III)	g	2,46E-03	
	(w) Chromium (Cr III, Cr VI)	g	7,56E-04	
	(w) COD (Chemical Oxygen Demand)	g	3,02E-01	
	(w) Nitrate (NO3-)	g	2,84E-02	
	(w) Nitrogenous Matter (unspecified, as N)	g	1,75E-01	
	(w) Oils (unspecified)	g	7,04E-01	
	Viscose fabric to: Finishing	kg	1,00E+02	
	Wastewater	l	1,89E+03	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	1,19E+01
		E Fuel Energy	MJ	6,35E+02
E Non Renewable Energy		MJ	6,28E+02	
E Renewable Energy		MJ	1,86E+01	
E Total Primary Energy		MJ	6,47E+02	
Electricity		MJ elec	1,43E+02	
COD to Wastewater Treatment Plant		kg	1,40E+00	
TSS to Wastewater Treatment Plant		kg	1,28E-01	



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	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUT</b>	(r) Iron (Fe, ore)	kg	7,85E-02
	(r) Natural Gas (in ground)	kg	1,60E+01
	(r) Oil (in ground)	kg	1,28E+00
	(r) Uranium (U, ore)	kg	3,12E-05
	Silk fabric	kg	1,00E+02
	Water: from Softening Treatment	litre	1,67E+03
	Water: Unspecified Origin	litre	3,82E+01
<b>OUTPUT</b>	(a) Aldehyde (unspecified)	g	4,88E-04
	(a) Alkane (unspecified)	g	1,97E+00
	(a) Ammonia (NH3)	g	3,41E-03
	(a) Arsenic (As)	g	8,54E-04
	(a) Benzene (C6H6)	g	2,98E-01
	(a) Butane (n-C4H10)	g	6,87E-01
	(a) Carbon Dioxide (CO2, fossil)	g	4,39E+04
	(a) Carbon Monoxide (CO)	g	2,77E+01
	(a) Cadmium (Cd)	g	1,41E-03
	(a) Ethane (C2H6)	g	3,36E+00
	(a) Ethylene (C2H4)	g	7,91E+00
	(a) Hexane (C6H14)	g	4,10E-02
	(a) Hydrocarbons (except methane)	g	1,71E+01
	(a) Hydrocarbons (unspecified)	g	1,35E+00
	(a) Hydrogen Chloride (HCl)	g	6,93E-01
	(a) Lead (Pb)	g	5,09E-03
	(a) Manganese (Mn)	g	3,94E-03
	(a) Methane (CH4)	g	8,13E+01
	(a) Nickel (Ni)	g	2,79E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	3,09E+01
	(a) Propane (C3H8)	g	9,47E-01
	(a) Sulphur Oxides (SOx as SO2)	g	6,50E+01
	(a) Vanadium (V)	g	1,09E-01
	(w) Ammonia (NH4+, NH3, as N)	g	7,04E-02
	(w) Benzene (C6H6)	g	1,94E-02
	(w) Cadmium (Cd++)	g	7,00E-05
	(w) Chromium (Cr III)	g	3,47E-03
	(w) Chromium (Cr III, Cr VI)	g	3,19E-04
	(w) Nitrogenous Matter (unspecified, as N)	g	8,41E-02
	(w) Oils (unspecified)	g	7,62E-01
	(s) Arsenic (As)	g	1,32E-04
	(s) Chromium (Cr III, Cr VI)	g	1,65E-03
	(s) Zinc (Zn)	g	4,96E-03
	Silk yarn	kg	1,00E+02
Wastewater	litre	1,67E+03	
<b>REMINDERS</b>	E Feedstock Energy	MJ	1,25E+01
	E Fuel Energy	MJ	7,28E+02
	E Non Renewable Energy	MJ	7,33E+02
	E Renewable Energy	MJ	7,55E+00
	E Total Primary Energy	MJ	7,41E+02
	Electricity	MJ elec	5,40E+01
	COD to Wastewater Treatment Plant	kg	1,44E-01
	TSS to Wastewater Treatment Plant	kg	3,61E-02



## 18 Medium dyeing- Silk fabric

<b>Name</b>	Silk Medium Acid Dyeing			
<b>Sources</b>	PIDACS I15 G.2.1 Silk medium acid dyeing (in Jigger)			
<b>Reference year</b>	2001			
<b>Geographic reference</b>	Italy			
<b>Technological level</b>	average			
<b>Reference flow</b>	100 kg of silk fabric			
<b>Equipment</b>	<p>Jigger</p> <p>operating mode: batch</p> <p>bath volume (m3): 0,2</p> <p>cycle time (h,m): 1,20</p> <p>N. of cycle/year 1038</p> <p>absorbed power (kW): 3,5</p> <p>processed yarn per cycle (kg): 72</p> <p>processed yarn (kg/yr): 74772</p>			
<b>Notes</b>	Production of chemicals considered: Acetic acid			
<b>Procedural steps (flow-chart)</b>				
<p><b>Water from Softening:</b> equip volume</p> <p>Equalizing agent = 0,5 g/l Antifoaming agent = 0,5 g/l 0,5% &lt; Acid dyestuffs &lt; 1,5% Acetic acid = 1 g/l</p> <p><b>Steam</b></p> <p><b>Water from Softening:</b> 1000 l</p>	<table border="1"> <tr> <td> <p><b>Bath</b></p> <p>T=60°C;</p> <p>t=30 min.</p> <p>Indirect heating</p> <p><b>Discharge</b></p> <p>Continuous washing (10 lysis)</p> </td> <td> <p><b>Wastewater:</b> equip. volume</p> <p>COD [mg/l]= 820 TSS [mg/l]= 50</p> <p><b>Wastewater:</b> 1000 l</p> <p>COD [mg/l]= 70 TSS [mg/l]= 20</p> </td> </tr> </table>	<p><b>Bath</b></p> <p>T=60°C;</p> <p>t=30 min.</p> <p>Indirect heating</p> <p><b>Discharge</b></p> <p>Continuous washing (10 lysis)</p>	<p><b>Wastewater:</b> equip. volume</p> <p>COD [mg/l]= 820 TSS [mg/l]= 50</p> <p><b>Wastewater:</b> 1000 l</p> <p>COD [mg/l]= 70 TSS [mg/l]= 20</p>	
<p><b>Bath</b></p> <p>T=60°C;</p> <p>t=30 min.</p> <p>Indirect heating</p> <p><b>Discharge</b></p> <p>Continuous washing (10 lysis)</p>	<p><b>Wastewater:</b> equip. volume</p> <p>COD [mg/l]= 820 TSS [mg/l]= 50</p> <p><b>Wastewater:</b> 1000 l</p> <p>COD [mg/l]= 70 TSS [mg/l]= 20</p>			

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	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUT</b>	(r) Iron (Fe, ore)	kg	7,86E-02
	(r) Natural Gas (in ground)	kg	1,60E+01
	(r) Oil (in ground)	kg	1,34E+00
	(r) Uranium (U, ore)	kg	3,12E-05
	Silk fabric	kg	1,00E+02
	Water: from Softening Treatment	litre	1,67E+03
	Water: Unspecified Origin	litre	3,84E+01
<b>OUTPUT</b>	(a) Aldehyde (unspecified)	g	4,89E-04
	(a) Alkane (unspecified)	g	1,97E+00
	(a) Ammonia (NH3)	g	3,44E-03
	(a) Arsenic (As)	g	8,72E-04
	(a) Benzene (C6H6)	g	3,14E-01
	(a) Butane (n-C4H10)	g	6,94E-01
	(a) Carbon Dioxide (CO2, fossil)	g	4,41E+04
	(a) Carbon Monoxide (CO)	g	3,03E+01
	(a) Cadmium (Cd)	g	1,45E-03
	(a) Ethane (C2H6)	g	3,40E+00
	(a) Ethylene (C2H4)	g	7,92E+00
	(a) Hexane (C6H14)	g	4,31E-02
	(a) Hydrocarbons (except methane)	g	1,78E+01
	(a) Hydrocarbons (unspecified)	g	1,36E+00
	(a) Hydrogen Chloride (HCl)	g	7,03E-01
	(a) Lead (Pb)	g	6,75E-03
	(a) Manganese (Mn)	g	3,94E-03
	(a) Methane (CH4)	g	8,25E+01
	(a) Nickel (Ni)	g	2,86E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	3,17E+01
	(a) Propane (C3H8)	g	9,59E-01
	(a) Sulphur Oxides (SOx as SO2)	g	6,65E+01
	(a) Vanadium (V)	g	1,12E-01
	(w) Ammonia (NH4+, NH3, as N)	g	7,39E-02
	(w) Benzene (C6H6)	g	2,01E-02
	(w) Cadmium (Cd++)	g	7,28E-05
	(w) Chromium (Cr III)	g	3,47E-03
	(w) Chromium (Cr III, Cr VI)	g	3,33E-04
	(w) Nitrogenous Matter (unspecified, as N)	g	8,83E-02
	(w) Oils (unspecified)	g	7,66E-01
	(s) Arsenic (As)	g	1,32E-04
	(s) Chromium (Cr III, Cr VI)	g	1,65E-03
	(s) Zinc (Zn)	g	4,97E-03
Silk yarn	kg	1,00E+02	
Wastewater	litre	1,67E+03	
<b>REMINDERS</b>	E Feedstock Energy	MJ	1,25E+01
	E Fuel Energy	MJ	7,31E+02
	E Non Renewable Energy	MJ	7,36E+02
	E Renewable Energy	MJ	7,71E+00
	E Total Primary Energy	MJ	7,44E+02
	Electricity	MJ elec	5,53E+01
	COD to Wastewater Treatment Plant	kg	3,25E-01
	TSS to Wastewater Treatment Plant	kg	4,17E-02

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## 19 Dark acid dyeing- Silk fabric

<b>Name</b>	Dark Acid Dyeing	
<b>Sources</b>	Report LCA I15: TM-108-006	G.3.1 Silk dark acid dyeing (in Jigger)
<b>Reference year</b>	2001	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of silk fabric	
<b>Equipment</b>	Boat operating mode: batch bath volume (m3): 0,3 cycle time (h,m): 1,35 N. of cycle/year 844 absorbed power (kW): 2,3 processed fabric per run (kg/run): 72 processed fabric (kg/yr): 60803	
<b>Notes</b>	Production of chemicals considered: Sodium chloride, Acetic acid	
<b>Procedural steps (flow-chart)</b>		
<b>Water from Softening:</b> equip volume Lubricating agent = 1 g/l Equalizing agent = 0,5 g/l Antifoaming agent = 0,5 g/l Acid dyestuffs > 1,5% Sodium chloride = 5 g/l; Acetic acid = 1 g/l.  <b>Steam</b>   <b>Water from Softening:</b> equip. volume    <b>Water from Storage:</b> equip. volume    <b>Water from Storage:</b> equip. volume	Bath  T=60°C; t=25 min.  Indirect heating  Discharge  1 <sup>st</sup> rinsing  Discharge  2 <sup>nd</sup> rinsing  Discharge  Filling  Discharge	<b>Wastewater:</b> equip. volume  COD [mg/l]= 950 TSS [mg/l]= 10  <b>Wastewater:</b> equip. volume  COD [mg/l]= 220 TSS [mg/l]= 10  <b>Wastewater:</b> equip. volume  COD [mg/l]= 80 TSS [mg/l]= 20  <b>Wastewater:</b> equip. volume  COD [mg/l]= 23 TSS [mg/l]= 23

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	<b>Flow</b>	<b>Units</b>	<b>Value</b>	
<b>INPUT</b>	(r) Iron (Fe, ore)	kg	1,16E-01	
	(r) Natural Gas (in ground)	kg	2,37E+01	
	(r) Oil (in ground)	kg	1,35E+00	
	(r) Uranium (U, ore)	kg	4,75E-05	
	Silk fabric to Dyeing	kg	1,00E+02	
	Water to: Sand filtration	litre	0,00E+00	
	Water: from Softening Treatment	litre	8,32E+02	
	Water: from Storage	litre	8,32E+02	
	Water: Unspecified Origin	litre	5,90E+01	
<b>OUTPUT</b>	(a) Aldehyde (unspecified)	g	7,20E-04	
	(a) Alkane (unspecified)	g	2,87E+00	
	(a) Ammonia (NH3)	g	4,28E-03	
	(a) Arsenic (As)	g	8,59E-04	
	(a) Benzene (C6H6)	g	5,05E-01	
	(a) Butane (n-C4H10)	g	9,25E-01	
	(a) Cadmium (Cd)	g	1,24E-03	
	(a) Carbon Dioxide (CO2, fossil)	g	6,29E+04	
	(a) Ethane (C2H6)	g	4,13E+00	
	(a) Ethylene (C2H4)	g	1,17E+01	
	(a) Hydrocarbons (except methane)	g	2,30E+01	
	(a) Hydrogen Chloride (HCl)	g	8,12E-01	
	(a) Lead (Pb)	g	1,30E-02	
	(a) Methane (CH4)	g	9,78E+01	
	(a) Nickel (Ni)	g	2,45E-02	
	(a) Nitrogen Oxides (NOx as NO2)	g	4,28E+01	
	(a) Propane (C3H8)	g	1,20E+00	
	(a) Sulphur Oxides (SOx as SO2)	g	6,38E+01	
	(a) Vanadium (V)	g	9,39E-02	
	(s) Arsenic (As)	g	1,96E-04	
	(s) Chromium (Cr III, Cr VI)	g	2,45E-03	
	(s) Zinc (Zn)	g	7,37E-03	
	(w) Ammonia (NH4+, NH3, as N)	g	8,62E-02	
	(w) COD (Chemical Oxygen Demand)	g	2,28E+00	
	(w) Nitrate (NO3-)	g	4,69E-02	
	(w) Nitrogenous Matter (unspecified, as N)	g	9,97E-02	
	Silk fabric to Finishing	kg	1,00E+02	
	Wastewater	litre	1,66E+03	
	<b>REMINDERS</b>	E Feedstock Energy	MJ	1,63E+01
		E Fuel Energy	MJ	1,05E+03
		E Non Renewable Energy	MJ	1,06E+03
		E Renewable Energy	MJ	7,32E+00
		E Total Primary Energy	MJ	1,07E+03
Electricity		MJ elec	4,94E+01	
COD to Wastewater Treatment Plant		kg	5,30E-01	
TSS to Wastewater Treatment Plant		kg	2,62E-02	

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## 20 Light direct disperse dyeing - Synthetic fibres

<b>Name</b>	Light Direct Disperse Dyeing	
<b>Sources</b>	PIDACS I15	<b>G.4.1 Light direct disperse dyeing</b>
<b>Reference year</b>	2001	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of synthetic fibres	
<b>Equipment</b>	Overflow operating mode: batch bath volume (m3): 1,2 cycle time (h,m): 2,40 N. of cycle/year 191 absorbed power (kW): 3,7 processed fabric per cycle (kg): 216 processed fabric (kg/yr): 41721	
<b>Notes</b>	Production of chemicals considered: Sodium chloride	
<b>Procedural steps (flow-chart)</b>		
<b>Water from Softening:</b> equip volume  Lubricating agent = 1,5 g/l Dispersant agent = 1 g/l Antifoaming agent = 0,5 g/l Disperse dyestuffs <0,5% Direct dyestuffs < 0,5% Sodium chloride = 5 g/l  <b>Steam</b>    <b>Water from Softening:</b> equip. volume       <b>Water from Storage:</b> equip. volume	Bath  T=85°C  t=40 min.  Indirect heating  Discharge   1 <sup>st</sup> rinsing  Discharge   Filling  Discharge	<b>Wastewater:</b> equip. volume COD [mg/l]= 800 TSS [mg/l]= 65  <b>Wastewater:</b> equip. volume COD [mg/l]= 70 TSS [mg/l]= 12  <b>Wastewater:</b> equip. volume COD [mg/l]= 10 TSS [mg/l]= 0

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	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUT</b>	(r) Iron (Fe, ore)	kg	2,40E-01
	(r) Natural Gas (in ground)	kg	4,95E+01
	(r) Oil (in ground)	kg	1,38E+00
	(r) Uranium (U, ore)	kg	9,67E-05
	Synthetic fibres	kg	1,00E+02
	Water: from Softening Treatment	litre	1,11E+03
	Water: from Storage	litre	5,56E+02
<b>OUTPUT</b>	Water: Unspecified Origin	litre	1,14E+02
	(a) Aldehyde (unspecified)	g	1,47E-03
	(a) Alkane (unspecified)	g	5,79E+00
	(a) Ammonia (NH3)	g	7,64E-03
	(a) Arsenic (As)	g	1,25E-03
	(a) Benzene (C6H6)	g	9,46E-01
	(a) Butane (n-C4H10)	g	1,79E+00
	(a) Cadmium (Cd)	g	1,52E-03
	(a) Carbon Dioxide (CO2, fossil)	g	1,28E+05
	(a) Carbon Monoxide (CO)	g	9,06E+01
	(a) Ethane (C2H6)	g	7,43E+00
	(a) Ethylene (C2H4)	g	2,45E+01
	(a) Hydrocarbons (except methane)	g	3,66E+01
	(a) Hydrogen Chloride (HCl)	g	1,36E+00
	(a) Lead (Pb)	g	1,50E-02
	(a) Methane (CH4)	g	1,72E+02
	(a) Nickel (Ni)	g	3,01E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	7,86E+01
	(a) Propane (C3H8)	g	2,21E+00
	(a) Sulphur Oxides (SOx as SO2)	g	9,20E+01
	(a) Toluene (C6H5CH3)	g	4,25E-01
	(a) Vanadium (V)	g	1,13E-01
	(w) Ammonia (NH4+, NH3, as N)	g	9,13E-02
	(w) Benzene (C6H6)	g	2,71E-02
	(w) Cadmium (Cd++)	g	1,17E-04
	(w) Chromium (Cr III)	g	1,08E-02
	(w) Chromium (Cr III, Cr VI)	g	3,76E-04
	(w) Nitrogenous Matter (unspecified, as N)	g	8,99E-02
	(w) Oils (unspecified)	g	2,17E+00
	(s) Arsenic (As)	g	4,10E-04
	(s) Chromium (Cr III, Cr VI)	g	5,13E-03
	(s) Zinc (Zn)	g	1,54E-02
	Synthetic fibres	kg	1,00E+02
	Wastewater	litre	1,67E+03
<b>REMINDERS</b>	E Feedstock Energy	MJ	1,13E+01
	E Fuel Energy	MJ	2,15E+03
	E Non Renewable Energy	MJ	2,15E+03
	E Renewable Energy	MJ	1,08E+01
	E Total Primary Energy	MJ	2,16E+03
	Electricity	MJ elec	6,83E+01
	COD to Wastewater Treatment Plant	kg	4,89E-01
	TSS to Wastewater Treatment Plant	kg	4,28E-02

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## 21 Medium direct disperse dyeing- Synthetic fibres

<b>Name</b>	Medium Direct Disperse Dyeing	
<b>Sources</b>	PIDACS I15	G.5.1 Synthetic fibres medium direct-disperse dyeing
<b>Reference year</b>	2001	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of synthetic fibres	
<b>Equipment</b>	Overflow operating mode: batch bath volume (m3): 1,2 cycle time (h,m): 3,35 N. of cycle/year 138 absorbed power (kW): 3,7 processed fabric per cycle (kg): 216 processed fabric (kg/yr): 29715	
<b>Notes</b>	Production of chemicals considered: Sodium chloride	
<b>Procedural steps (flow-chart)</b>		
<b>Water from Softening:</b> equip. volume  Lubricating agent = 1,5 g/l Dispersant agent = 1 g/l Antifoaming agent = 0,5 g/l 0,5% < Disperse dyestuffs < 1,5% 0,5% < Direct dyestuffs < 1,5% Sodium chloride = 10 g/l  <b>Steam</b>	<b>Bath</b>  T=85°C; t=60 min.  Indirect heating	<b>Wastewater:</b> equip. volume  COD [mg/l]= 1800 TSS [mg/l]= 110
<b>Water from Softening:</b> equip. volume	Discharge  1 <sup>st</sup> rinsing	<b>Wastewater:</b> equip. volume  COD [mg/l]= 185 TSS [mg/l]= 28
<b>Water from Softening:</b> equip. volume  <b>Steam</b>	2 <sup>nd</sup> rinsing  T=50°C t=10 min  Indirect heating	<b>Wastewater:</b> equip. volume  COD [mg/l]= 98 TSS [mg/l]= 85
<b>Water from Softening:</b> equip. volume	Discharge  3 <sup>rd</sup> rinsing	<b>Wastewater:</b> equip. volume  COD [mg/l]= 81 TSS [mg/l]= 13
<b>Water from Storage:</b> equip. volume	Discharge  4 <sup>th</sup> rinsing	<b>Wastewater:</b> equip. volume  COD [mg/l]= 39 TSS [mg/l]= 16
<b>Water from Storage:</b> equip. volume	Filling	<b>Wastewater:</b> equip. volume
	Discharge	COD [mg/l]= 10 TSS [mg/l]= 0

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	<b>Flow</b>	<b>Units</b>	<b>Value</b>
<b>INPUT</b>	(r) Iron (Fe, ore)	kg	3,59E-01
	(r) Natural Gas (in ground)	kg	7,39E+01
	(r) Oil (in ground)	kg	2,04E+00
	(r) Uranium (U, ore)	kg	1,45E-04
	Synthetic fibres	kg	1,00E+02
	Water: from Softening Treatment	litre	2,22E+03
	Water: from Storage	litre	1,11E+03
	Water: Unspecified Origin	litre	1,73E+02
<b>OUTPUT</b>	(a) Aldehyde (unspecified)	g	1,14E-02
	(a) Alkane (unspecified)	g	8,64E+00
	(a) Ammonia (NH3)	g	1,13E-02
	(a) Arsenic (As)	g	1,82E-03
	(a) Benzene (C6H6)	g	1,46E+00
	(a) Butane (n-C4H10)	g	2,67E+00
	(a) Cadmium (Cd)	g	2,16E-03
	(a) Carbon Dioxide (CO2, fossil)	g	1,90E+05
	(a) Carbon Monoxide (CO)	g	1,43E+02
	(a) Ethane (C2H6)	g	1,10E+01
	(a) Ethylene (C2H4)	g	3,65E+01
	(a) Hydrocarbons (except methane)	g	5,54E+01
	(a) Hydrogen Chloride (HCl)	g	2,01E+00
	(a) Lead (Pb)	g	2,68E-02
	(a) Methane (CH4)	g	2,55E+02
	(a) Nickel (Ni)	g	4,26E-02
	(a) Nitrogen Oxides (NOx as NO2)	g	1,18E+02
	(a) Propane (C3H8)	g	3,28E+00
	(a) Sulphur Oxides (SOx as SO2)	g	1,33E+02
	(a) Toluene (C6H5CH3)	g	6,34E-01
	(a) Vanadium (V)	g	1,58E-01
	(w) Ammonia (NH4+, NH3, as N)	g	1,39E-01
	(w) Benzene (C6H6)	g	4,01E-02
	(w) Cadmium (Cd++)	g	1,76E-04
	(w) Chromium (Cr III)	g	1,61E-02
	(w) Chromium (Cr III, Cr VI)	g	5,57E-04
	(w) Nitrogenous Matter (unspecified, as N)	g	1,37E-01
	(w) Oils (unspecified)	g	3,24E+00
	(s) Arsenic (As)	g	6,12E-04
	(s) Chromium (Cr III, Cr VI)	g	7,66E-03
	(s) Zinc (Zn)	g	2,30E-02
	Synthetic fibres	kg	1,00E+02
	Wastewater	litre	3,33E+03
<b>REMINDERS</b>	E Feedstock Energy	MJ	1,65E+01
	E Fuel Energy	MJ	3,21E+03
	E Non Renewable Energy	MJ	3,21E+03
	E Renewable Energy	MJ	1,55E+01
	E Total Primary Energy	MJ	3,23E+03
	Electricity	MJ elec	9,70E+01
	COD to Wastewater Treatment Plant	kg	1,23E+00
	TSS to Wastewater Treatment Plant	kg	1,40E-01



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## 22 Dark direct disperse dyeing – Synthetic fibres

<b>Name</b>	Synthetic fibres Dark Direct Disperse Dyeing	
<b>Sources</b>	Report LCA I15: TM-108-006 G.6.1 Synthetic fibres dark direct-disperse dyeing	
<b>Reference year</b>	2001	
<b>Geographic reference</b>	Italy	
<b>Technological level</b>	average	
<b>Reference flow</b>	100 kg of synthetic fibres	
<b>Equipment</b>	Overflow operating mode: batch bath volume (m3) 1,2 cycle time (h,m): 3,45 N. of cycle/year 436 absorbed power (kW): 3,7 processed fabric per cycle (kg): 216 processed fabric (kg/yr): 94097	
<b>Notes</b>	Production of chemicals considered: Sodium chloride	
<b>Procedural steps (flow-chart)</b>		
<b>Water from Softening:</b> equip volume  Lubricating agent = 1,5 g/l Dispersant agent = 1 g/l Antifoaming agent = 0,5 g/l Disperse dyestuffs > 1,5% Direct dyestuffs > 1,5% Sodium chloride = 20 g/l  <b>Steam</b>  <b>Water from Softening:</b> equip. volume  <b>Water from Softening:</b> equip. volume  <b>Water from Softening:</b> equip. volume  <b>Water from Storage:</b> equip. volume  <b>Water from Storage:</b> equip. volume	<b>Bath</b>  T=85°C; t=60 min.  Indirect heating  Discharge  1 <sup>st</sup> rinsing  Discharge  2 <sup>nd</sup> rinsing  T=50°C t=10 min  Indirect heating  Discharge  3 <sup>rd</sup> rinsing  Discharge  4 <sup>th</sup> rinsing  Discharge  Filling  Discharge	<b>Wastewater:</b> equip. volume COD [mg/l]= 3200 TSS [mg/l]= 200  <b>Wastewater:</b> equip. volume COD [mg/l]= 480 TSS [mg/l]= 35  <b>Wastewater:</b> equip. volume COD [mg/l]= 19 TSS [mg/l]= 109  <b>Wastewater:</b> equip. volume COD [mg/l]= 81 TSS [mg/l]= 13  <b>Wastewater:</b> equip. volume COD [mg/l]= 39 TSS [mg/l]= 16  <b>Wastewater:</b> equip. volume COD [mg/l]= 10 TSS [mg/l]= 0

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	Flow	Units	Value	
<b>INPUT</b>	(r) Coal (in ground)	kg	7,96E+01	
	(r) Iron (Fe, ore)	kg	1,01E+00	
	(r) Natural Gas (in ground)	kg	1,55E+02	
	(r) Oil (in ground)	kg	2,09E+02	
	(r) Uranium (U, ore)	kg	1,54E-04	
	Synthetic fibres	kg	1,00E+02	
	Water: from Softening Treatment	litre	2,22E+03	
	Water from Storage	litre	1,11E+03	
	Water: Unspecified Origin	litre	1,21E+03	
	<b>OUTPUT</b>	(a) Aldehyde (unspecified)	g	7,43E-03
(a) Alkane (unspecified)		g	3,50E+01	
(a) Ammonia (NH3)		g	2,88E-01	
(a) Arsenic (As)		g	1,31E-01	
(a) Benzene (C6H6)		g	5,15E+00	
(a) Butane (n-C4H10)		g	3,70E+01	
(a) Carbon Dioxide (CO2, fossil)		g	1,18E+06	
(a) Cadmium (Cd)		g	2,67E-01	
(a) Ethane (C2H6)		g	2,90E+02	
(a) Ethylene (C2H4)		g	8,12E+01	
(a) Hexane (C6H14)		g	7,50E+00	
(a) Hydrocarbons (except methane)		g	1,49E+03	
(a) Hydrogen Chloride (HCl)		g	7,64E+01	
(a) Lead (Pb)		g	5,87E-01	
(a) Methane (CH4)		g	7,73E+03	
(a) Nickel (Ni)		g	5,25E+00	
(a) Nitrogen Oxides (NOx as NO2)		g	1,96E+03	
(a) Propane (C3H8)		g	7,36E+01	
(a) Sulphur Oxides (SOx as SO2)		g	1,04E+04	
(a) Vanadium (V)		g	2,09E+01	
(w) Ammonia (NH4+, NH3, as N)		g	9,13E+00	
(w) Benzene (C6H6)		g	2,70E+00	
(w) Cadmium (Cd++)		g	7,29E-03	
(w) Chromium (Cr III)		g	3,31E-02	
(w) Chromium (Cr III, Cr VI)		g	4,97E-02	
(w) Nitrogenous Matter (unspecified, as N)		g	1,15E+01	
(w) Oils (unspecified)		g	2,17E+01	
(s) Arsenic (As)		g	1,26E-03	
(s) Chromium (Cr III, Cr VI)		g	1,57E-02	
(s) Zinc (Zn)		g	4,73E-02	
Synthetic fibres		kg	1,00E+02	
Wastewater		litre	3,33E+03	
<b>REMINDERS</b>		E Feedstock Energy	MJ	6,91E+02
		E Fuel Energy	MJ	1,69E+04
		E Non Renewable Energy	MJ	1,64E+04
	E Renewable Energy	MJ	1,19E+03	
	E Total Primary Energy	MJ	1,76E+04	
	Electricity	MJ elec	9,30E+03	
	COD to Wastewater Treatment Plant	kg	2,22E+00	
	TSS to Wastewater Treatment Plant	kg	2,07E-01	