APPENDIX A

- **Tables for Soak Liquor Analysis**

Table A.1 Total dissolved solids in soak liquors of different stages

Sample no.	Weight of empty porcelain basin (g)	1st weight of porcelain basin after drying (g)	2nd weight of porcelain basin after drying (g)	3rd weight of porcelain basin after drying (g)	Total dissolved solids (g/L)
E- 01	65.2299	65.3016	65.2991	65.2986	068.7000
ε-01	86.6585	86.7337	86.7293	86.7290	070.5000
ε-02	55.6021	55.7354	55.7275	55.7269	124.8000
ε-03	58.9986	59.2384	59.2239	59.2223	223.7000
ε-04	56.1173	56.3899	56.3564	56.3552	237.9000
ε-05	44.8754	45.2952	45.2354	45.1893	313.9000
ε-06	86.6621	87.0445	86.9970	86.9812	319.1000
ε-07	55.6024	56.0400	55.9576	55.9346	323.2000
ε-08	58.9985	59.4921	59.3937	59.3481	349.6000
ε-09	56.0975	56.5053	56.4637	56.4582	360.7000
ε-10	49.8367	50.3679	50.2822	50.2161	379.4000
ε-11	65.2265	65.6693	65.6210	65.6151	388.6000

Total dissolved solids = (3rd weight of porcelain basin after drying - Weight of empty porcelain basin) x 1000

Table A.2 Salinity (as NaCl) of different soak liquors

Sample no.	Volume of dilute sample taken (mL)	Volume of (N/10)$AgNO_3$solution required for titration (mL)	Average volume of (N/10) $AgNO_3$solution (mL)	Salinity contents (g/L)
Tap water*	5 (without dilution)	0.60 0.60 0.60	0.60	000.702
E- 01	5	0.55 0.55 0.60	0.56	065.520
ε-01	5	0.60 0.60 0.60	0.60	070.200
ε-02	5	1.05 1.05 1.10	1.06	124.020
ε-03	5	1.85 1.95 1.90	1.90	222.300
ε-04	5	1.95 2.00 2.05	2.00	234.000
ε-05	5	2.40 2.25 2.40	2.35	274.950
ε-06	5	2.60 2.65 2.55	2.60	304.200
ε-07	5	2.70 2.60 2.60	2.63	307.710
ε-08	5	2.70 2.70 2.80	2.73	319.410
ε-09	5	3.00 2.90 2.80	2.90	339.300
ε-10	5	3.00 2.90 2.90	2.93	342.810
ε-11	5	3.10 3.10 3.20	3.13	366.210

Salinity contents = 117 x Average volume of (N/10) $AgNO_3$ solution

Table A.3 BOD_5^{20} value of different soak liquors

Sample no.	Volume of empty BOD bottle (mL)	Volume of dilute sample taken (mL)	Initial titration reading of 0.025(N) Hypo solution (mL)	Final (i.e. after 5-days) titration reading of 0.025(N) Hypo solution (mL)	BOD_5^{20} value (mg/L)
Ɛ-01	152.0	55.0	1.850	1.749	0055.82
Ɛ-02	188.0	38.5	1.750	1.643	0104.49
Ɛ-03	134.0	11.2	1.500	1.378	0291.92
Ɛ-04	152.0	14.0	1.700	1.537	0353.94
Ɛ-05	188.0	15.5	1.450	1.272	0431.79
Ɛ-06	192.4	22.0	1.500	1.113	0676.89
Ɛ-07	152.0	16.5	1.700	1.060	1179.15
Ɛ-08	196.0	15.5	1.700	1.219	1216.46
Ɛ-09	202.0	15.0	1.400	0.750	1750.66
Ɛ-10	202.0	14.0	1.750	1.100	1875.71
Ɛ-11	202.0	15.0	1.600	0.850	2020.00

BOD_5^{20} value = 200x Volume of empty BOD bottle x (Initial titration reading - Final titration reading) / Volume of dilute sample taken

Table A.4 COD value of different soak liquors

Sample no.	Volume of 0.025(N) Hypo solution required for blank (mL)	Average Volume of 0.025(N) Hypo solution required for sample (mL)	Volume difference between sample and blank (mL)	COD value (mg/L)
Tap water	3.400	3.500	Insignificant	000000
E- 01	3.400	3.380	0.020	004000
Ɛ-01	3.400	3.385	0.015	003000
Ɛ-02	3.400	3.350	0.050	010000
Ɛ-03	3.400	3.325	0.075	015000
Ɛ-04	3.400	3.300	0.100	020000
Ɛ-05	3.400	3.150	0.250	050000
Ɛ-06	3.400	3.075	0.325	065000
Ɛ-07	3.400	3.050	0.350	070000
Ɛ-08	3.400	2.925	0.475	095000
Ɛ-09	3.400	2.850	0.550	110000
Ɛ-10	3.400	2.700	0.700	140000
Ɛ-11	3.400	2.650	0.750	150000

COD value = 200000 x Volume difference between sample and blank

APPENDIX B

➢ Tables for Physical and Chemical Properties of Finished Leathers

Table B.1 Thickness and Length of the finished leathers

Sample no.	Position on the sides where thickness is measured (in mm)							Average thickness (mm)	Length along the back-bone (mm)
	Along the back-bone towards neck	Along the back-bone towards back	Along the back-bone towards tail	Across the back-bone towards back	Across the back-bone towards belly	Across the back-bone towards shell	Across the back-bone towards flank		
E-01	0.8	0.8	0.9	0.8	0.9	0.9	0.9	0.857	765
ε-01	0.8	0.9	0.9	0.9	0.9	0.9	0.8	0.871	770
E-02	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.814	830
ε-02	0.8	0.9	0.9	0.8	0.8	0.8	0.8	0.828	830
E-03	1.0	1.0	1.0	0.9	0.9	0.9	1.0	0.957	800
ε-03	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.900	800
E-04	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.814	710
ε-04	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.814	705
E-05	1.0	0.8	0.9	0.9	0.8	0.9	0.9	0.886	770
ε-05	0.8	0.9	0.8	0.8	0.6	0.8	0.8	0.786	800
E-06	1.1	0.9	0.9	0.6	0.8	0.9	1.0	0.886	760
ε-06	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.814	760
E-07	0.9	0.6	0.8	0.6	0.8	0.8	0.8	0.757	800
ε-07	0.9	0.8	0.9	0.8	0.8	0.9	0.9	0.857	790
E-08	0.8	0.8	0.9	0.8	0.8	0.9	0.9	0.843	840
ε-08	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.914	860
E-09	0.9	0.8	0.9	0.8	0.9	0.8	0.8	0.843	870
ε-09	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.857	800
E-10	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.800	710
ε-10	0.8	0.8	0.8	0.8	0.6	0.7	0.7	0.743	680
E-11	0.9	0.7	0.8	0.7	0.7	0.8	0.7	0.757	630
ε-11	0.8	0.8	0.8	0.7	0.6	0.8	0.8	0.757	630

Table B.2 Shrinkage Temperature of the finished leathers

Sample no.	Shrinkage temperature (in ^{0}C)		Average value (in ^{0}C)
	Along the back-bone	Perpendicular to the back-bone	
E-01	107	105	106.0
ε-01	108	112	110.0
E-02	109	110	109.5
ε-02	114	116	115.0
E-03	105	109	107.0
ε-03	114	116	115.0
E-04	109	107	108.0
ε-04	115	116	115.5
E-05	109	110	109.5
ε-05	114	117	115.5
E-06	109	106	107.5
ε-06	114	116	115.0
E-07	110	112	111.0
ε-07	115	114	114.5
E-08	109	109	109.0
ε-08	115	117	116.0
E-09	109	109	109.0
ε-09	116	116	116.0
E-10	110	111	110.5
ε-10	115	115	115.0
E-11	105	104	104.5
ε-11	113	111	112.0

Table B.3 Water vapour permeability of the finished leathers

Sample no.	Thickness of the sample (mm)	Mean diameter of the sample (mm)	Initial weight of the bottle with sample (g)	Weight of the bottle after 1-hrs. with sample (g)	Water vapors permeability after 1-hrs. ($x10^{-6}$ g/min/cm^2)	Weight of the bottle after another2-hrs. with sample (g)	Water vapour permeability after another 2-hrs. ($x10^{-6}$ g/min/cm^2)
E-01	0.85	37.50	271.05	271.21	377	271.87	777
ε-01	0.95	37.75	261.25	261.42	401	261.72	354
E-02	0.90	38.00	268.35	268.64	683	269.14	589
ε-02	0.90	37.00	261.64	261.82	424	262.10	330
E-03	1.00	38.00	260.91	261.16	589	261.82	777
ε-03	0.95	37.75	265.90	266.09	448	266.43	401
E-04	0.80	38.00	258.09	258.22	306	258.87	767
ε-04	0.80	37.00	262.37	262.59	519	262.95	424
E-05	0.90	38.00	262.12	262.26	330	262.90	754
ε-05	0.85	37.50	257.39	257.56	401	257.82	306
E-06	0.85	38.00	261.47	261.63	377	262.32	813
ε-06	0.80	38.00	266.78	267.03	589	267.41	448
E-07	0.70	37.50	271.17	271.32	354	271.62	354
ε-07	0.75	37.50	257.68	257.86	424	258.14	330
E-08	0.70	37.50	256.78	256.98	471	257.37	460
ε-08	0.85	38.00	263.41	263.57	377	263.87	354
E-09	0.80	37.75	262.02	262.16	330	262.48	377
ε-09	1.00	38.25	268.17	268.33	377	268.57	283
E-10	0.70	37.75	260.35	260.50	354	260.82	377
ε-10	0.70	38.00	259.83	260.02	447	260.30	330
E-11	0.70	37.50	269.35	269.46	259	269.72	306
ε-11	0.90	38.25	257.76	257.93	401	258.20	318

Diameter of the orifice hole=30mm, temperature-34.2^{0}C, relative humidity- 72.6%.

Water vapour permeability = 2356.902 x 10^{-6} x Difference in sample weight (g) / time required (in hr)

Table B.4 Tensile Strength and % Elongation at break of the finished leathers

Sample no.	Sample position	L	B	D	L_1	L_2	F	T	E	Ave. T	Ave. E
E-01	A.B.B.	43.5	10.80	0.96	10.9	12.9	23.0	221.84	04.60	146.74	09.49
	P.B.B.	44.5	11.20	0.86	11.0	17.4	06.9	071.64	14.38		
ε-01	A.B.B.	43.5	11.00	0.85	11.5	14.3	20.4	218.18	06.44	154.17	09.25
	P.B.B.	44.0	10.60	0.90	11.4	16.7	08.6	090.15	12.05		
E-02	A.B.B.	48.5	11.60	0.84	11.0	12.8	22.8	233.99	03.71	153.15	09.65
	P.B.B.	43.0	10.83	0.83	11.4	18.1	06.5	072.31	15.58		
ε-02	A.B.B.	44.5	10.80	0.88	11.3	14.0	22.8	239.89	06.07	159.99	09.06
	P.B.B.	44.0	10.60	0.86	11.4	16.7	07.3	080.08	12.05		
E-03	A.B.B.	43.0	11.16	1.02	10.7	12.9	25.2	221.17	05.12	160.77	11.07
	P.B.B.	43.5	11.00	0.96	11.4	18.8	10.6	100.37	17.01		
ε-03	A.B.B.	44.0	10.50	1.08	11.0	13.0	26.0	229.27	04.55	173.43	08.98
	P.B.B.	44.0	10.80	1.00	11.4	17.3	12.7	117.59	13.41		

Table B.4 (Continued)

Sample no.	Sample position	L	B	D	L_1	L_2	F	T	E	Ave. T	Ave. E
E-04	A.B.B.	44.5	10.60	0.96	11.2	13.0	18.0	176.88	04.04	153.05	11.21
	P.B.B.	43.0	10.60	0.73	12.0	19.9	10.0	129.23	18.37		
ε-04	A.B.B.	48.0	11.50	0.86	10.8	13.0	13.2	133.47	04.58	107.64	08.14
	P.B.B.	44.5	11.00	0.60	11.5	16.7	05.4	081.81	11.69		
E-05	A.B.B.	44.5	10.83	0.80	11.3	13.6	19.0	219.29	05.17	140.58	10.12
	P.B.B.	44.5	11.16	0.85	11.1	17.8	06.1	061.86	15.06		
ε-05	A.B.B.	43.5	10.50	0.75	11.3	13.7	20.3	257.77	05.52	194.40	08.51
	P.B.B.	43.5	10.60	0.72	11.5	16.5	10.0	131.03	11.49		
E-06	A.B.B.	43.5	10.83	0.82	11.2	13.4	35.2	396.36	05.06	240.54	12.42
	P.B.B.	44.5	11.00	0.88	11.7	20.5	08.2	084.71	19.78		
ε-06	A.B.B.	44.5	10.60	0.82	11.2	13.5	25.3	291.07	05.17	216.56	11.09
	P.B.B.	43.5	11.00	0.80	11.8	19.2	12.5	142.05	17.01		

Table B.4 (Continued)

Sample no.	Sample position	L	B	D	L_1	L_2	F	T	E	Ave. T	Ave. E
E-07	A.B.B.	48.5	11.33	0.61	10.6	12.1	13.9	201.12	03.09	146.11	09.31
	P.B.B.	42.5	11.50	0.63	11.6	18.2	06.6	091.09	15.53		
ε-07	A.B.B.	43.5	11.16	0.68	12.6	14.9	10.2	134.41	05.29	117.13	07.82
	P.B.B.	43.5	11.16	0.70	11.8	16.3	07.8	099.85	10.34		
E-08	A.B.B.	48.5	11.50	0.69	10.7	12.6	19.5	245.75	03.92	167.06	07.87
	P.B.B.	44.0	11.16	0.72	11.3	16.5	07.1	088.36	11.82		
ε-08	A.B.B.	44.5	10.50	0.80	10.7	12.7	24.9	296.43	04.49	198.48	11.11
	P.B.B.	44.0	11.16	0.82	11.0	18.8	09.2	100.53	17.73		
E-09	A.B.B.	48.5	11.66	0.84	10.6	12.1	24.3	248.10	03.09	170.10	10.27
	P.B.B.	43.0	11.16	0.72	11.5	19.0	07.4	092.09	17.44		
ε-09	A.B.B.	44.0	11.30	0.90	11.8	14.1	21.1	207.47	05.23	156.97	11.14
	P.B.B.	44.0	11.00	0.76	10.8	18.3	08.9	106.46	17.05		

Table B.4 (Continued)

Sample no.	Sample position	L	B	D	L_1	L_2	F	T	E	Ave. T	Ave. E
E-10	A.B.B.	43.5	11.00	0.60	11.4	12.9	17.8	269.69	03.45	174.13	09.31
	P.B.B.	43.5	11.16	0.65	11.6	18.2	05.7	078.57	15.17		
ε-10	A.B.B.	48.0	11.50	0.60	11.0	12.7	19.3	279.71	03.54	199.11	09.05
	P.B.B.	44.0	11.16	0.62	10.6	17.0	08.2	118.51	14.55		
E-11	A.B.B.	42.0	10.00	0.70	11.5	14.5	18.8	268.57	07.14	191.86	10.95
	P.B.B.	42.0	10.00	0.66	11.3	17.5	07.6	115.15	14.76		
ε-11	A.B.B.	44.0	11.16	0.92	10.5	14.2	24.2	235.70	08.41	187.16	12.14
	P.B.B.	43.5	11.30	0.83	10.7	17.6	13.0	138.61	15.86		

Temperature-33.90C, Relative humidity- 69.1%, Tensile strength (T) = (F x 100) / (B x D) in kg/sq. cm. % Elongation at break (E) = $100(L_2 - L_1) / L$, Notation used in the table: E =% Elongation at break, L = Length of the sample in mm. B = Breadth of the sample in mm. D = Thickness of the sample in mm. L_1 = Initial length in mm. L_2 = Length at break in mm. F = Load at break in kg. T = Tensile strength in kg/sq. cm. A.B.B. = Along the back-bone. P.B.B. = Perpendicular to the back-bone.

Table B.5 Double- hole stitch tear strength of the finished leathers

Sample no	Sample position	Average thickness along the holes (mm)	Load at break (kg)	Stitch tear strength (kg/cm thickness)	Average value (kg/cm thickness)
E-01	A.B.B.	0.81	08.9	109.88	077.855
	P.B.B.	0.96	04.4	045.83	
ε-01	A.B.B.	0.97	09.1	093.81	077.585
	P.B.B.	0.88	05.4	061.36	
E-02	A.B.B.	0.72	07.8	108.33	086.040
	P.B.B.	0.80	05.1	063.75	
ε -02	A.B.B.	0.97	08.2	084.54	077.100
	P.B.B.	0.89	06.2	069.66	
E-03	A.B.B.	1.00	12.1	121.00	099.335
	P.B.B.	1.03	08.0	077.67	
ε -03	A.B.B.	0.87	08.8	101.15	093.350
	P.B.B.	0.90	07.7	085.55	
E -04	A.B.B.	0.73	10.3	141.10	114.925
	P.B.B.	0.80	07.1	088.75	
ε -04	A.B.B.	0.81	06.2	076.54	069.135
	P.B.B.	0.81	05.0	061.73	
E -05	A.B.B.	0.88	09.2	104.55	072.275
	P.B.B.	1.00	04.0	040.00	
ε -05	A.B.B.	0.79	09.3	117.72	098.725
	P.B.B.	0.74	05.9	079.73	
E -06	A.B.B.	0.82	10.4	126.83	097.36
	P.B.B.	1.09	07.4	067.89	
ε -06	A.B.B.	0.65	05.9	090.77	081.215
	P.B.B.	0.60	04.3	071.66	

Table B.5 (Continued)

Sample no	Sample position	Average thickness along the holes (mm)	Load at break (kg)	Stitch tear strength (kg/cm thickness)	Average value (kg/cm thickness)
E -07	A.B.B.	0.64	08.0	125.00	095.285
	P.B.B.	0.61	04.0	065.57	
ε -07	A.B.B.	0.77	06.8	088.31	082.670
	P.B.B.	0.74	05.7	077.03	
E -08	A.B.B.	0.80	07.2	090.00	069.375
	P.B.B.	0.80	03.9	048.75	
ε -08	A.B.B.	0.93	08.0	086.02	070.785
	P.B.B.	0.90	05.0	055.55	
E -09	A.B.B.	0.68	06.0	088.24	074.365
	P.B.B.	0.81	04.9	060.49	
ε -09	A.B.B.	0.80	08.4	105.00	085.375
	P.B.B.	0.73	04.8	065.75	
E-10	A.B.B.	0.66	05.0	075.76	062.530
	P.B.B.	0.71	03.5	049.30	
ε-10	A.B.B.	0.63	05.0	079.37	074.685
	P.B.B.	0.60	04.2	070.00	
E-11	A.B.B.	0.65	06.5	100.00	085.965
	P.B.B.	0.57	04.1	071.93	
ε-11	A.B.B.	0.87	05.1	058.62	055.085
	P.B.B.	0.97	05.0	051.55	

Temperature-32.50C, Relative humidity- 71.3%, Stitch tear strength = 10 x Load at break / Average thickness along the holes. Notation used in the table: A.B.B. = Along the back-bone.

P.B.B. = Perpendicular to the back-bone

Table B.6 Grain crack strength and ball-bursting strength of the finished leathers

Sample no.	Thickness (mm)	Load required just to crack the grain (kg)	Distension at crack (mm)	Load required just to burst the grain (kg)	Distension at burst (mm)	Grain crack strength (kg/cm)	Bursting strength (kg/cm)
E-01	0.88	8.10	11.50	15.60	12.20	092.04	177.27
ε-01	0.92	4.00	08.90	08.50	10.80	043.48	092.39
E-02	0.88	2.80	06.60	05.80	10.90	031.82	065.91
ε-02	0.92	3.70	07.80	08.50	10.50	040.22	092.39
E-03	1.20	4.90	07.90	10.00	11.60	040.83	083.33
ε-03	0.95	4.90	07.70	13.60	10.30	051.58	143.16
E-04	0.80	1.25	05.10	11.10	10.20	015.63	138.75
ε-04	0.80	2.40	06.70	07.90	10.50	030.00	098.75
E-05	0.95	3.00	06.80	10.50	10.00	031.58	110.53
ε-05	0.82	4.60	08.00	08.20	10.90	056.09	100.00
E-06	0.88	3.20	05.90	11.30	10.50	036.36	128.40
ε-06	0.78	4.30	08.40	07.70	10.00	055.13	098.72
E-07	0.68	2.90	06.50	07.50	10.70	042.65	110.29
ε-07	0.73	3.20	07.60	05.70	09.60	043.84	078.08
E-08	0.72	4.60	06.20	08.00	10.70	063.88	111.11
ε-08	0.85	5.20	08.00	09.80	11.10	061.18	115.29
E-09	0.80	4.20	06.80	10.30	10.50	052.50	128.75
ε-09	1.00	4.10	07.70	10.10	11.20	041.00	101.00
E-10	0.69	4.00	06.80	06.70	09.50	057.97	097.10
ε-10	0.70	5.60	08.60	10.90	11.20	080.00	155.71
E-11	0.63	6.80	08.50	09.60	10.90	107.93	152.38
ε-11	0.90	6.50	07.90	10.80	10.10	072.22	120.00

Temperature = 33.5 ^{0}C, Relative humidity = 76.7%

Grain crack strength = 10 x Load required just to crack the grain / Thickness

Bursting strength = 10 x Load required just to burst the grain / Thickness

Table B.7 Absorption of water of finished leather: Kubelka method

Sample no	L (mm)	B (mm)	D (mm)	W (g)	Vol. of water absorbed (mL)		P (% absorption on apparent volume)		Q (% absorption on apparent weight)		Apparent density (P/Q)	
					After 30 min.	After 60 min.	After 30 min.	After 60 min.	After 30 min.	After 60 min.	After 30 min.	After 60 min.
E-01	40	40	1.02	1.09	1.20	1.30	073.53	079.66	110.09	119.27	0.67	0.67
ε-01	40	40	0.88	0.78	1.20	1.30	085.23	092.33	153.85	166.66	0.55	0.55
E-02	40	40	0.78	0.78	1.10	1.30	088.14	104.17	141.03	166.67	0.62	0.63
ε-02	40	40	0.76	0.75	1.20	1.40	098.68	115.13	160.00	186.67	0.62	0.62
E-03	40	40	1.00	0.97	1.60	1.70	100.00	106.25	164.95	175.26	0.61	0.61
ε-03	40	40	0.90	0.85	1.50	1.60	104.17	111.11	176.47	188.24	0.59	0.59
E-04	40	40	0.79	0.89	1.10	1.20	087.03	094.94	123.60	134.83	0.70	0.70
ε-04	40	40	0.80	0.74	1.20	1.30	093.75	101.56	162.16	175.68	0.58	0.58
E-05	40	40	0.85	0.92	1.00	1.20	073.53	088.24	108.70	130.43	0.68	0.68
ε-05	40	40	0.72	0.74	0.90	1.00	078.13	086.81	121.62	135.14	0.64	0.64
E-06	40	40	1.05	1.12	1.42	1.60	084.52	095.24	126.79	142.86	0.66	0.66
ε-06	40	40	0.72	0.65	1.00	1.10	086.81	095.49	153.85	169.23	0.56	0.56
E-07	40	40	0.68	0.78	0.80	0.90	073.53	082.72	102.56	115.38	0.72	0.72
ε-07	40	40	0.73	0.72	1.10	1.20	094.18	102.74	152.78	166.67	0.62	0.62

Table B.7 (Continued)

Sample no	L (mm)	B (mm)	D (mm)	W (g)	Vol. of water absorbed (mL)		P (% absorption on apparent volume)		Q (% absorption on apparent weight)		Apparent density (P/Q)	
					After 30 min.	After 60 min.	After 30 min.	After 60 min.	After 30 min.	After 60 min.	After 30 min.	After 60 min.
E-08	40	40	0.66	0.74	1.00	1.10	094.67	104.17	135.12	148.65	0.70	0.70
ε-08	40	40	0.88	0.77	1.40	1.60	099.43	113.64	181.82	207.79	0.55	0.55
E-09	40	40	0.80	0.86	1.10	1.20	085.94	093.75	127.91	139.53	0.67	0.67
ε-09	40	40	0.80	0.75	1.20	1.30	093.75	101.56	160.00	173.33	0.59	0.59
E-10	40	40	0.66	0.68	0.90	1.00	085.23	094.70	132.35	147.06	0.64	0.64
ε-10	40	40	0.63	0.60	1.00	1.10	099.21	109.13	166.67	183.33	0.60	0.60
E-11	40	40	0.72	0.85	1.10	1.30	095.49	112.85	129.41	152.94	0.74	0.74
ε-11	40	40	0.85	0.70	1.30	1.60	095.56	117.65	185.71	228.57	0.51	0.51

Average temperature = 32.7^0C, average relative humidity =78.5%. Notation used in the table: L= length of the sample, B= breadth of the sample, D= thickness of the sample, W= apparent weight of the sample. P= 10^5 x v/ L x B x D. Q= 10^2 x v/ W

Table B.8 Dry-rub and Wet-rub colour fastness of the finished leathers

Sample no	Grey scale reading			
	Dry rub fastness		Wet rub fastness	
	Leather	Cloth of Pad	Leather	Cloth of Pad
E-01	4	4/5	4	4
ε-01	5	5	4	4/5
E-02	4	4/5	4	4
ε-02	5	5	4	4/5
E-03	4	4/5	3	4
ε-03	5	5	4	4/5
E-04	4	4/5	3	3/4
ε-04	5	5	3	4
E-05	4	4/5	4	4/5
ε-05	5	5	4	4/5
E-06	4	4/5	4	4
ε-06	5	5	4	4
E-07	5	4/5	4	4
ε-07	5	5	4	4
E-08	4	4/5	3	3/4
ε-08	5	5	4	4
E-09	4	4/5	4	4
ε-09	5	5	4	4
E-10	4	4/5	4	4
ε-10	4	4/5	4	4
E-11	4	4/5	3	4
ε-11	5	5	4	4/5

Table B.9 Volatile matter content in leather

Sample no	Weight of empty porcelain basin (g)	Weight of sample taken (g)	1st weight after drying (g)	2nd weight after drying (g)	3rd weight after drying (g)	Volatile matter content (%)
E-01	64.5393	3.0043	67.1116	67.0969	67.0934	14.99
ε-01	65.3800	3.0039	67.9722	67.9698	67.9638	13.99
E-02	68.7190	3.0015	71.2846	71.2741	71.2582	15.40
ε-02	58.9795	3.0020	61.5583	61.5504	61.5442	14.57
E-03	63.3971	3.0092	65.9475	65.9473	65.9341	15.69
ε-03	51.9014	3.0008	54.4844	54.4746	54.4738	14.28
E-04	74.7112	3.0056	77.2399	77.2384	77.2305	16.18
ε-04	61.7873	3.0003	64.3630	64.3558	64.3546	14.43
E-05	58.5934	3.0052	61.1665	61.1600	61.1569	14.70
ε-05	71.3183	3.0004	73.9037	73.9017	73.8970	14.05
E-06	74.7428	3.0006	77.2662	77.2621	77.2612	16.07
ε-06	72.4262	3.0067	74.9847	74.9674	74.9657	15.54
E-07	55.5873	3.0058	58.1353	58.1335	58.1325	15.32
ε-07	64.8254	3.0030	67.3438	67.3421	67.3306	17.40
E-08	42.9092	3.0012	45.4553	45.4502	45.4468	15.45
ε-08	71.9933	3.0012	74.5997	74.5944	74.5778	13.88
E-09	51.9636	3.0005	54.5202	54.5196	54.5077	15.21
ε-09	54.6559	3.0032	57.2366	57.2290	57.2278	14.36
E-10	49.6022	3.0008	52.1802	52.1796	52.1733	14.32
ε-10	73.0136	3.0042	75.5707	75.5684	75.5528	15.48
E-11	43.1751	3.0033	45.7475	45.7458	45.7431	14.49
ε-11	55.9140	3.0014	58.5375	58.5316	58.5237	13.05

% volatile matter content = (Weight of empty porcelain basin +Weight of sample taken - 3rd weight after drying) x 100 / Weight of sample taken.

Table B.10 Ash content in leather

Sample no	Weight of empty crucible (g)	Weight of sample taken (g)	1st weight after ashing (g)	2nd weight after ashing (g)	3rd weight after ashing (g)	Ash content (%)
E-01	28.0299	5.0080	28.5340	28.5327	28.5323	10.03
ε-01	28.1771	5.0005	28.7266	28.7265	28.7259	10.97
E-02	28.4512	5.0022	28.9457	28.9442	28.9438	09.85
ε-02	30.9732	5.0049	31.5144	31.5144	31.5139	10.80
E-03	31.3027	5.0010	31.8059	31.8054	31.8053	10.04
ε-03	31.0007	5.0038	31.6204	31.6192	31.6188	12.35
E-04	30.2735	5.0036	30.6918	30.6917	30.6914	08.35
ε-04	29.8634	5.0031	30.4211	30.4202	30.4194	11.11
E-05	28.7960	5.0012	29.2516	29.2516	29.2512	09.10
ε-05	27.1878	5.0030	27.7758	27.7750	27.7746	11.73
E-06	28.4036	5.0025	28.8367	28.8361	28.8355	08.63
ε-06	27.9198	5.0028	28.5439	28.5428	28.5421	12.44
E-07	27.5741	5.0010	28.0050	28.0049	28.0049	08.61
ε-07	28.3940	5.0048	28.8194	28.8186	28.8183	08.48
E-08	28.3940	5.0048	28.8194	28.8186	28.8183	08.48
ε-08	30.0728	5.0009	30.6448	30.6443	30.6427	11.39
E-09	31.1714	5.0008	31.6106	31.6099	31.6098	08.77
ε-09	28.5956	5.0014	29.1772	29.1767	29.1758	11.60
E-10	31.4760	5.0032	31.9095	31.9095	31.9094	08.66
ε-10	28.1717	5.0044	28.8346	28.8341	28.8332	13.21
E-11	28.8858	5.0056	29.3490	29.3489	29.3489	09.25
ε-11	27.4047	5.0042	27.9673	27.9670	27.9663	11.22

% ash content = (3rd weight after ashing - Weight of empty crucible) x 100 / Weight of sample taken.

Table B.11 Chloride (as NaCl) content in leather

Sample no	Weight of sample taken for ashing (g)	Volume of sample solution (mL)	Average volume of 0.01(N) $AgNO_3$ soln. required (mL)	NaCl present in 50 ml solution ($x\ 10^{-5}$ g)	Nacl content ($x\ 10^{-3}$ %)
E-01	5.0080	50	1.12	065.520	065
ε-01	5.0005	50	1.38	080.730	081
E-02	5.0022	50	1.13	066.105	066
ε-02	5.0049	50	1.47	085.995	086
E-03	5.0010	50	1.18	069.030	069
ε-03	5.0038	50	1.53	089.505	089
E-04	5.0036	50	1.03	060.255	060
ε-04	5.0031	50	1.56	091.260	091
E-05	5.0012	50	1.15	067.275	067
ε-05	5.0030	50	1.62	094.770	095
E-06	5.0025	50	1.10	064.350	064
ε-06	5.0028	50	1.67	097.695	098
E-07	5.0010	50	1.28	074.880	075
ε-07	5.0048	50	1.77	103.545	104
E-08	5.0048	50	1.08	063.180	063
ε-08	5.0009	50	1.92	112.320	112
E-09	5.0008	50	1.02	059.670	060
ε-9	5.0014	50	2.12	124.020	124
E-10	5.0032	50	1.12	065.520	065
ε-10	5.0044	50	2.37	138.645	139
E-11	5.0056	50	1.17	068.445	068
ε-11	5.0042	50	2.78	162.630	162

% chloride content = (NaCl present in 50 mL solution x 5x100) / Weight of sample taken for ashing

NaCl present in 50 mL solution = 0.01 x 58.5 x Average volume of 0.01(N) $AgNO_3$ soln. required / 1000

Table B.12 Total sulphate (as Na_2SO_4) content in leather

Sample no	Weight of sample taken for ashing (g)	Weight of empty crucible (g)	1st weight after ignition (g)	2nd weight after ignition (g)	3rd weight after ignition (g)	Sulphate content (%)
Blank	0.0000	29.0057	29.0093	29.0088	29.0084	0.0027*
E-01	5.0020	28.6340	28.6645	28.6645	28.6637	2.70
ε-01	5.0077	31.3937	31.4305	31.4305	31.4304	3.40
E-02	5.0087	27.7877	27.8208	27.8207	27.8201	2.97
ε-02	5.0020	30.4847	30.5244	30.5243	30.5239	3.65
E-03	5.0063	28.6480	28.6788	28.6775	28.6769	2.62
ε-03	5.0004	30.6206	30.6523	30.6517	30.6504	2.71
E-04	5.0017	29.1641	29.1937	29.1935	29.1931	2.63
ε-04	5.0033	31.6257	31.6594	31.6593	31.6593	3.09
E-05	5.0015	31.3628	31.3971	31.3968	31.3953	2.98
ε-05	5.0019	27.9229	27.9559	27.9558	27.9558	3.02
E-06	5.0018	28.8044	28.8379	28.8377	28.8376	3.05
ε-06	5.0007	30.4688	30.5042	30.5040	30.5037	3.22
E-07	5.0017	31.4929	31.5281	31.5271	31.5266	3.10
ε-07	5.0075	29.0365	29.0800	29.0800	29.0794	4.01
E-08	5.0035	28.7302	28.7636	28.7635	28.7634	3.05
ε-08	5.0039	28.6667	28.7086	28.7085	28.7083	3.89
E-09	5.0018	31.6762	31.7123	31.7119	31.7111	3.22
ε-09	5.0060	28.6815	28.7235	28.7230	28.7229	3.87
E-10	5.0013	31.7317	31.7670	31.7668	31.7667	3.23
ε-10	5.0048	27.8147	27.8577	27.8576	27.8572	3.98
E-11	5.0039	28.7717	28.8031	28.8031	28.8026	2.82
ε-11	5.0038	31.6217	31.6636	31.6635	31.6632	3.88

*0.0027 g sulphate is present in 50mL distilled water

% total sulphate content = (3rd weight after ignition - Weight of empty crucible – 0.0027) x 5 x100 / Weight of sample taken for ashing.

Table B.13 Chromium (as Cr) content in leather

Sample no	Weight of sample taken for ashing (g)	(N/10) Hypo [f=1.00027] required for titration (in mL)				Chromium content (%)
		1st reading	2nd reading	3rd reading	Average value	
E-01	5.0042	19.85	19.80	19.90	19.85	3.43
ε-01	5.0014	20.65	20.45	20.50	20.53	3.55
E-02	5.0027	20.00	19.95	19.90	19.95	3.45
ε-02	5.0008	21.00	20.90	20.50	20.80	3.59
E-03	5.0047	19.80	20.10	20.00	19.97	3.45
ε-03	5.0006	20.85	21.20	20.90	20.98	3.63
E-04	5.0034	19.20	19.50	19.50	19.40	3.35
ε-04	5.0037	20.15	20.95	21.10	21.06	3.64
E-05	5.0045	20.55	21.00	21.05	20.87	3.61
ε-05	5.0042	21.20	21.20	21.05	21.15	3.66
E-06	5.0004	18.95	19.20	19.40	19.18	3.32
ε-06	5.0020	20.95	21.15	21.00	21.03	3.64
E-07	5.0037	20.10	19.80	20.00	19.97	3.45
ε-07	5.0015	20.20	20.35	20.45	20.33	3.52
E-08	5.0012	19.95	20.15	20.20	20.10	3.48
ε-08	5.0007	21.55	21.60	21.65	21.60	3.74
E-09	5.0018	19.50	20.10	19.80	19.80	3.42
ε-09	5.0020	21.50	21.85	21.60	21.65	3.74
E-10	5.0007	19.05	20.60	20.60	20.08	3.47
ε-10	5.0030	21.10	21.00	21.05	21.05	3.64
E-11	5.0073	20.10	20.10	20.00	20.07	3.47
ε-11	5.0009	20.50	20.60	20.60	20.57	3.56

%Chromium content = Average value x f x 5 x 0.00173 x 100/ Weight of sample taken for ashing.

Table B.14 Average value of different physical and chemical properties of finished lining leathers

Sl. no.	Properties	Average value		Values as per IS specification
		Samples (ε) obtained following proposed repeated soaking	Samples (E) obtained following conventional soaking	
1	Thickness	0.831mm	0.837mm	As agreed to between the purchaser and the supplier
2	Length along the back-bone	765.90mm	785.50mm	-
3	Shrinkage Temperature(T_S)	114.75^{0}C	108.31^{0}C	100^{0}C
4	Water vapour permeability (after 1-hr)	437.09 x10^{-6} g/min/cm^2	402.72 x10^{-6} g/min/cm^2	-
5	Water vapour permeability (after 2-hrs)	352.54 x10^{-6} g/min/cm^2	577.36 x10^{-6} g/min/cm^2	-
6	Tensile strength	169.55 kg/cm^2	167.64 kg/cm^2	150 kg/cm^2 (minimum)
7	% Elongation at break	9.66	10.15	100 (maximum)
8	Double-hole stitch tear strength	78.70 kg/cm-thickness	85.03 kg/cm-thickness	50 kg/cm (minimum)
9	Grain-crack strength	52.25 kg/cm-thickness	52.11 kg/cm-thickness	-
10	Ball-bursting strength	108.68 kg/cm-thickness	118.53 kg/cm-thickness	-
11	Water absorption on apparent volume (after 30-minutes)	93.55%	85.60%	100% (minimum)
12	Water absorption on apparent volume (after 60-minutes)	104.29%	96.06%	100% (minimum)
13	Water absorption on apparent weight (after 30-minutes)	161.36%	127.50%	100% (minimum)

Table B.14 (Continued)

Sl. no.	Properties	Average value		Values as per IS specification
		Samples (ε) obtained following proposed repeated soaking	Samples (E) obtained following conventional soaking	
14	Water absorption on apparent weight (after 30-minutes)	180.12%	142.99%	100% (minimum)
15	Apparent density	0.58 g/cc	0.67 g/cc	-
16	Dry-rub colour fastness of leather	4.90 (grey scale reading)	4.09 (grey scale reading)	-
17	Wet-rub colour fastness of leather	3.90 (grey scale reading)	3.63 (grey scale reading)	-
18	Volatile matter content	14.79%	15.25%	-
19	Ash content	11.40%	9.05%	-
20	Chloride (as NaCl) content	107.36×10^{-3} %	65.63×10^{-3} %	-
21	Sulphate (as Na_2SO_4) content	3.52%	2.94%	-
22	Chromium (as Cr) content	3.62%	3.44%	3%

APPENDIX C

➢ Column Charts of Soak Liquor Analysis

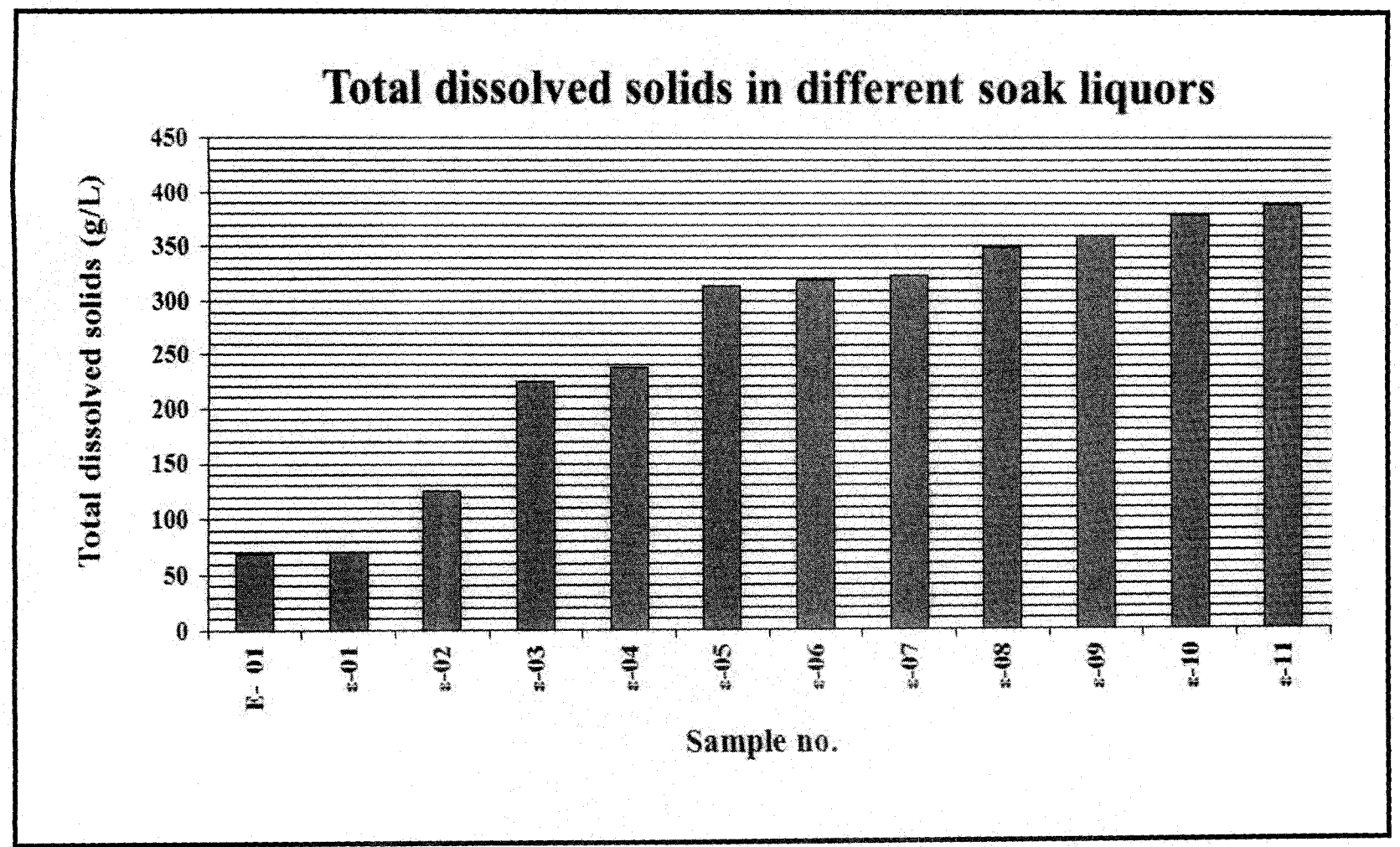
Total dissolved solids in different soak liquors
Total dissolved solids (g/L)
450
400
350
300
250
200
150
100
50
0
E- 01
E-01
E-02
E-03
E-04
E-05
E-06
E-07
E-08
E-09
E-10
E-11
Sample no.

Figure- A.1

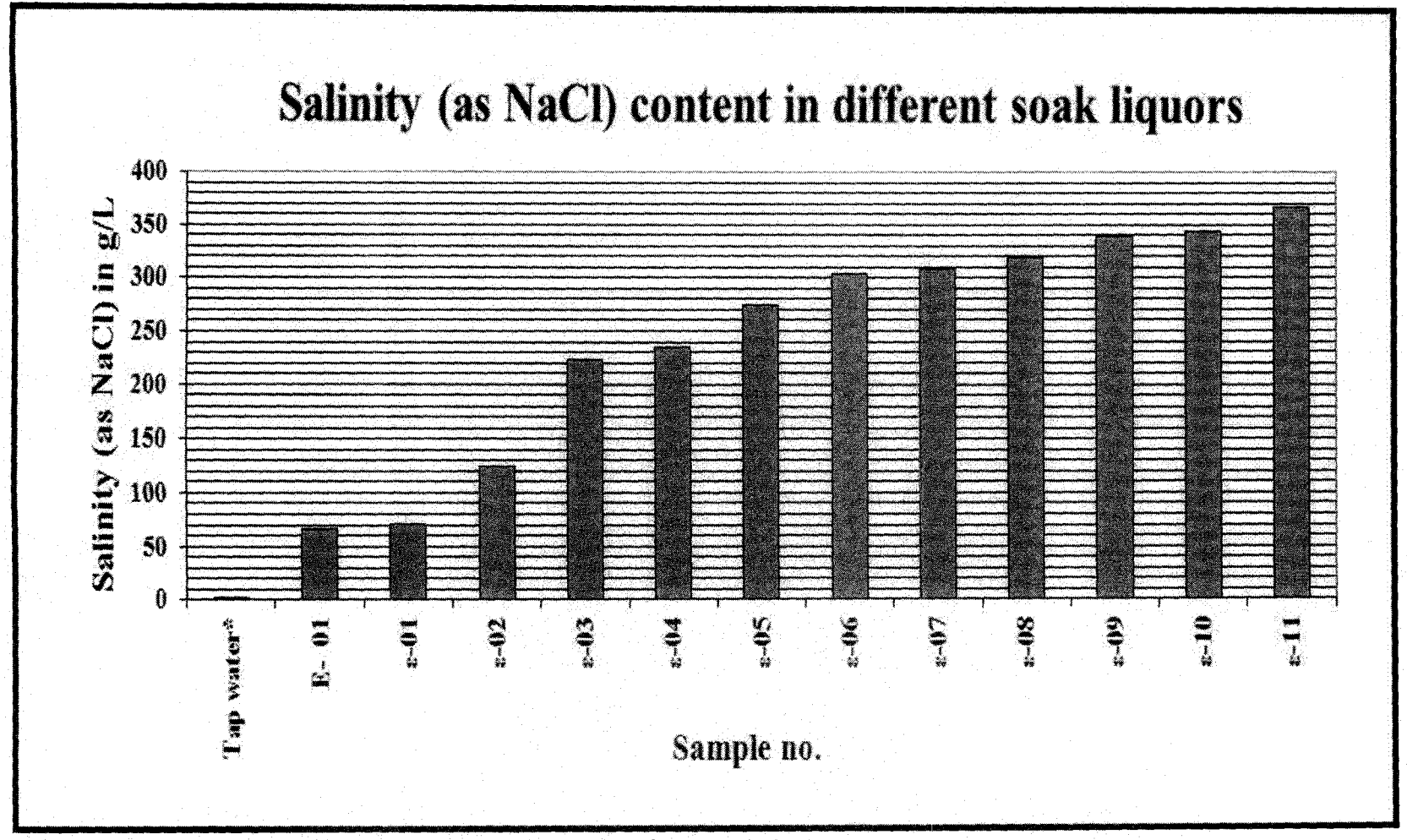
Salinity (as NaCl) content in different soak liquors
Salinity (as NaCl) in g/L
400
350
300
250
200
150
100
50
0
Tap water*
E- 01
#-01
#-02
#-03
#-04
#-05
#-06
#-07
#-08
#-09
#-10
#-11
Sample no.

Figure- A.2

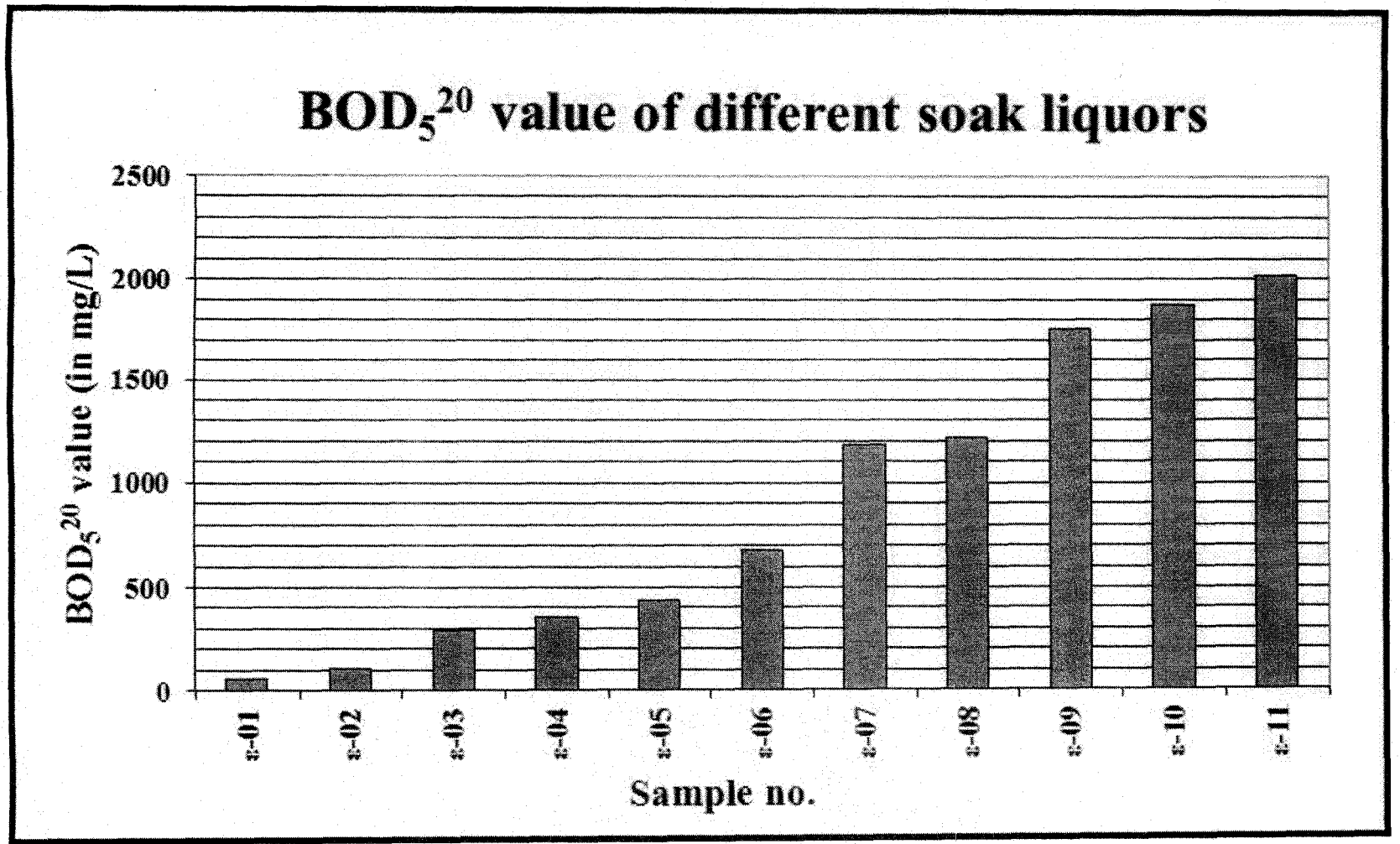
BOD5^20 value of different soak liquors
BOD5^20 value (in mg/L)
2500
2000
1500
1000
500
0
#-01
#-02
#-03
#-04
#-05
#-06
#-07
#-08
#-09
#-10
#-11
Sample no.

Figure- A.3

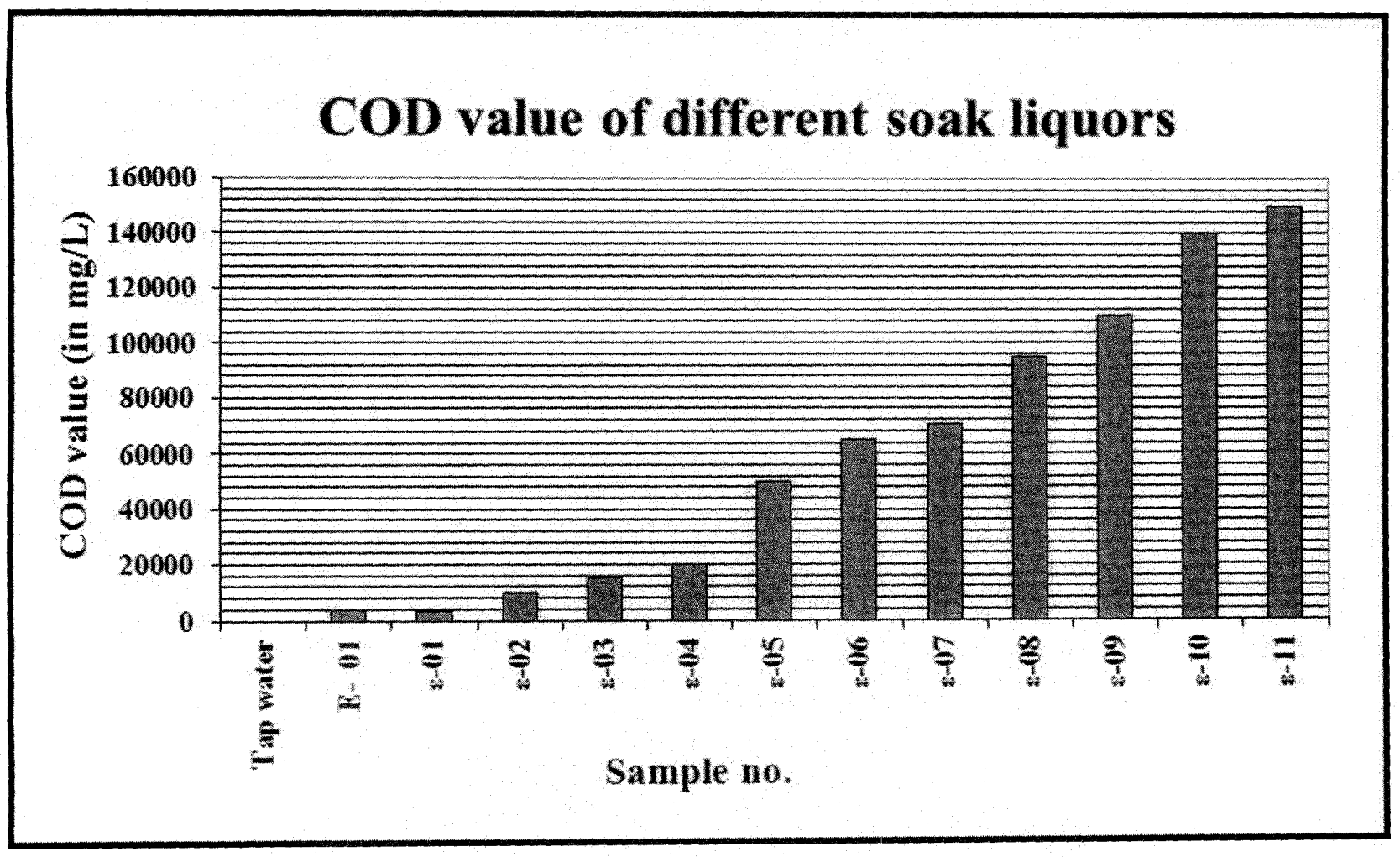
COD value of different soak liquors
COD value (in mg/L)
160000
140000
120000
100000
80000
60000
40000
20000
0
Tap water
E- 01
s-01
s-02
s-03
s-04
s-05
s-06
s-07
s-08
s-09
s-10
s-11
Sample no.

Figure- A.4

APPENDIX D

➢ Column Charts of Physical and Chemical Properties of Finished Leathers

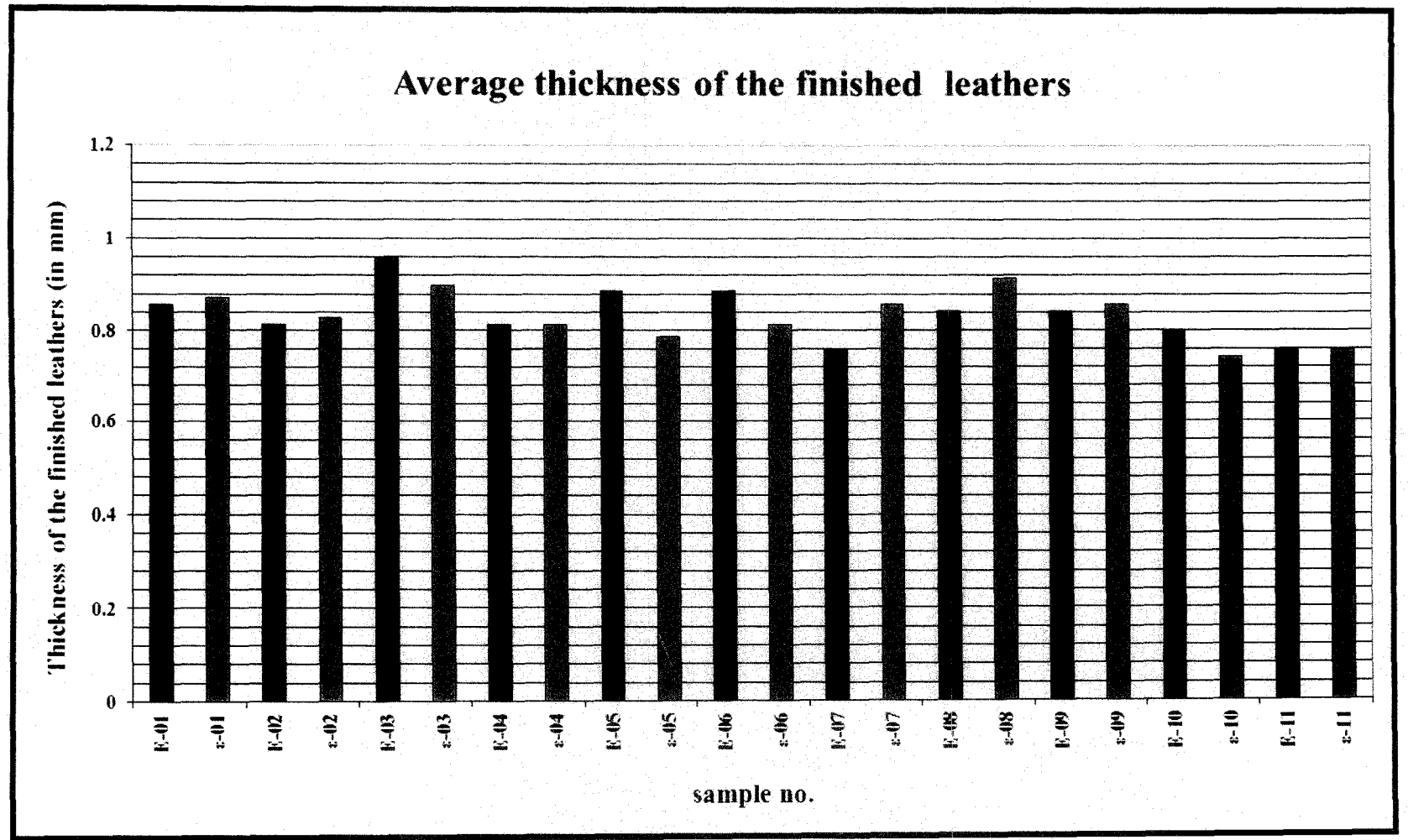
Average thickness of the finished leathers
Thickness of the finished leathers (in mm)
1.2
1
0.8
0.6
0.4
0.2
0
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
sample no.

Figure- B.1.1

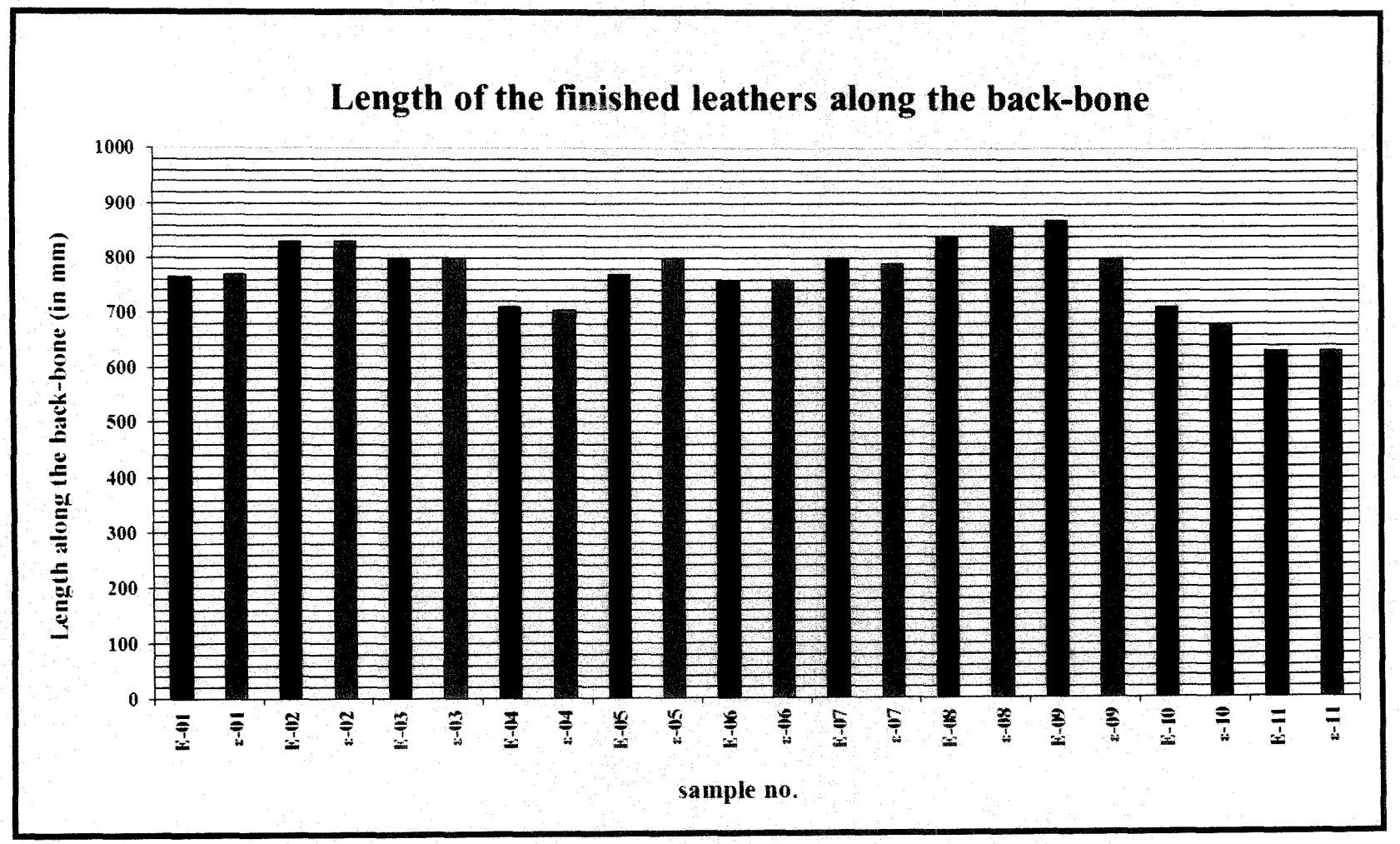
Length of the finished leathers along the back-bone
Length along the back-bone (in mm)
1000
900
800
700
600
500
400
300
200
100
0
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
sample no.

Figure- B.1.2

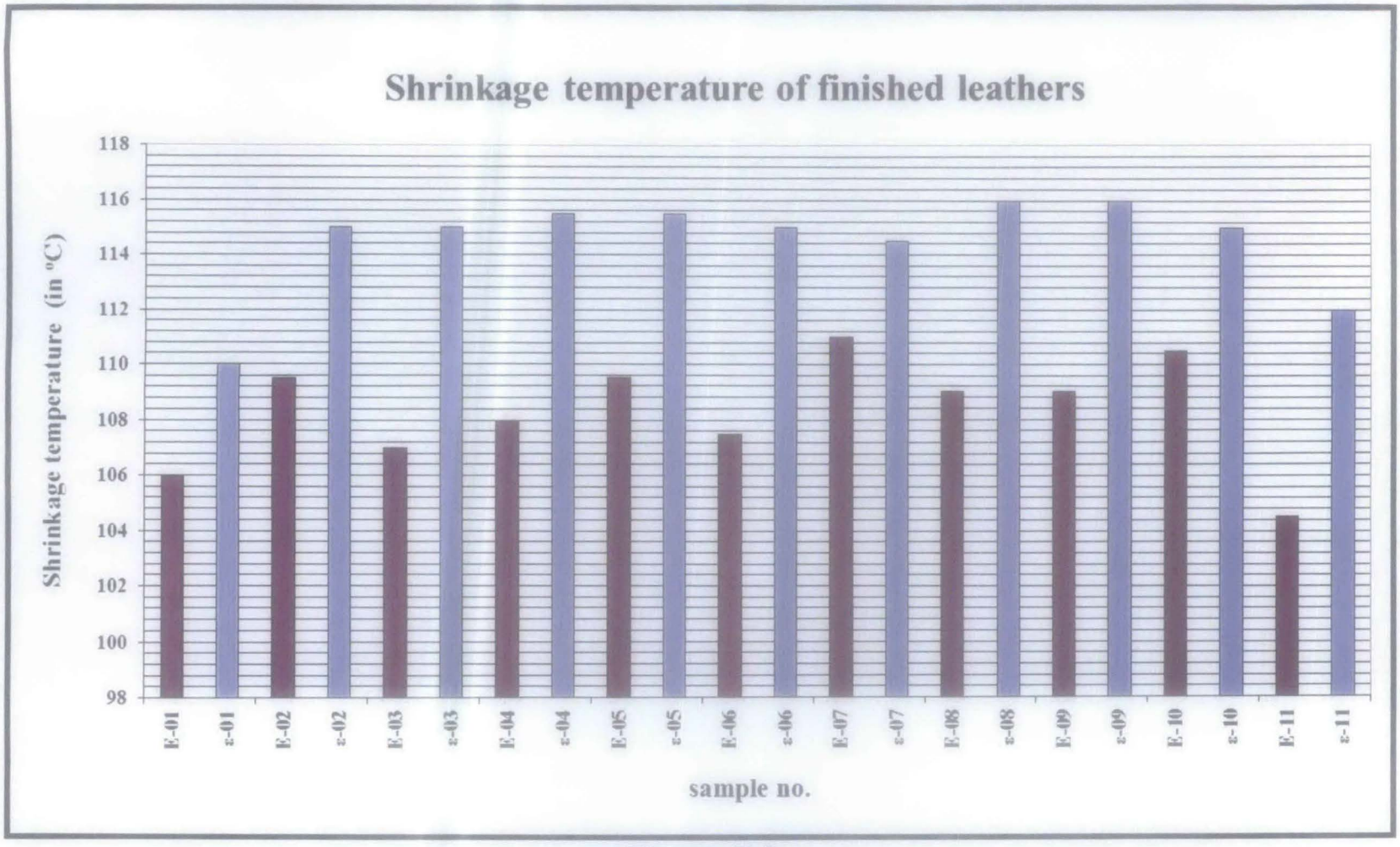
Shrinkage temperature of finished leathers
Shrinkage temperature (in °C)
118
116
114
112
110
108
106
104
102
100
98
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
sample no.

Figure- B.2

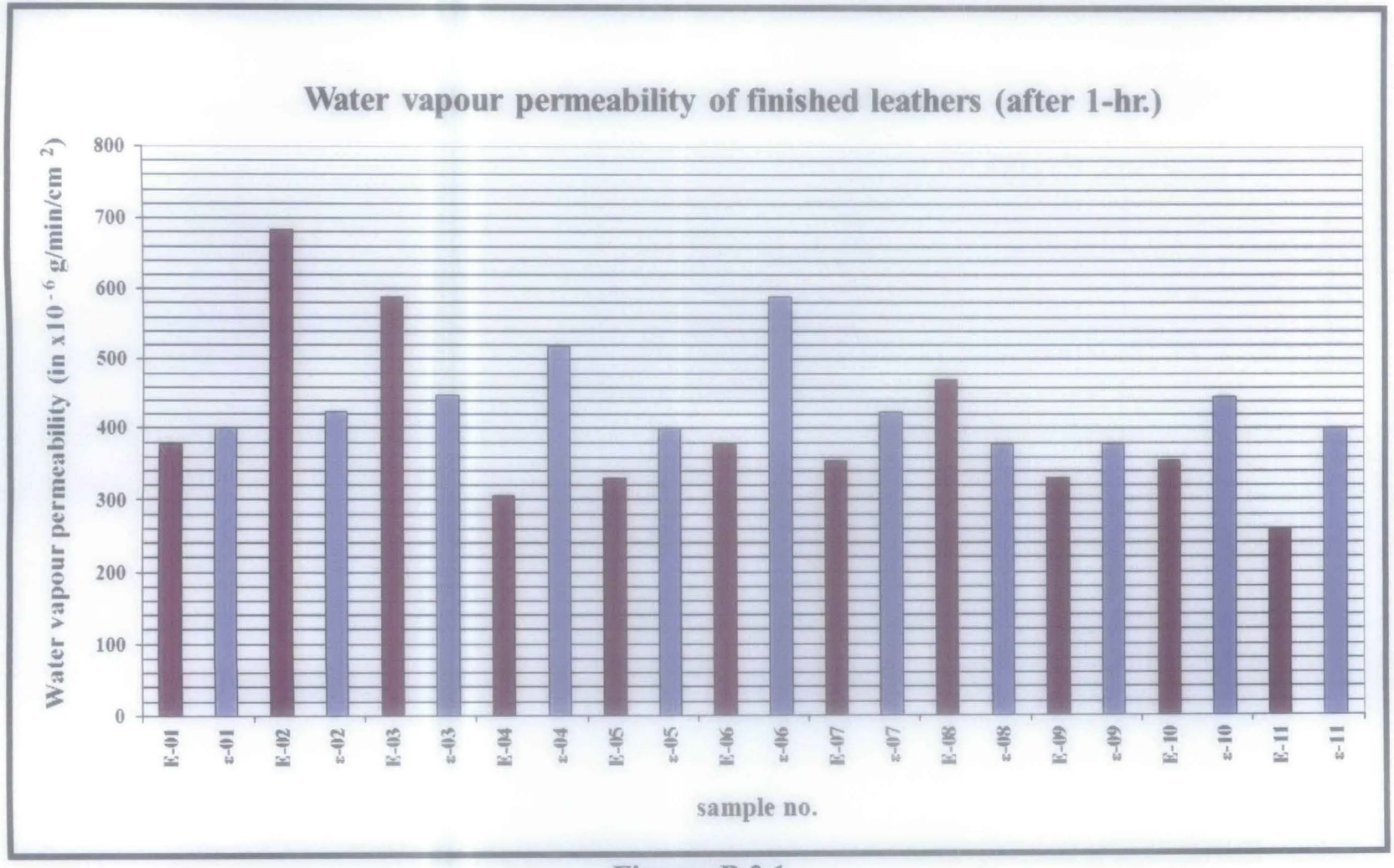
Water vapour permeability of finished leathers (after 1-hr.)
Water vapour permeability (in x10 -6 g/min/cm 2)
800
700
600
500
400
300
200
100
0
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
sample no.

Figure- B.3.1

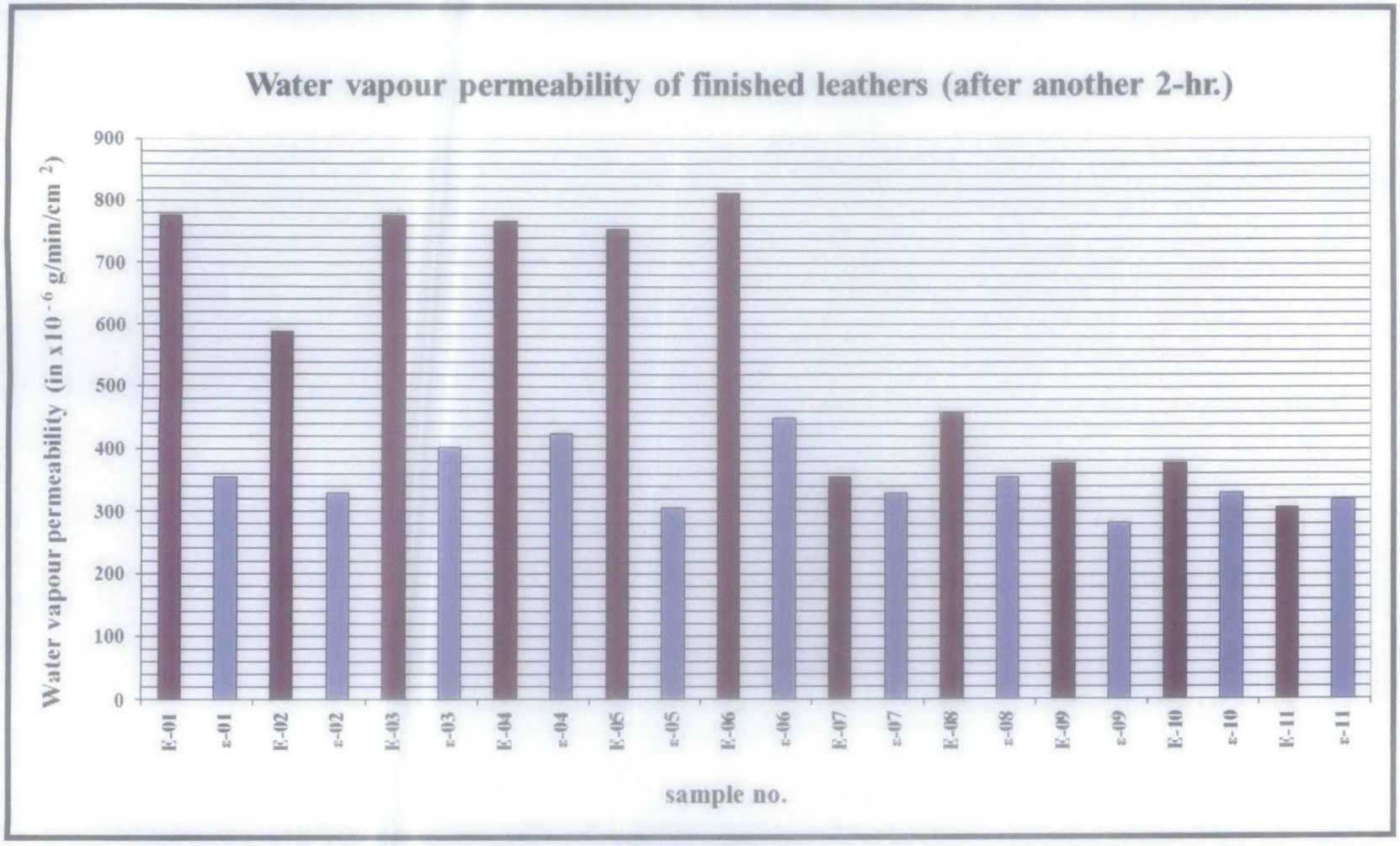
Water vapour permeability of finished leathers (after another 2-hr.)
Water vapour permeability (in x10 - 6 g/min/cm 2)
900
800
700
600
500
400
300
200
100
0
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
sample no.

Figure- B.3.2

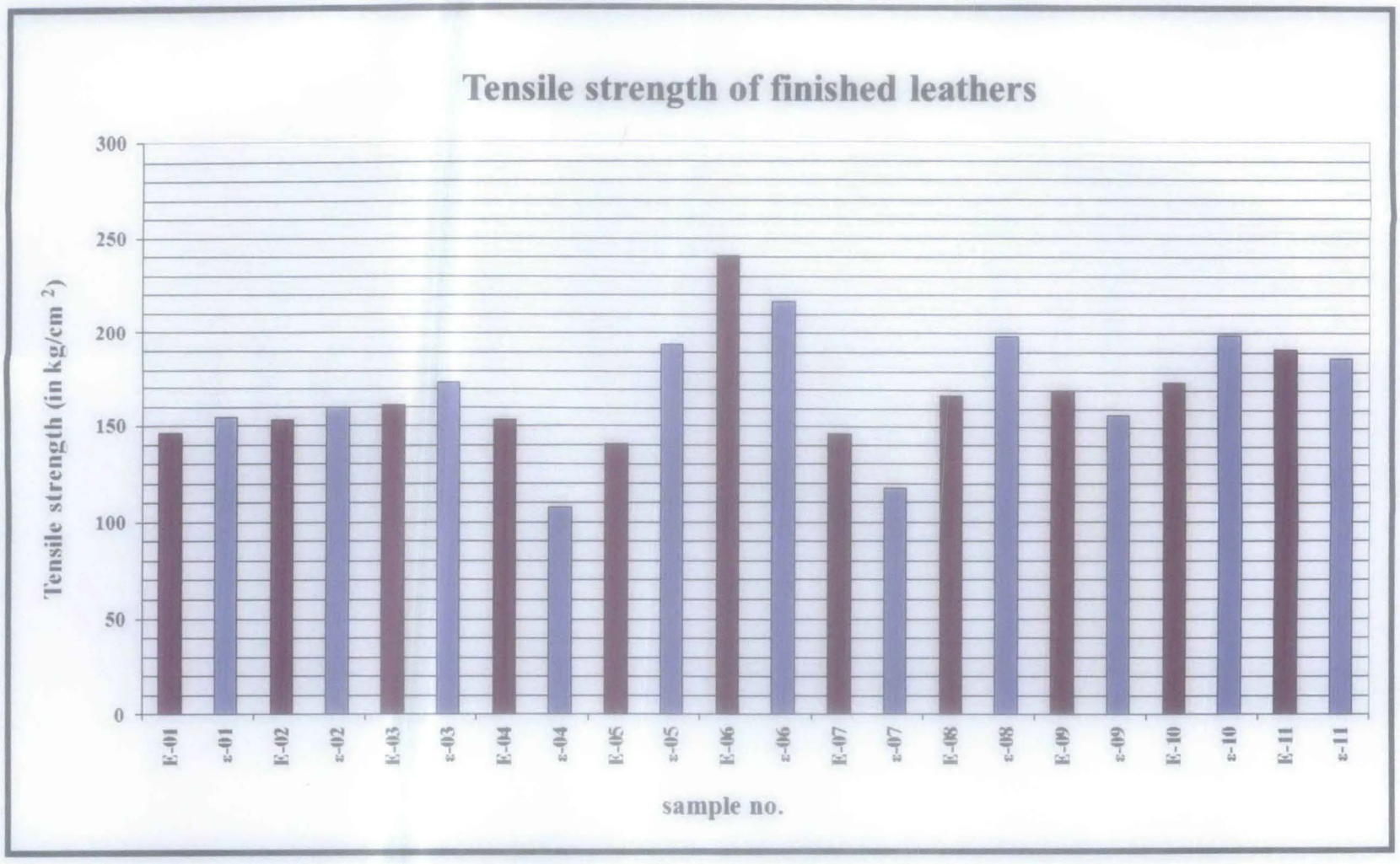
Tensile strength of finished leathers
Tensile strength (in kg/cm 2)
300
250
200
150
100
50
0
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
sample no.

Figure- B.4.1

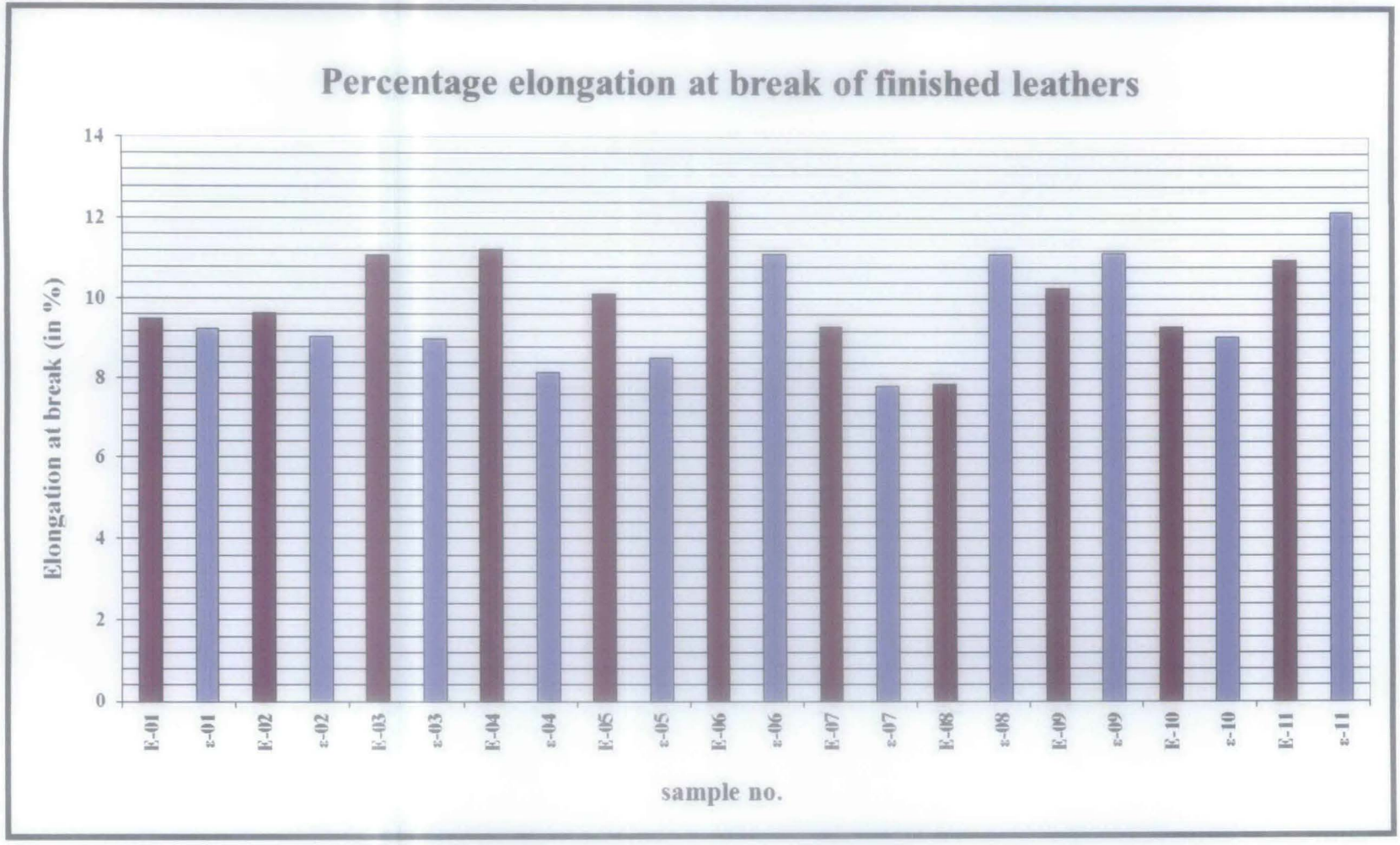
Percentage elongation at break of finished leathers
Elongation at break (in %)
14
12
10
8
6
4
2
0
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
sample no.

Figure- B.4.2

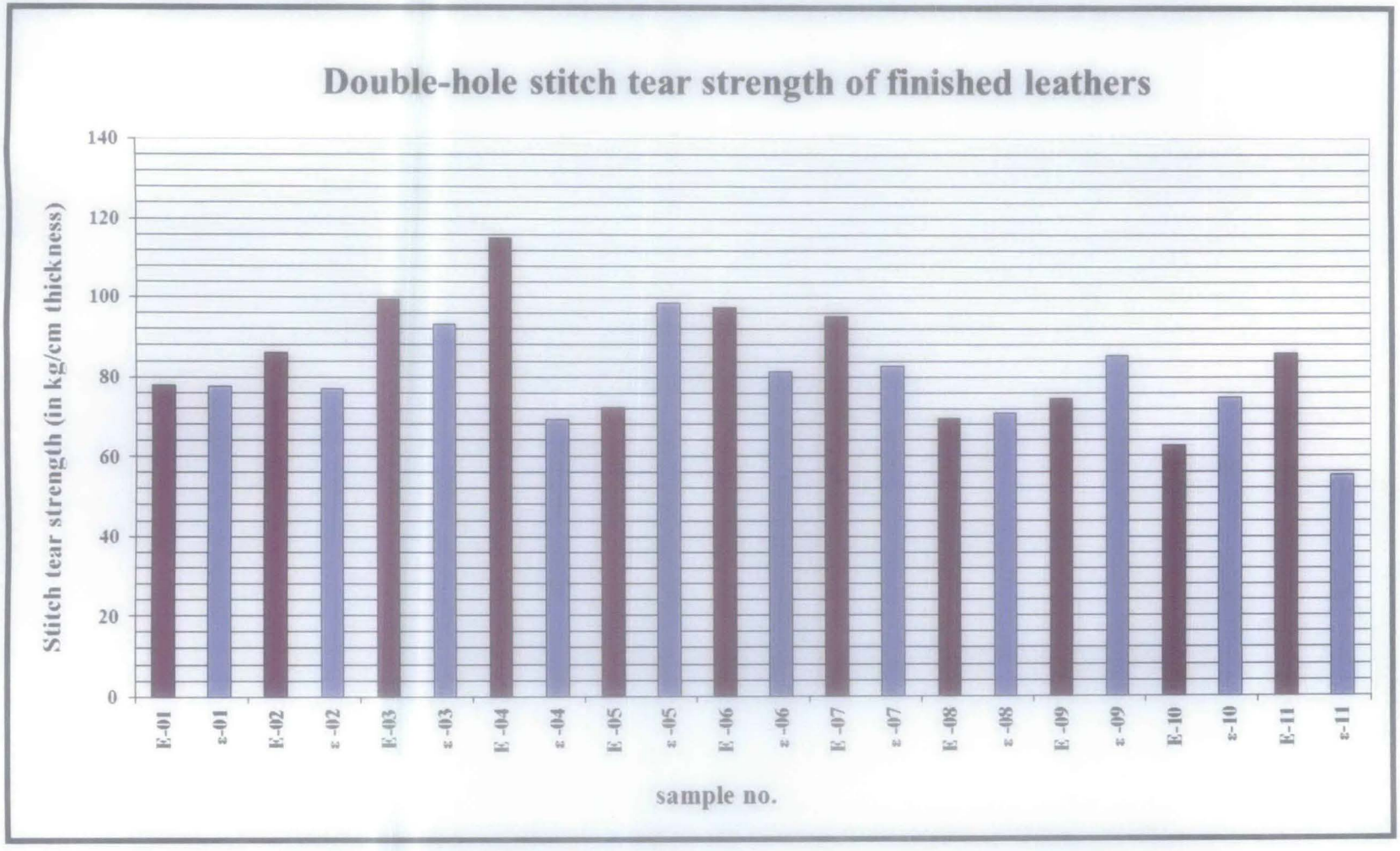
Double-hole stitch tear strength of finished leathers
Stitch tear strength (in kg/cm thickness)
140
120
100
80
60
40
20
0
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
sample no.

Figure- B.5

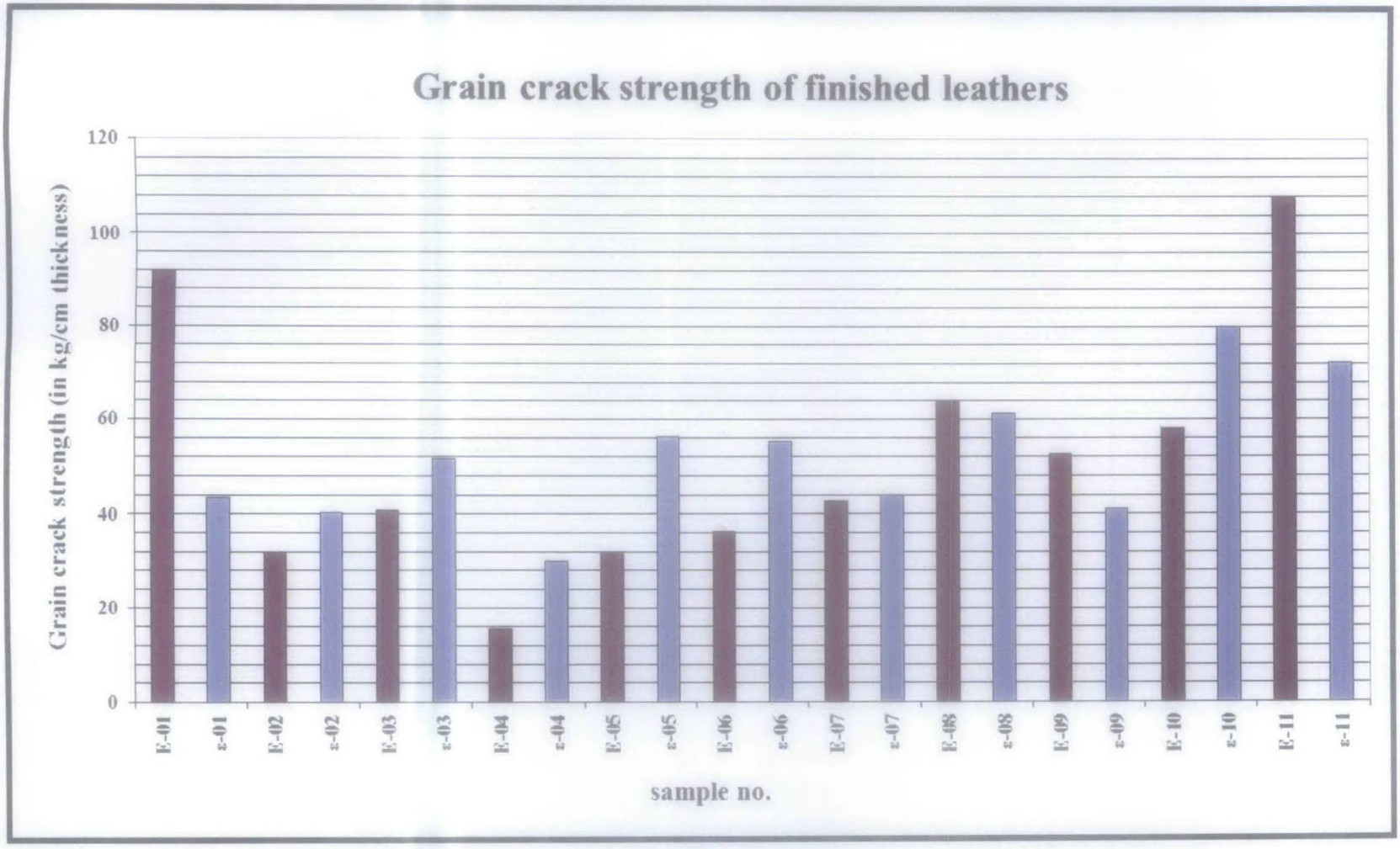
Grain crack strength of finished leathers
Grain crack strength (in kg/cm thickness)
120
100
80
60
40
20
0
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
sample no.

Figure- B.6.1

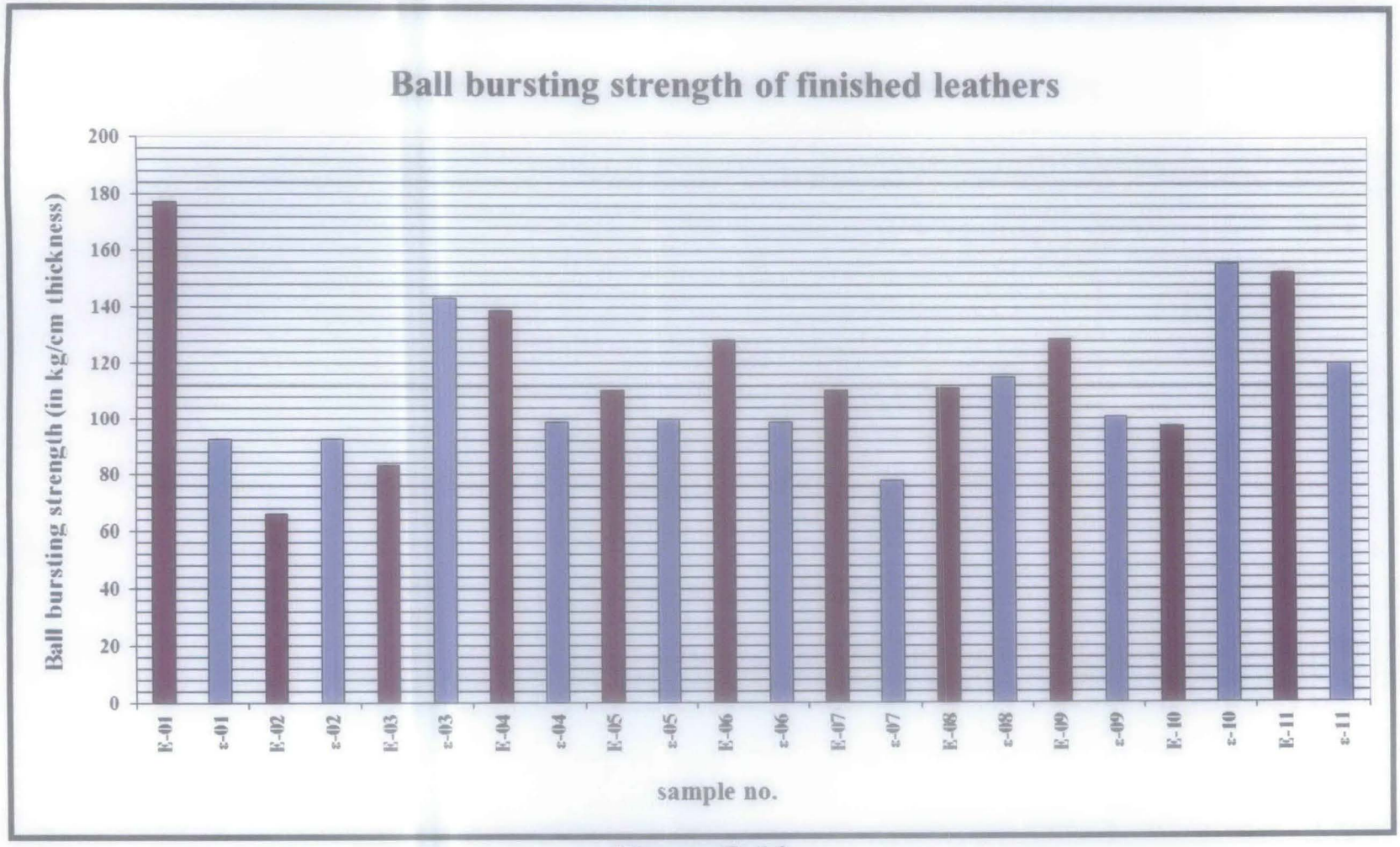
Ball bursting strength of finished leathers
Ball bursting strength (in kg/cm thickness)
200
180
160
140
120
100
80
60
40
20
0
E-01
ε-01
E-02
ε-02
E-03
ε-03
E-04
ε-04
E-05
ε-05
E-06
ε-06
E-07
ε-07
E-08
ε-08
E-09
ε-09
E-10
ε-10
E-11
ε-11
sample no.

Figure- B.6.2

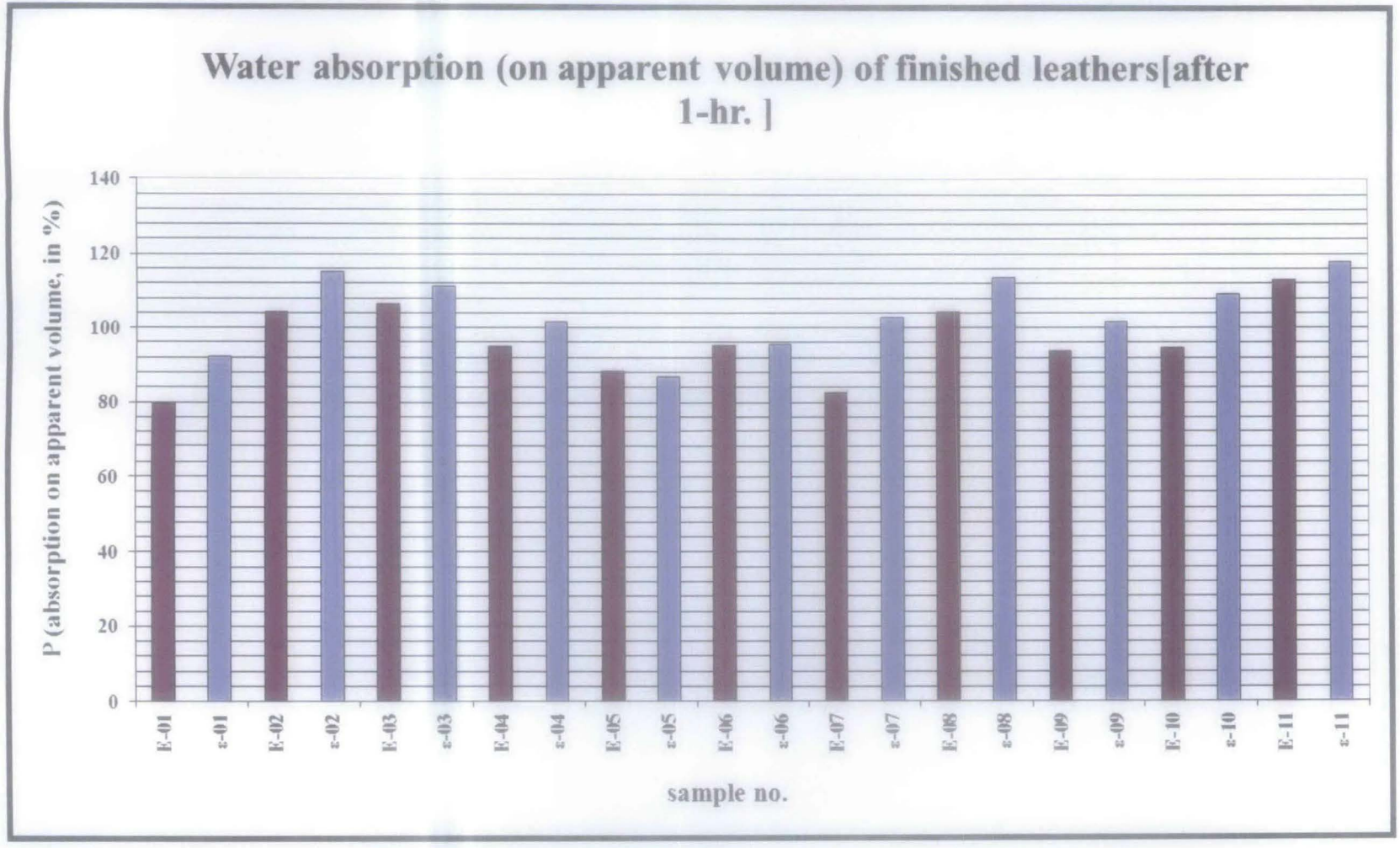
Water absorption (on apparent volume) of finished leathers[after 1-hr.]
P (absorption on apparent volume, in %)
140
120
100
80
60
40
20
0
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
sample no.

Figure- B.7.1

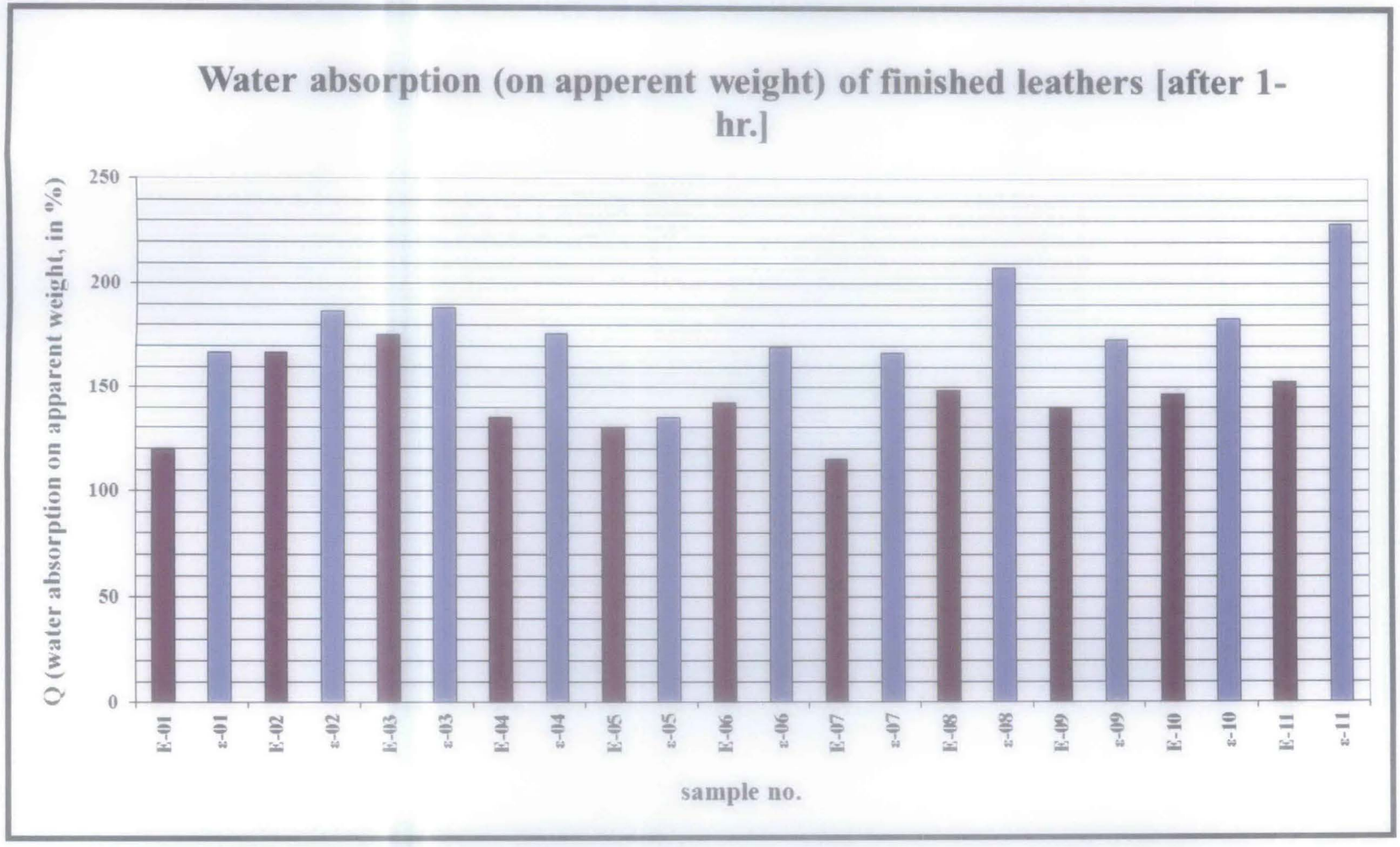
Water absorption (on apperent weight) of finished leathers [after 1-hr.]
Q (water absorption on apparent weight, in %)
250
200
150
100
50
0
E-01
ε-01
E-02
ε-02
E-03
ε-03
E-04
ε-04
E-05
ε-05
E-06
ε-06
E-07
ε-07
E-08
ε-08
E-09
ε-09
E-10
ε-10
E-11
ε-11
sample no.

Figure- B.7.2

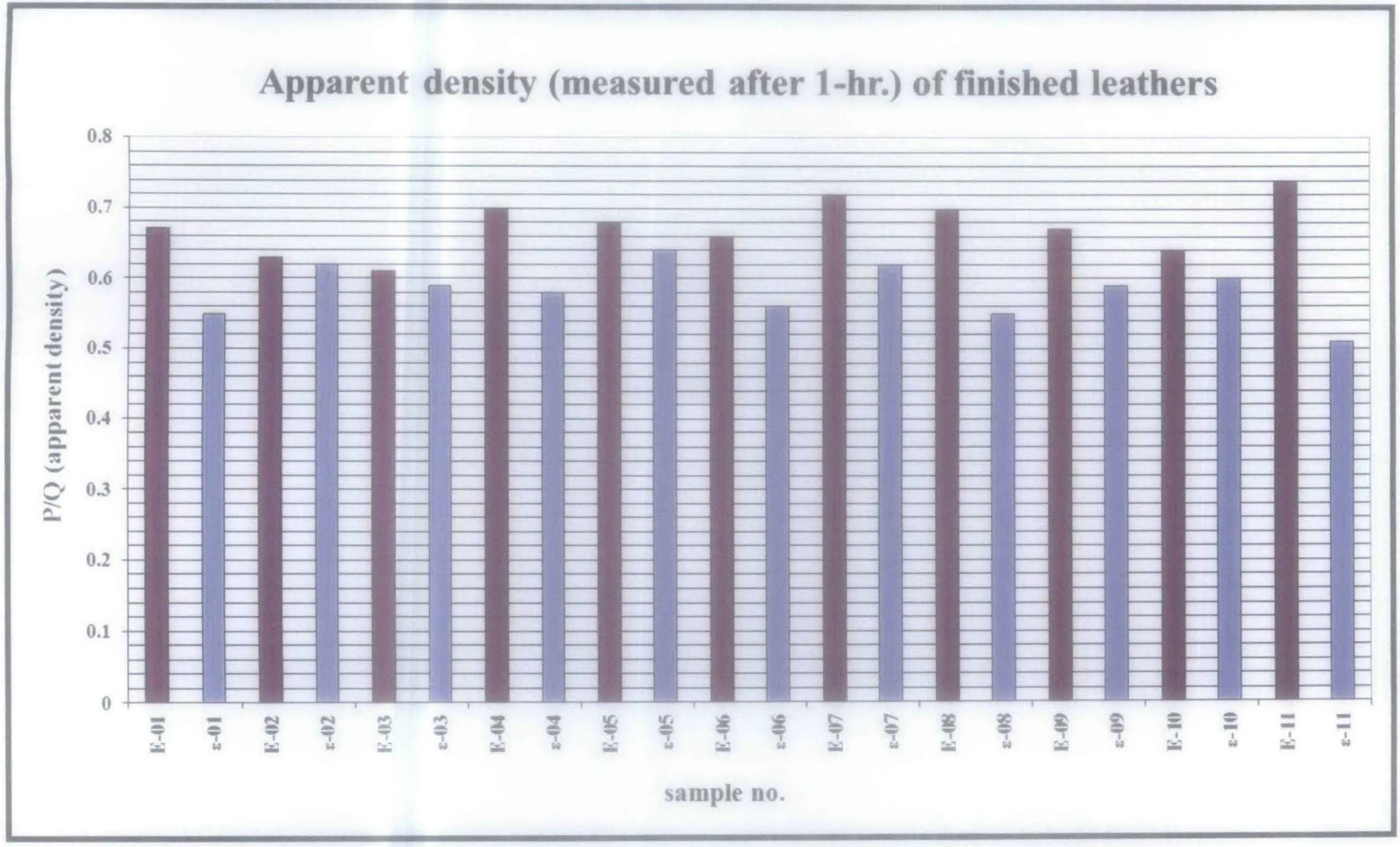
Apparent density (measured after 1-hr.) of finished leathers
P/Q (apparent density)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
sample no.

Figure- B.7.3

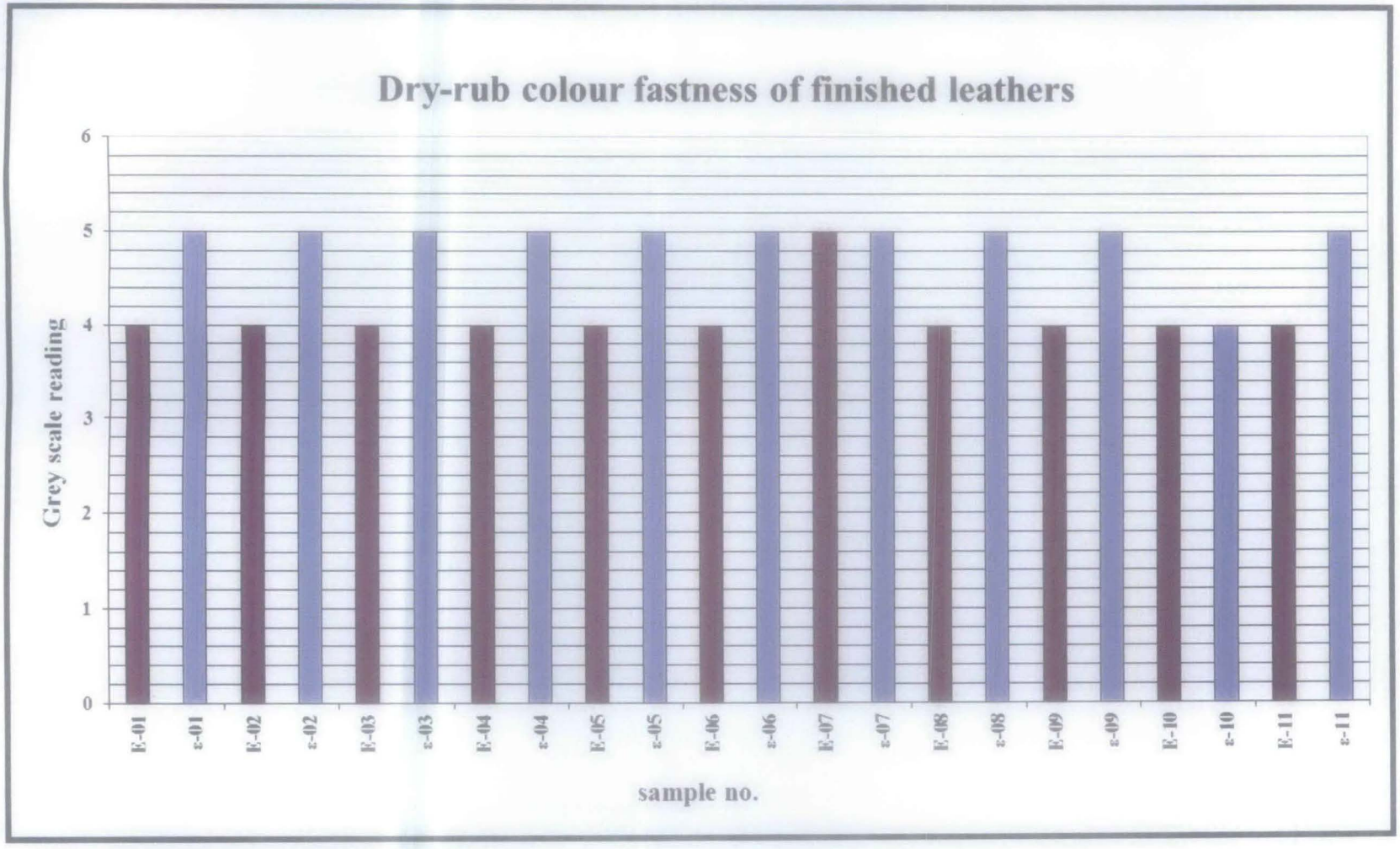
Dry-rub colour fastness of finished leathers
Grey scale reading
6
5
4
3
2
1
0
E-01
ε-01
E-02
ε-02
E-03
ε-03
E-04
ε-04
E-05
ε-05
E-06
ε-06
E-07
ε-07
E-08
ε-08
E-09
ε-09
E-10
ε-10
E-11
ε-11
sample no.

Figure- B.8.1

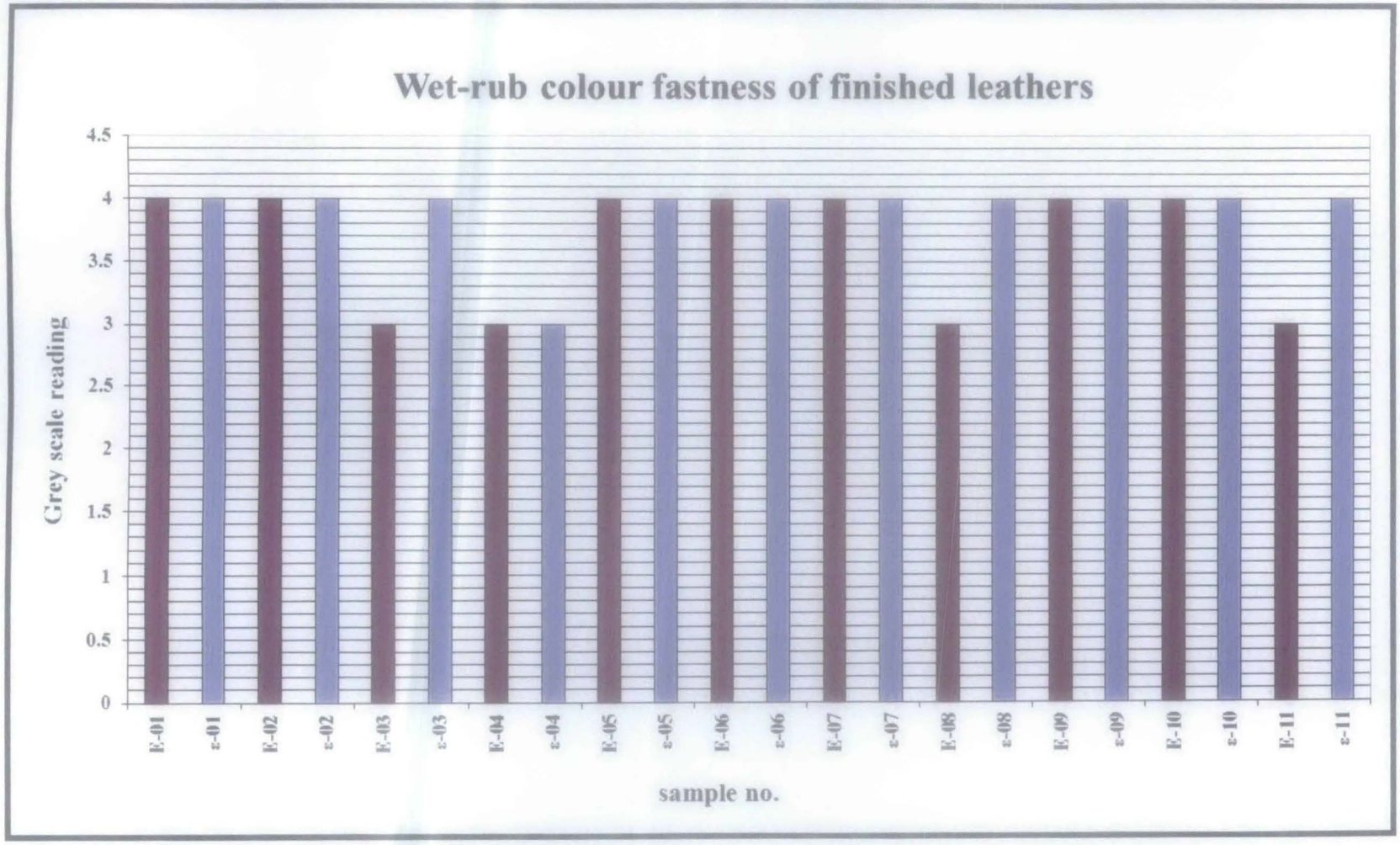
Wet-rub colour fastness of finished leathers
Grey scale reading
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
E-01
ε-01
E-02
ε-02
E-03
ε-03
E-04
ε-04
E-05
ε-05
E-06
ε-06
E-07
ε-07
E-08
ε-08
E-09
ε-09
E-10
ε-10
E-11
ε-11
sample no.

Figure- B.8.2

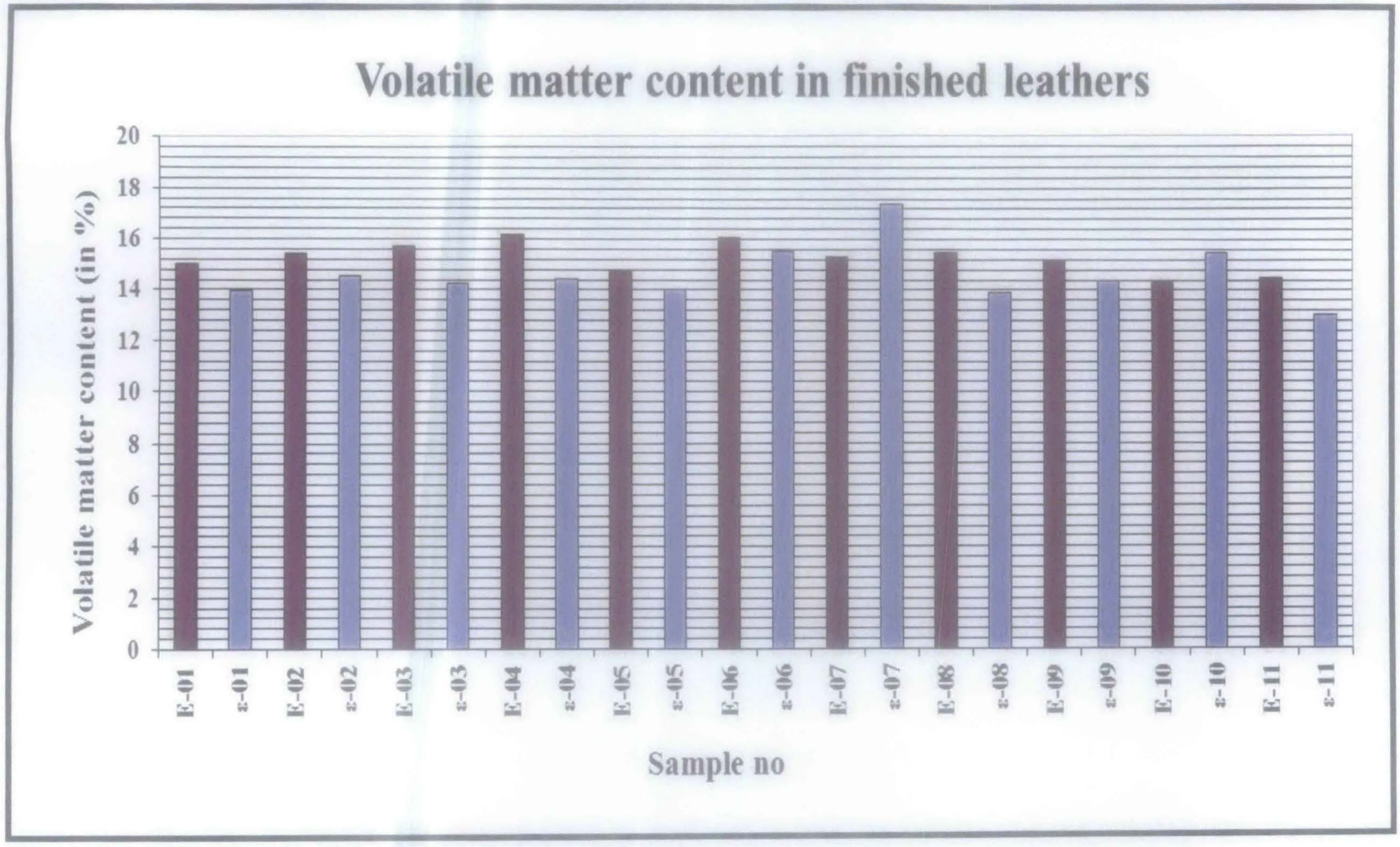
Volatile matter content in finished leathers
Volatile matter content (in %)
20
18
16
14
12
10
8
6
4
2
0
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
Sample no

Figure- B.9

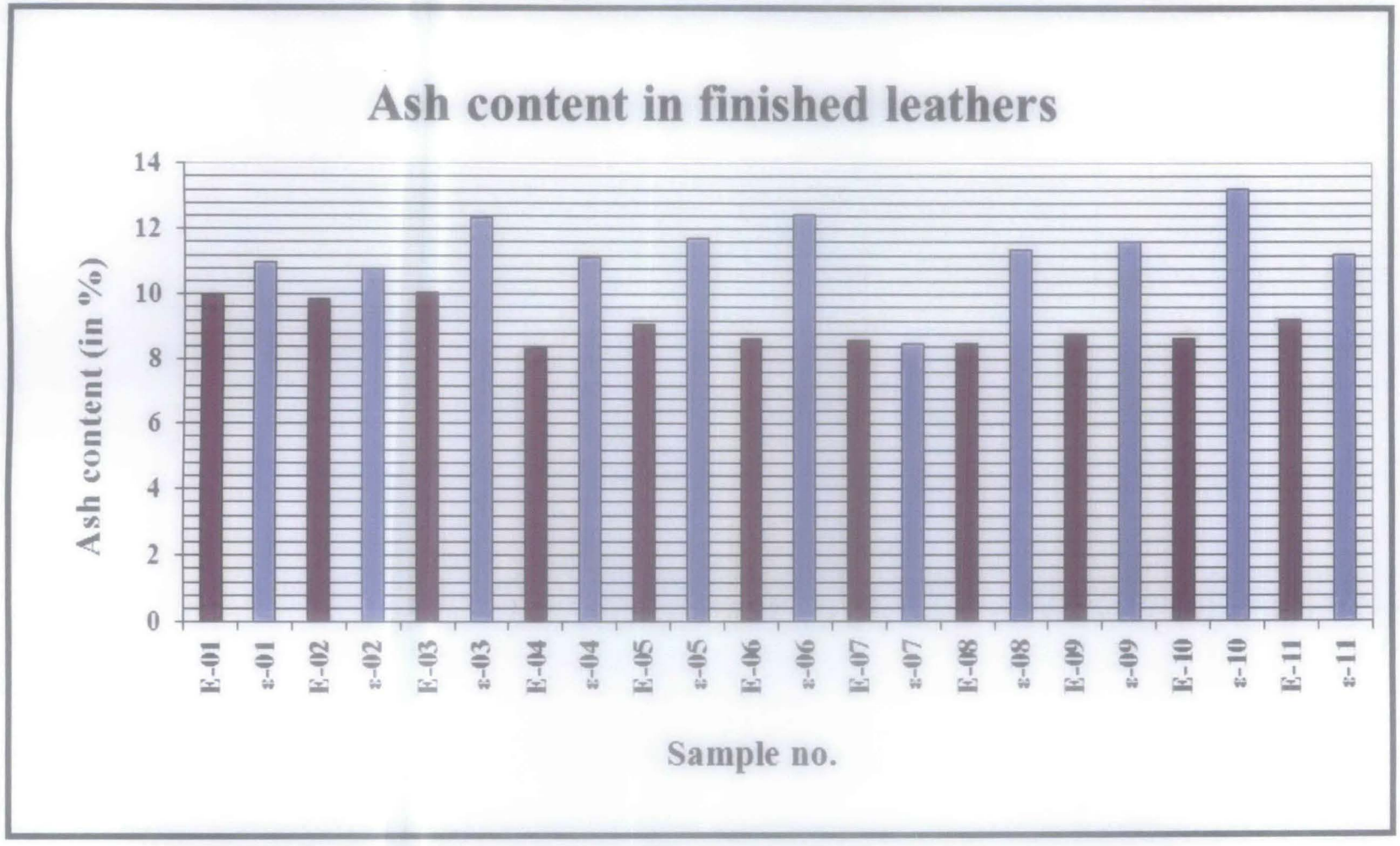
Ash content in finished leathers
Ash content (in %)
14
12
10
8
6
4
2
0
E-01
s-01
E-02
s-02
E-03
s-03
E-04
s-04
E-05
s-05
E-06
s-06
E-07
s-07
E-08
s-08
E-09
s-09
E-10
s-10
E-11
s-11
Sample no.

Figure- B.10

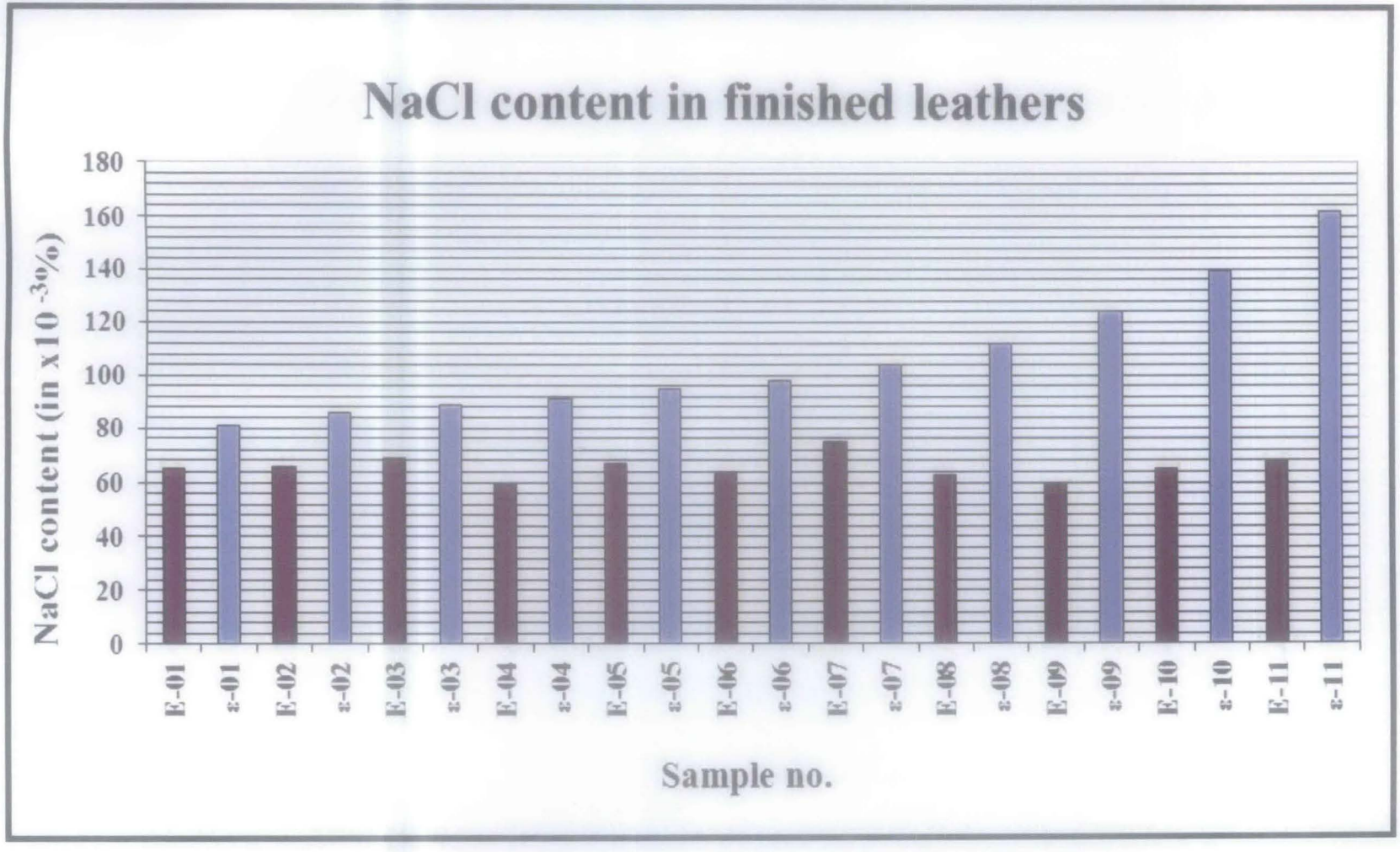
NaCl content in finished leathers
NaCl content (in x10 -3%)
180
160
140
120
100
80
60
40
20
0
E-01
ε-01
E-02
ε-02
E-03
ε-03
E-04
ε-04
E-05
ε-05
E-06
ε-06
E-07
ε-07
E-08
ε-08
E-09
ε-09
E-10
ε-10
E-11
ε-11
Sample no.

Figure- B.11

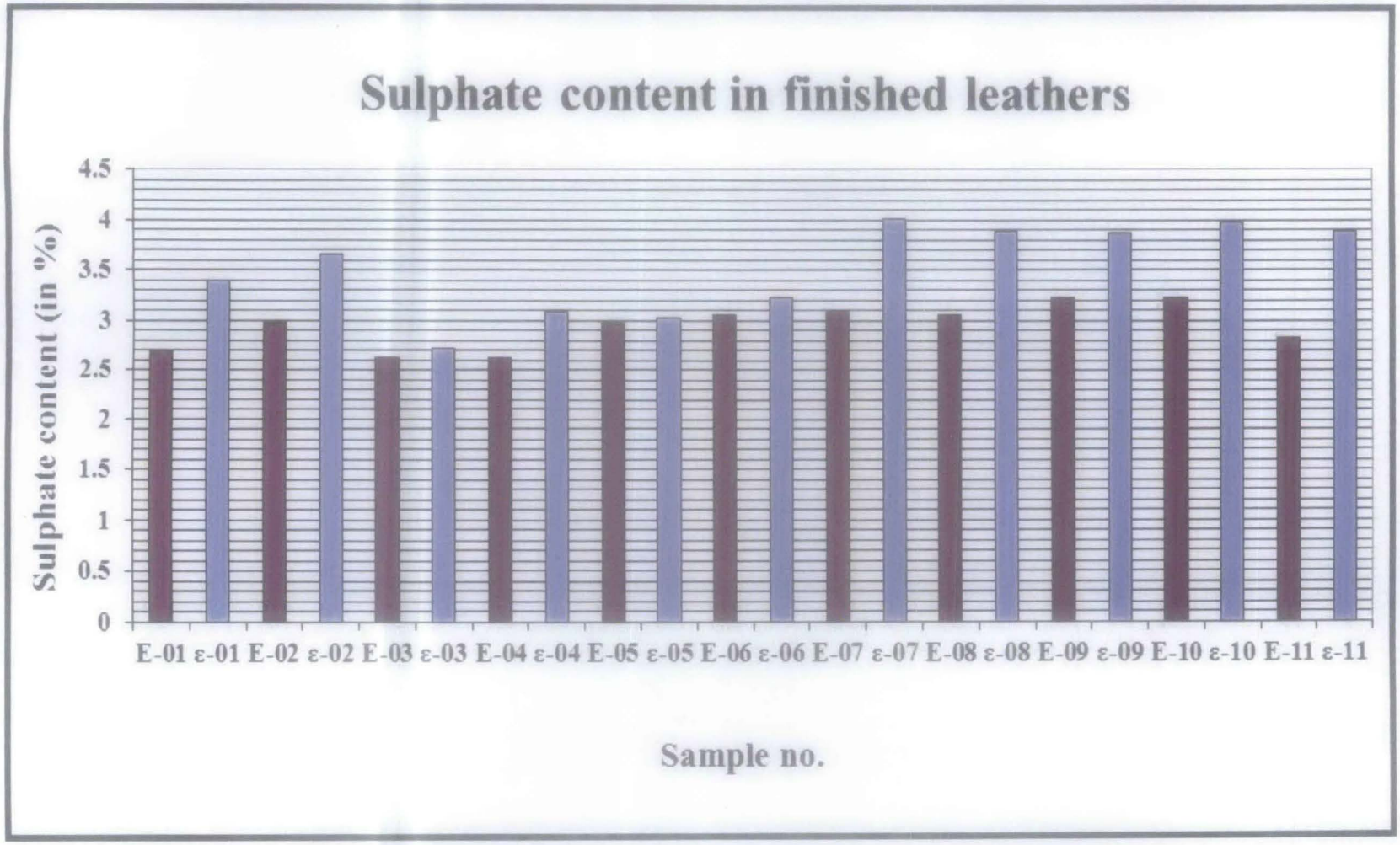
Sulphate content in finished leathers
Sulphate content (in %)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
E-01 ε-01 E-02 ε-02 E-03 ε-03 E-04 ε-04 E-05 ε-05 E-06 ε-06 E-07 ε-07 E-08 ε-08 E-09 ε-09 E-10 ε-10 E-11 ε-11
Sample no.

Figure- B.12

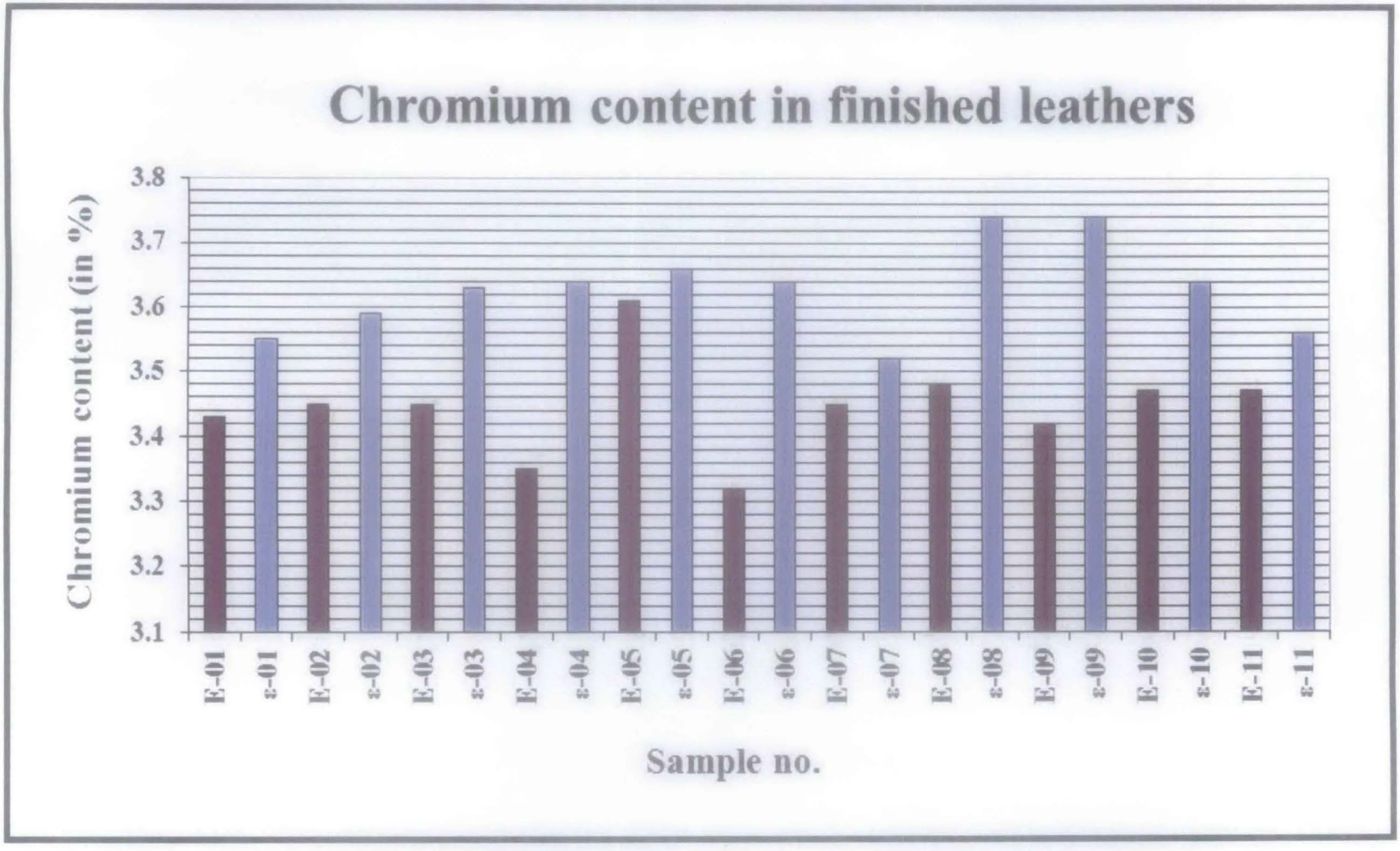
Chromium content in finished leathers
Chromium content (in %)
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
E-01
ε-01
E-02
ε-02
E-03
ε-03
E-04
ε-04
E-05
ε-05
E-06
ε-06
E-07
ε-07
E-08
ε-08
E-09
ε-09
E-10
ε-10
E-11
ε-11
Sample no.

Figure- B.13