

**INDUSTRIAL EFFLUENT &
MANAGEMENT
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World Bank Guidelines for effluents from Leather and Textile Industries

Pollutant	Tanning and leather finishing	Textile industry
Ammonia	10 mg/L	10 mg/L
BOD	50 mg/L	30 mg/L
Cadmium	--	0.02 mg/L
Chloride	1000 mg/L	--
Cobalt	--	0.5 mg/L
COD	250 mg/L	160 mg/L
Cr (total)	0.5 mg/L	0.5 mg/L
Cr+6	0.1 mg/L	0.1 mg/L
Nickel	--	0.5 mg/L
Oil and Grease	10 mg/L	10 mg/L
Pesticides	--	0.05-0.1 mg/L
pH	6 – 9	6 – 9
Phenol	0.5 mg/L	0.5 mg/L
Sulfate	300 mg/L	--
Sulfide	1 mg/L	1 mg/L
Temperature(+/-)	3 deg C	3 deg C
Total Nitrogen	10 mg/L	10 mg/L
Total Phosphorus	2 mg/L	2 mg/L
TSS	50 mg/L	50 mg/L
Zinc	--	2 mg/L
Coliform bacteria	400 MPN/100 ml	400 MPN/100 ml

Textile Wastes

Main Sources of Textile Wastes

1. Processing Chemicals, which are used and then removed during different processes.

Cotton: Raw cotton is carded, spun, spooled and warped, slashed, drawn and woven or knitted into cloth. Except in slashing, no water-borne pollution is produced in these operations because these are mechanical processes.

In slashing, warp thread is sized with starch to give it tensile strength and smoothness, which is necessary for subsequent weaving. Starch, used for sizing, is cellulose derivatives such as polyvinyl alcohol, polyacrylates, carboxymethyl cellulose.

Sizing liquid is generally wasted in small amount. However it has very high BOD, COD & suspended solids.

Now, this sized cloth is called “grey goods,” which contains 8-15% slashing compounds, which are removed during Desizing.

Grey goods then go to the following wet processes:

Desizing: It is the process, in which sizes are removed by detergent or enzyme to avoid their interference with dyeing & finishing process. It causes up to 50% of total BOD.

Scouring: It is the process, in which all the impurities are removed. Natural impurities are oil, fat, wax, minerals, plant parts. Un-natural impurities are grease, knitting oil, lubricant etc. Scouring of raw wool is the most polluting process. 30-70% of raw wool is impurities like, natural wool grease, soil, excrement.

Wool Carbonizing: It removes the material in wool that survived above processes. In this process, strong acid is used to degrade cellulose at high temperature into weak hydrocellulose. Materials are then rinsed to remove acids and impurities. Generated wastewater has low organic matter but dissolved solids due to acid treatment.

Wool Felting: It causes the fabric to mat, shrink and thus becomes denser. In this process, soda ash or sulphuric acid with modern auxiliaries are used. GWW has very high BOD.

Bleaching: It is used to remove natural colour of cotton or wool. In this process, sodium hypochlorite, hydrogen peroxide and other modern brighteners are used. GWW has low BOD but solid content is high. Denim process in bleaching has very high suspended solids due to use of pumice stone.

Cotton Mercerizing: It improves strength, luster and dye affinity of cotton. Cold sodium hydroxide solution is used which causes the fibres to swell. Then acid is applied to wash the solution. GWW has low BOD and solids.

Dyeing: (Most studied step in Textile Industry). Dyeing pigments have very complex structure. So sunlight, water or detergents can not generally degrade them. Its small amount decreases the transparency of water, which inhibit the sunlight penetration for photosynthesis.

Process requires high water use for dyeing and for its rinsing. GWW has colour organic acids, fixing agents, oxidizing/reducing agents, and diluents. It contributes most of the metals, almost all salts and colour, which are released during entire textile effluent.

Printing: In this process, colour is applied to specific parts of fabric. Dyes and auxiliaries are similar to Dyeing Process except the use of print pastes, which consist of water, thickener, urea and other solvents. Urea is used for cotton, viscose and silk to improve the solubility of hardly water-soluble dyes to fix them on the fabric.

GWW has high COD, nitrogen and dye. GWW is low in volume but highly concentrated, even higher than GWW from dyeing process.

Finishing: it enhances the properties that affect care, comfort, durability and human safety of fabric. The process may be chemical or mechanical. In mechanical process, no effluent is produced.

Rinsing: It uses 30-80% of water of the entire textile effluent. GWW is much less polluted than the earlier processes. Why?

Simplified Flow Diagram for Wet Processing
(Water litre/kg)

Input	Grey Goods (Cotton)	Output
<ul style="list-style-type: none"> - Enzyme/H₂SO₄ - Water (2.5-20)* 	Desizing	Wastewater
<ul style="list-style-type: none"> - NaOH - Soap - Water (19-43)* - Steam 	Scouring & Washing	Wastewater
<ul style="list-style-type: none"> - NaOH Conc. - Water (1)* 	Mercerizing & Washing	Wastewater
<ul style="list-style-type: none"> - H₂O₂ - Soap - Stabilize - Soda Ash - Steam - Water (2.5-124)* 	Bleaching & Washing	Wastewater
<ul style="list-style-type: none"> - Dyes - Auxiliary Chemical - Steam - Water (8-292)* 	Dyeing & Washing	Wastewater
<ul style="list-style-type: none"> - Pigments - Kerosene - Water (5-110)* - Steam 	Printing	Wastewater
<ul style="list-style-type: none"> - Finishing Resin - Water (0-5) - Heat 	Finishing & Drying	Wastewater

Chemicals Used in Different Wet Processes

Desizing: Enzymes and solvents like Varsol ® are used to convert water in-soluble sizing agents (starches, polymers, natural gums) into water soluble substances so as to remove them.

Scouring: Chemical used in it are divided into seven groups.

- It contains caustic soda which reacts with water insoluble natural oil & waxes in the presence of water to form water soluble soap so as to remove them.
- It includes soaps & detergents to emulsify natural oil & waxes.
- It includes surfactants, which reduce water surface tension and water-oil interfacial tension.
- It includes chelating agents (sequesting agents) to block active sites of heavy metals ions to prevent them to take part in un-desired reactions.
- It includes penetrants (sodium silicate), which assist other chemicals to penetrate in lignin mass of cellulosic materials.
- It includes builders (borates, silicates, phosphates, sodium chloride, sodium sulphate), which increase the activity of soaps & detergents.
- It includes solvents that are used with detergents for ultimate removal of water insoluble fats and waxes.

Bleaching: It's chemicals are divided into five groups:

- It includes chemicals (H_2O_2) & (H_2SO_4), which reacts with colouring matter of fabrics. H_2O_2 acts oxidizing agent and H_2SO_4 acts reducing agents.
- It includes buffering agents (alkalis/acids) to control pH of bleaching agents.
- It includes surfactants that reduce water surface tension and water-oil interfacial tension. Common surfactants are sulphate, phosphate, carbomethylate, methyltaurine, ethoxylated primary and secondary alcohols and fatty acids, mercaptan.
- It includes fluorescent whitening agents (optical brighteners) to improve the whiteness of textile materials.
- It includes defoamer, antiredeposition, sequesters, stabilizer like sodium silicate sodium nitrate.

Mercerizing: It's chemicals are divided into two groups:

- 1.It includes alkalis that improve luster, dyeing properties, strength.
- 2.It includes neutralizing agents to remove residual alkali that cause fibre crocking and poor dye fixation. NaOH and liquid ammonia is commonly used.

Printing: Pigments, dyes, auxiliaries like thickeners, binders, reductants are used in printing. Thickeners ensure the printing with clearly defined edges. Many polysaccharides from plant starch, seaweed alginates, plant gums, and cellulose ethers are used as thickeners. Common binders are acrylic copolymers for 100% fixation of prints. Reductants are used to destroy the existing dye to replace it with other to let the ground shade shine through.

Finishing: It includes wide range of chemicals to improve the quality of fabrics.

1. Abrasion-resistant to improve its abrasion damage
2. Absorbent to improve moisture holding capacity
3. Antistatic to reduce its static charges
4. Antiseptic to inhibit the development of smell/bacteria/fungi from perspiration/soil.
5. Flame retardants that reduce flammability, charring, or afterglow of fabrics.
6. Mothproof to prevent damage by moths and carpets beetles.
7. Stain and soil resistants that prevent stain and soil to penetrate fibres
8. Durable press to retain its original smooth surface during wear.

Waste Generated During Textile Manufacturing

Process	Emission	Effluents	Solid Waste
Spinning	Little or None	Little or None	Packaging Waste, Size yarn, fibre waste cleaning waste
Slashing / Sizing	VOCs	Metals, size, cleaning waste, BOD, COD	Fibre lint, yarn waste, packaging waste, un-used Sizes
Weaving	Little or None	Little or None	Packaging waste, yarn fabric scraps, used oil
Knitting	Little or None	Little or None	Packaging waste, yarn and fabric scraps
Desizing	VOCs	BOD from sizes lubricants, biocides,	Packaging waste, fibre lint, yarn waste, cleaning material
Scouring	VOCs	Disinfectants, insecticide residues, NaOH, detergents, oil, Knitting lubricants, spent Solvent	Little or None

Waste Generated During Textile Manufacturing

Process	Emission	Effluents	Solid Waste
Bleaching	Little or None	H ₂ O ₂ , stabilizer, high pH	Little or None
Singeing	Little gasses from urner	Little or None	Little or None
Mercerizing	Little or None	High pH, NaOH	Little or None
Dyeing	VOCs	Metals, salts, surfactant, organic material, color, BOD, COD, sulphide, spent solvents	Little or None
Printing	VOCs	Suspended solids, urea, Solvents, color, metals, Heat, BOD, foam	Little or None
Finishing	VOCs	COD, suspended solids, Spent Solvents	Fabric scraps & trimming, Packaging Waste

Pakistan's Exports (2009-19)	Value in '000' \$	% share
Cotton Fabrics	1,329,701	9.45
Hosiery	1,300,642	9.24
Bed ware	1,273,254	9.05
Cotton yarn	1,100,482	7.82
Readymade Garments	926,815	6.59
Towels	495,048	3.52
Textile madeup (Ex. Bedware, Towel)	391,081	2.78
Raw Cotton	192,931	1.37
Carpets	104,098	0.74
Knitted Fabrics	50,930	0.36
Tents and canning	47,896	0.34
Yarn other than cotton	32,822	0.23
Total Textile Prodcets	7,536,931	53.56
Rice	1,623,054	11.53
Petroleum	698,767	4.97
Leather and its products	640,196	4.55
Chemicals	544,765	3.87
Cement	357,465	2.54
Jewellery	330,477	2.35
Sports Goods	212,835	1.51
Fruits	202,840	1.44
Surgical instruments	177,278	1.26
Engineering goods	168,714	1.20
Fish	157,843	1.12
Vegetables	81,847	0.58
Meat	70,830	0.50
Cutlery	46,492	0.33
Molasses	32,396	0.23
Marbles and trav	21,022	0.15
Furniture	5,988	0.04
Other Commodities	1,162,643	8.26

Production of Hides/Skins – Top 30 Countries (Million pieces)

Source: FAO 2008

S.#	Country	Bovine	Country	Sheep & Lamb	Country	Goat
1	China	56.8	China	179.4	China	166.8
2	India	43.2	New Zealand	30.0	India	47.7
3	Brazil	37.6	Australia	28.0	Pakistan	22.3
4	USA	34.3	Iran	21.7	Bangladesh	19.6
5	Argentina	15.0	Spain	20.9	Sudan	13.3
6	Russia	10.4	India	19.9	Iran	7.5
7	Australia	9.0	U.K.	17.3	Greece	5.98
8	Mexico	7.8	Turkey	17.2	Ethiopia	5.8
9	Pakistan	7.0	Algeria	11.0	Nigeria	5.6
10	France	5.3	Syria	10.4	Indonesia	5.2
11	Italy	4.2	Pakistan	10.2	Nepal	3.7
12	New Zealand	4.0	Sudan	9.3	Burkina Faso	3.5
13	Canada	4.0	Nigeria	9.2	Somalia	3.3
14	Germany	3.9	Greece	9.1	Kenya	3.3
15	Columbia	3.7	South Africa	9.1	Kenya	3.3
16	Egypt	3.3	Morocco	8.5	Turkey	2.9
17	Uzbekistan	3.2	Russia	7.0	Tanzania	2.6
18	Ethiopia	3.1	Ethiopia	7.0	Yemen	2.6
19	South Africa	3.1	Italy	7.0	South Africa	2.5
20	Ukrain	3.0	Kazakhstan	6.1	Mexico	2.5
21	Sudan	2.8	Romania	6.1	Afghanistan	2.5
22	Spain	2.7	France	5.6	Brazil	2.4
23	U.K	2.7	Argentina	4.6	Niger	2.4
24	Iran	2.5	Afghanistan	4.5	Morocco	2.0
25	Kazakhstan	2.3	Brazil	4.4	Chad	1.9
26	Nigeria	2.2	Mongolia	4.1	Philippines	1.9
27	Tanzania	2.2	Tunisia	3.9	Saudi Arabia	1.6
28	Indonesia	2.0	Somalia	3.7	Cameron	1.5
29	Netherlands	1.9	Uzbekistan	3.7	Spain	1.4
30	Ireland	1.8	Uruguay	1.8	Egypt	1.0
31	Others	58.9	Others	90.7	Others	39.7
32	Total World	344	Total World	571.4	Total World	387.9

Leather Production (Top 30 Countries) in 2006

Source: FAO 2008

Countries	Million Sq Ft	%age Share
China	6,599	29.07
Italy	2,146	9.45
India	1,738	7.65
Brazil	1,647	7.25
Korea	1,446	6.37
USSR (Former)	1,224	5.39
Argentina	712	3.13
Mexico	591	2.60
Turkey	547	2.40
USA	477	2.10
Spain	442	1.94
Pakistan	363	1.59
Japan	315	1.38
Germany	281	1.23
Iran	250	1.10
Thailand	220	0.96
Uruguay	172	0.75
New Zealand	164	0.72
Egypt	155	0.68
Bangladesh	148	0.65
France	143	0.62
Sudan	139	0.61
Indonesia	138	0.60
UK	137	0.60
Australia	134	0.59
Colombia	115	0.50
Nigeria	102	0.44
Algeria	92	0.40
Morocco	80	0.35
Poland	79	0.34
Others	1,892	8.33
Global total	22,700	100

Simplified Flow diagram for converting raw hides into leather

Storage	Curing
Beamhouse Operations	Trimming Soaking and washing Fleshing Liming & Unhairing
Tanyard Operations	Deliming and Bating Pickling Chrome tanning Vegetable tanning Wringing/siding Splitting Shaving
Retanning Colour	Retanning Bleaching & Colouring Fat liquoring Setting out Dryieng
Finishing	Conditioning Buffing Finishing and plating

Tanneries in Pakistan

Cities	Units	Cities	Units
Kasur	223	Gujrat	2
Sialkot	210	Hyderabad	2
Karachi	174	Dadu	2
Gujranwala	51	Sukkur	2
Multan	43	Bahawalpur	1
Sheikhupura	28	Charsadda	1
Lahore	15	Jhelum	1
Sahiwal	8	Khushab	1
Faisalabad	7	Mirpur	1
Peshawar	6	Swabi	1
Sargodha	5	Total	770

Storage:

1.Curing: In this process, decay of hides and skins are prevented so as to store them. It is done by the following methods ---

- Drying:** It is used when salt is not available. Dry skin can be kept indefinitely.
- Salting:** Salts help hides to dry more quickly and wet back more easily.
- Chilling:** Cool air or ice is applied for maximum storage of three weeks.

Chemicals like sodium metabisulphite and boric acid and other chemicals are added to prevent bacterial growth. Insecticides are sprayed to kill insects.

Beamhouse Operations

1.Trimming: In this process, hide is trimmed at legs, belly, neck and tail parts to give it a smooth shape.

2.Soaking and Washing: In this process, salts and other solids are removed so as to restore moisture, which is lost during curing.

4. Fleshing: In this process, muscles, fat, and excess tissues are removed from the hide to impart its uniform thickness.

5. Liming and Un-hairing: Hide is then bathed in a drum of CaOH and sodium sulphide for the removal of hairs.

Tanyard Operations

•**Deliming:** Hide is then washed to remove lime to neutralize it.

•**Bating:** In this process, hide is placed in aqueous solution of ammonium salt proteolytic enzyme at 27 deg C to 32 deg C for 30 minutes to 12 hours. Bating delimes hide, reduces its swelling and stops protein degradation.

•**Pickling:** In this process, a solution of HCL, H₂SO₄, organic acids NaCl are added to adjust pH to stabilize skin.

•**Tanning:** It stabilizes the collagen structure of hide by any of the following methods ---

1.**Chrome tanning:** Chromium (III) salt, some aluminium and zirconium salts are used as tanning agent for 4 to 24 hours.

2.**Vegetable tanning:** Old method, but still used for sole saddler and heavy leather.

3.**Syntans or synthetic tanning agents** (e.g. sulphonated product of phenol, cresol and nephtalene etc.) are used for special leather.

After chrome tanning process, the leather is called “Wet blue leather”, which can be stored, transported and sold.

10. **Wringing or sammying:** In this process, water content of blue wet leather is reduced and evenly distributed.

11. **Siding:** In this process, big leather is cut through backbone into two halves.

•**Shaving:** In this process, flesh side is shaved by machine to produce the required and even thickness of leather.

•**Retanning:** In this process, the leather is retanned with vegetable tannins, syntan, resin etc. to fill loose and softer part of leather to produce the leather of uniform physical and chemical properties.

•**Bleaching and Colouring:** Natural colour is removed from the leather. Then it is coloured with required pigment or dye to improve its appearance and to increase its value. Leather dyeing into various appealing colour is vital for fashion industry.

•**Fatliqouring:** In this process, leather is placed in a drum of oil emulsion to regain the oil, which is lost during above processes to improve its softness, suppleness, extensibility, tensile strength, water proofness etc. it is done at 60 to 66 deg C for 30-40 minutes.

•**Setting Out:** It is the first step in the drying process and is carried by machine.

•**Drying:** In this process, water is removed by dryer from sammed leather.

•**Conditioning:** It softens leather by equalizing moisture content on both grain and flesh sides. Normally damp saw dusts are used for conditioning.

•**Buffing:** It is done by cylinder-type machine to remove grit particles.

•**Finis**

•**hing and Plating:** Finishing is any leather enhancing effect e.g. water proofing, waxing etc. While plating is a pressing leather with a heated plate under high pressure. It is soften used in upholstery leather to mask imperfections.

Upholstery Leather: Leather created from a whole hide and intended for use in furniture, automobiles, airplanes, and other upholstery applications.

Pollution Levels in Tannery Effluent (mg/l)

Source: ETPI

Parameters	Raw sheep & goat Skin Finish Leather	Raw calf hide Finish Leather	Wet blue (goat & sheep) Finish Leather	NEQS
Raw material	12000 kg/day	5500 kg/day	10000 kg/day	
Wastewater	600 M3/day	814 M3/day	110 m3/day	6 – 10
pH	9.33 – 9.88	7.35 – 7.67	3.52 – 3.55	80
BOD5	11050 – 14827	840-1740	714-1346	150
COD	41300 – 43000	1000 – 2680	2000 - 3500	150
SS	4270 – 4650	820 – 1920	1970 – 6620	600
Sulphate	1814 – 3146	800 – 860	5480 – 6480	1.0
Sulphide	288 – 292	1.2 – 2.6	Nil	1.0
Chromium	64 – 133.3	41	160 – 194	

SOLID WASTE GENERATED IN TANNERISS

Type	Rate of Generation	Characteristics of Solid Waste	Comments
Dusted Salt	100 gm/skin	1 kg contains 120 gm moisture, 120 gm VOC, 450 gm salt	Partly reused in curing, rest is dumped in land near tanneries
Raw Trimmings	24 gm/skin	Protein	Trims are sold soap, glue and poultry feed production
Fleshing to poultry	250 gm/skin	1 kg contains 240 gm protein, 200 gm fat, 3 gm sulphide	It is usually sold soap and feed makers.
Wet Trimming/ Wet Shaving	60 gm/skin	1 kg contains 240 gm of protein, 30 gm fat, 30 gm Cr oxide	It is collected poultry feed makers
Dry Trimming/ Dry Shaving/ Buffing Dust	60 gm/skin	1 kg contains 300 gm protein, 130 gm fat, 30 gm Cr oxide	It is collected poultry feed makers
Assorted Refuse	No consistent Quantity	Primarily cartons, bags, drums, etc.	It is normally sold separately (in bulk) in Retail market

Characterization of 4 different Streams of Tanneries
Source: Balasubramanian 1999 (Tamil Nado, India)

	TDS (ppm)				COD (ppm)			
Soaking	21,560	28,008	32,968	13,044	2,528	2,530	3,364	1,056
Liming	42,992	22,256	13,908	41,980	22,065	12,035	7,290	21,056
Pickling	33,448	45,344	40,408	30,000	1,068	2,084	2,218	943
Tanning	76,936	16,126	7,076	7,688	26,118	9,979	7,577	7,740
Rechroming	12,052	13,900	20,644	14,670	1,010	1,479	3,189	1,674

	BOD (ppm)				Sulphide (ppm)			
Soaking	730	810	1,140	600	14.69	31.06	40.54	14.88
Liming	10,550	5,600	3,680	10,470	526.64	368.00	171.20	421.00
Pickling	360	695	840	460	15.66	14.91	12.77	18.41
Tanning	13,501	4,220	2,839	2,932	44.20	19.94	12.78	24.30
Rechroming	217	313	662	353	50.62	25.47	18.41	24.30

	Cr (ppm)			
Soaking	-	-	-	-
Liming	-	-	-	-
Pickling	-	-	-	-
Tanning	355	90	80	75
Rechroming	285	1600	320	330

Beam house Inventory
For 1000 kg Processing of Hide (Rivela et. Al. 2004)

Input	Output (unit in Kg)				
Materials	Kg	Product	Soaking	Unhairing	Total
Wet Salted Hide	1,000	Pelts	1050		
Water for soaking	4,420	Fats	219		
Water for unhairing	6,085	Wastewater	3,245	6,280	10,065
NaOH	2	pH	7.1	11.5	10.1
Biocides	4	COD	21.8	65.3	87.1
Surfactants	9	BOD	7.6	16.6	24.2
Ca(OH) ₂	30	TN	1.3	6.2	7.5
NaHS	8	N-NH ₄	3.0	0.41	0.7
Na ₂ S	8	SO ₄ -2	0.6	1.1	1.7
Electricity	kWh	S-2	0.0023	1.7	1.7
Drums	14.65	Fats & Oil	2.6	2.5	5.1
Fleshing machine	23.63	Cl	55.2	35.6	90.7
		Psol	0.053	0.0076	0.061
		TS	112	97.1	209.1
		VS	11.5	35.4	46.9
		TSS	8.0	24.8	32.7
		VSS	5.5	16.2	21.8
		SM	0.04	0.56	0.61

The above analysis of input/output flows was carried out from 19 streams of Chilean tannery for during one-year period.

Settled material = SM
Psol = Soluble Phosphorus

Tanyard Inventory
For 1000 kg Processing of Hides

Input	Output (unit in Kg)				
Materials	Kg	Products	deliming	tanning	Total
Pelts	1,050	Grain Wet blue	355		
Water for Deliming	6,490	Split Wet blue	371		
Ammonium Sulphate	18.97	Trimming	37		
Sodium bisulphate	5.23	Shaving	17		
Pancreatic enzyme	3.15	Waste water	6,120	1,148	7,268
NaCl	52.3	pH	10.7	3.6	9.6
Sodium formiate	10.46	COD	10.2	7.5	17.8
H2SO4	16	BOD	3.5	2.0	5.5
Chromium salt	63	TN	3.7	1.0	4.6
Masking agents	15.8	N-NH4+	2.0	0.2	2.2
	SO4-2	12.9	38.6	40.5	
Electricity	kWh	S-2	0.17	0.1 x 10 ⁻³	0.17
Drums	14.65	Fats & Oil	1.1	0.1	1.2
Fleshing machine	23.63	Cl-	6.8	19.1	26.0
		Psol	2.2 x 10 ⁻³	0.3 x 10 ⁻³	2.5 x 10 ⁻³
		TS	32.5	95.9	128.3
		VS	14.8	17.1	32.5
		TSS	2.4	0.8	3.2
		VSS	1.6	0.5	2.1
		SM	7.5 X 10 ⁻³	4.5 X 10 ⁻²	5.3 X 10 ⁻²
		Cr	-	4.5 x 10 ⁻²	4.5 x 10 ⁻³
		Cr VI	-	2.5 x 10 ⁻⁷	2.5 x 10 ⁻⁷
		NH3 (air)	0.68	-	0.68

**Retanning and Dyeing Inventory
For 1000 Kg processing of Grain Wet Blue**

Input		Output(unit in Kg)			
Materials	Kg	Products	Retanning	Dyeing	Total
Grain Wet blue	355	Crust		420.9	
Water for Deliming	3,545	Wastewater	3,480	2,040	5,520
Water for pickling	1,990	pH	3.8	3.7	3.8
Surfactants	7.51	COD	19.1	9.5	28.6
Sodium Formiate	5.38	BOD	3.0	1.8	4.7
Fats	20.9	TN	0.8	0.14	1.0
Cr Salt	14.2	N-NH4+	0.28	0.05	0.33
Tanning Extracts	39.6	O4-2	18.2	3.0	21.24
Formic acid	3.6	S-2	1.0 X 10 ⁻³	0.36 X 10 ⁻³	1.4 xx10 ⁻³
Dye	1.4	Fats & Oil	0.2	0.30	0.5
		Cl-	3.9	0.8	4.7
Electricity	kWh	Psol	2.5 x 10 ⁻³	0.2 x 10 ⁻³	2.7 x 10 ⁻³
Drums	13.95	TS	48.7	8.9	57.6
		VS	12.1	4.2	16.3
		TSS	2.6	0.5	3.1
		VSS	1.9	0.49	2.4
		SM	0.07	3 X 10 ⁻³	0.07
		Cr	1.52 x 10 ⁻³	0.09 X 10 ⁻³	1.61 x 10 ⁻³
		Cr VI	1.1 x 10 ⁻⁷	2.4 x 10 ⁻⁷	3.5 x 10 ⁻⁷

THANKS