



The Indian Refractories Scenario

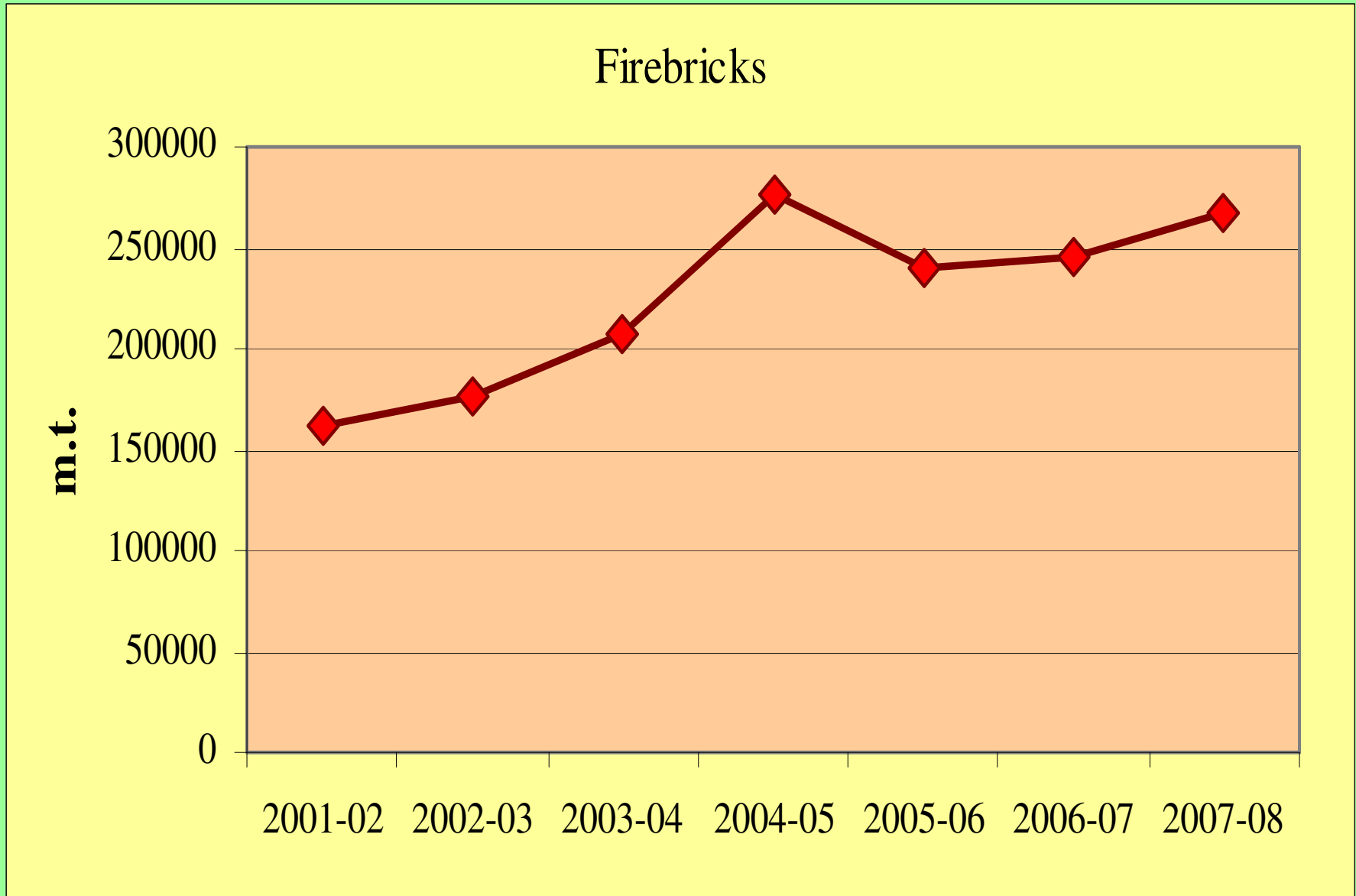


2009

About the IIRMA

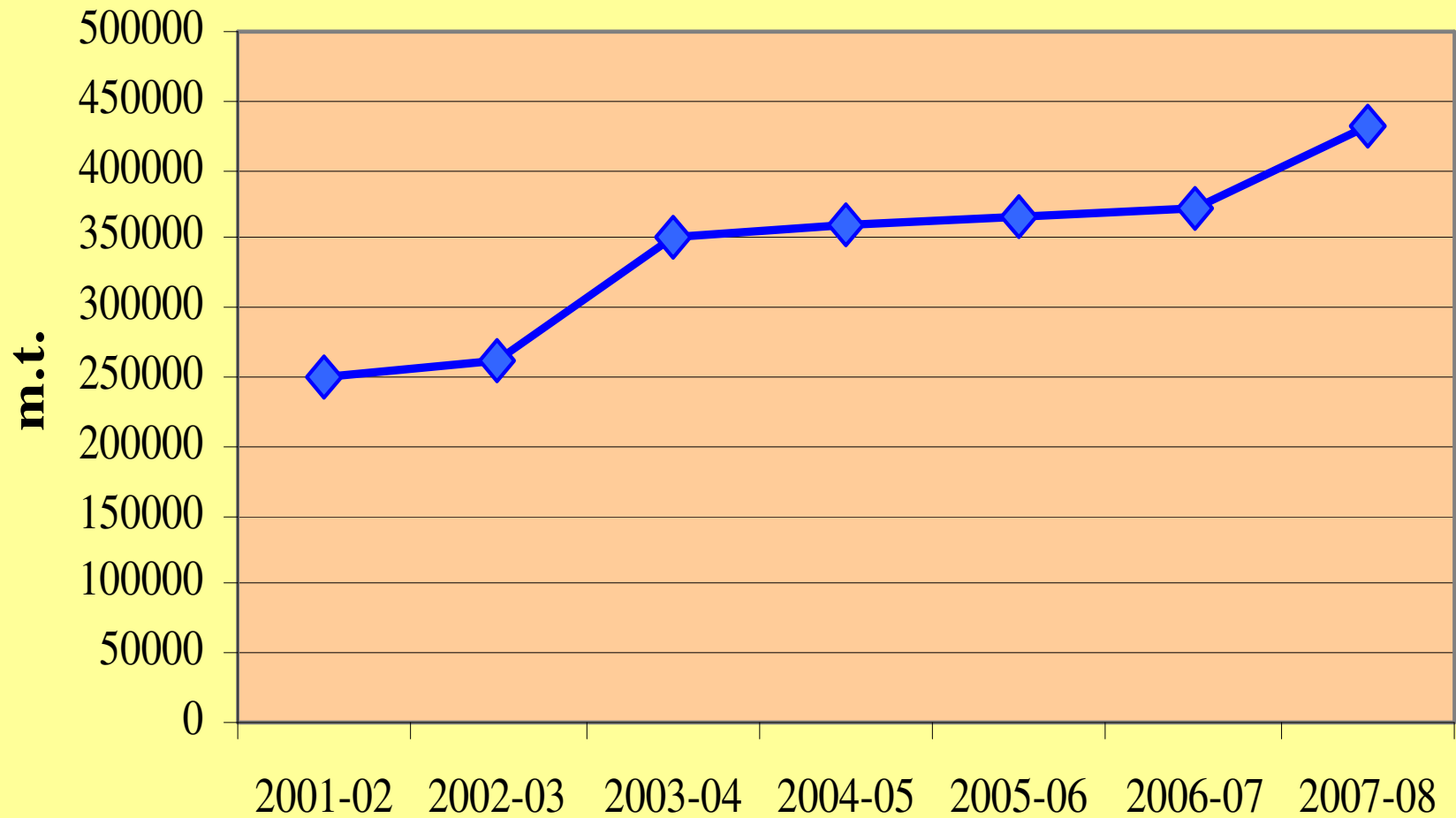
- **IIRMA** stands for the Indian Refractory Makers Association.
- **IIRMA** is the national organisation for the refractory manufacturing companies in India. It was set up in 1958.
- **IIRMA** has 70 member companies producing a wide range of refractories and 13 units as associate members.
- **IIRMA** provides a range of advisory and representational services to its members. It also extends information and data-bank services on refractories productions, specifications, raw materials, etc.

Refractories Production in India

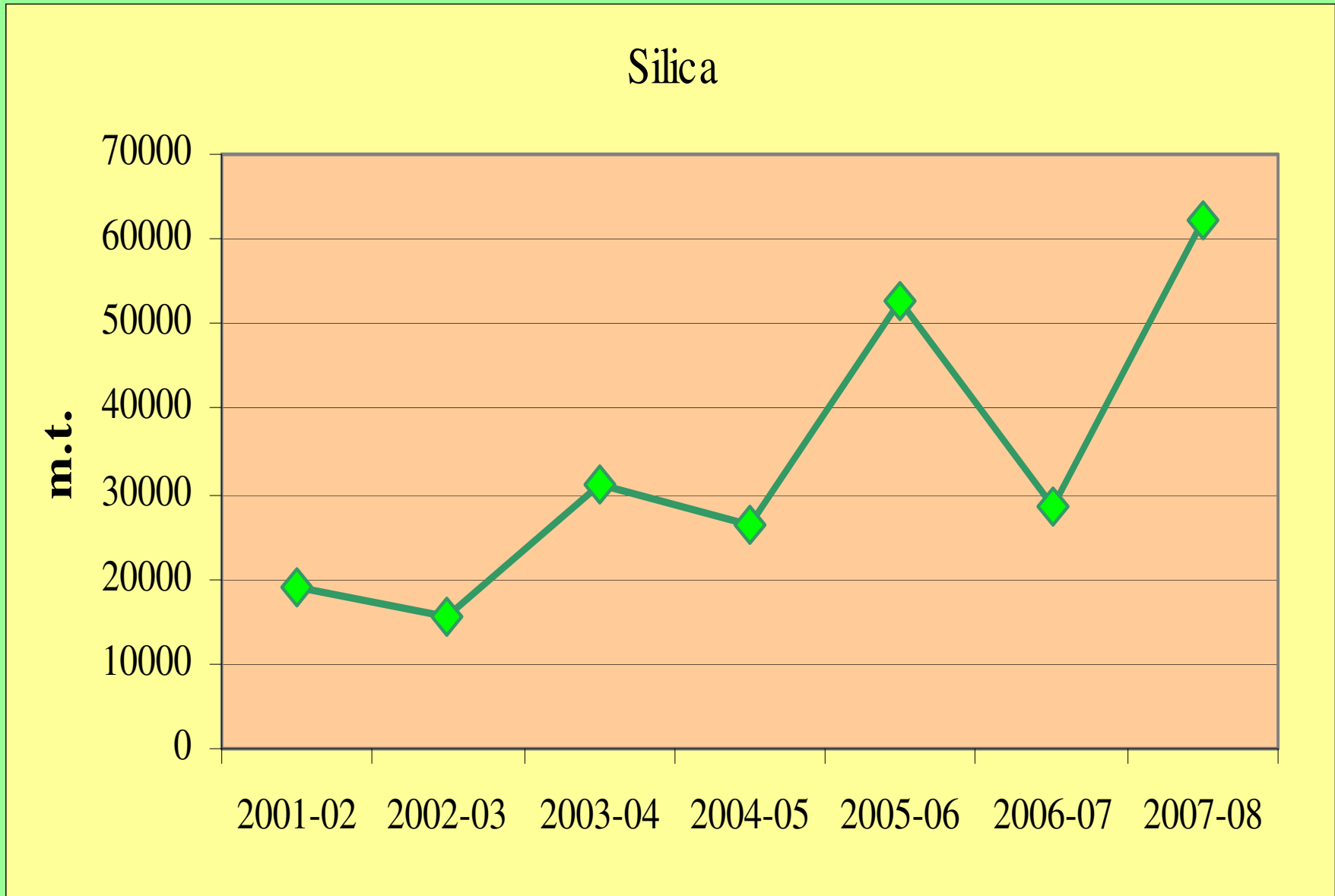


Refractories Production in India

High Alumina

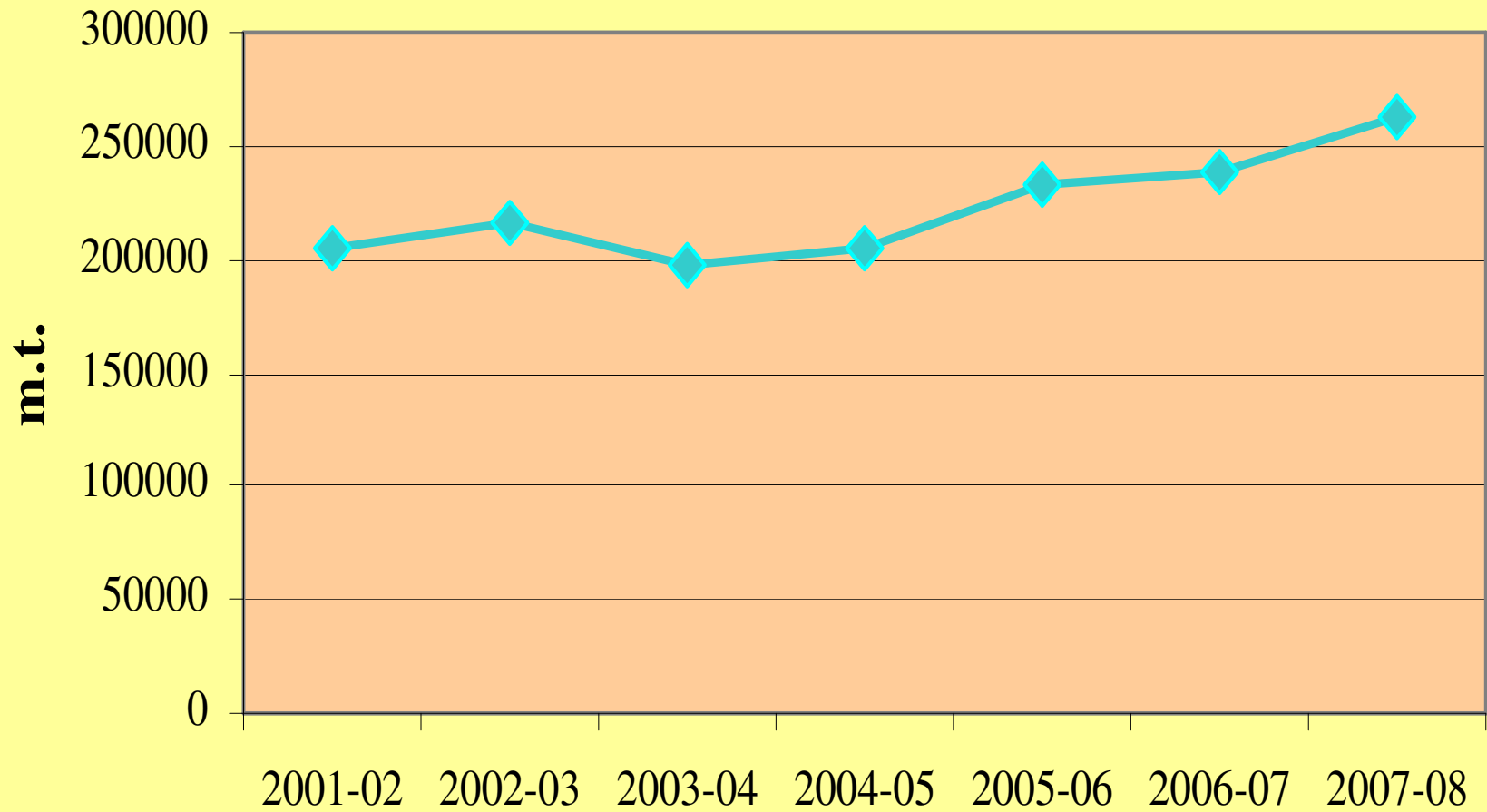


Refractories Production in India



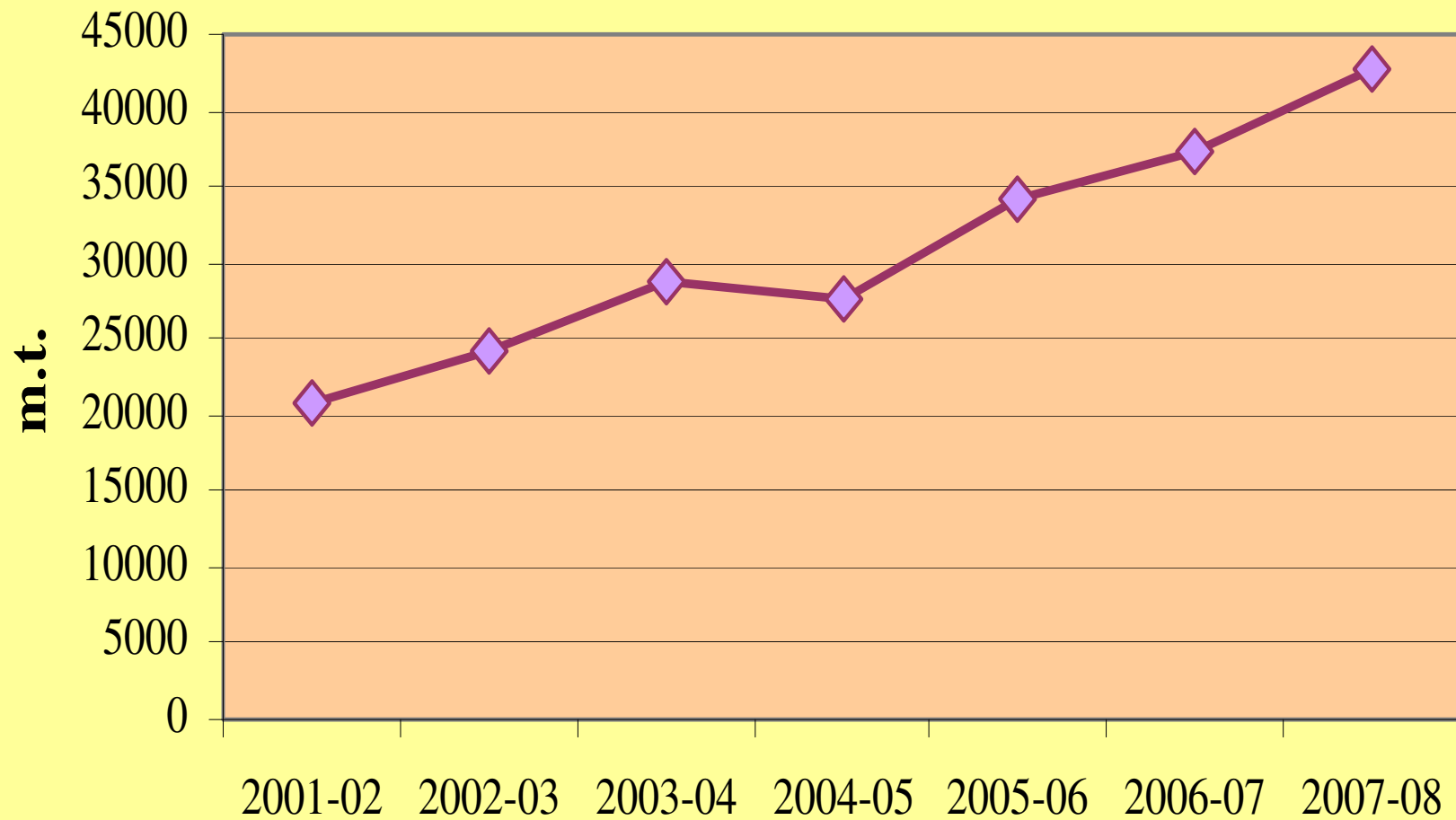
Refractories Production in India

Basic

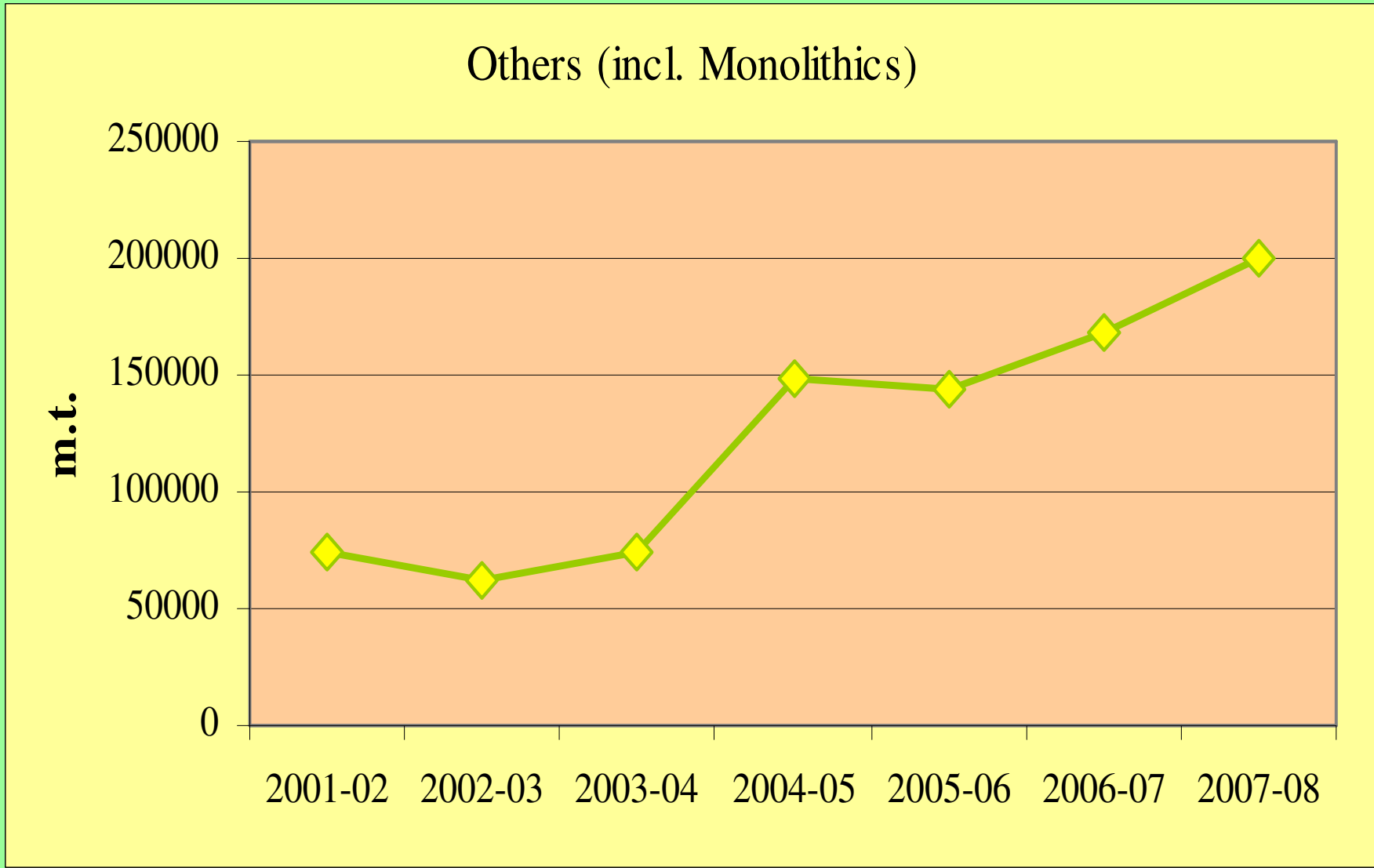


Refractories Production in India

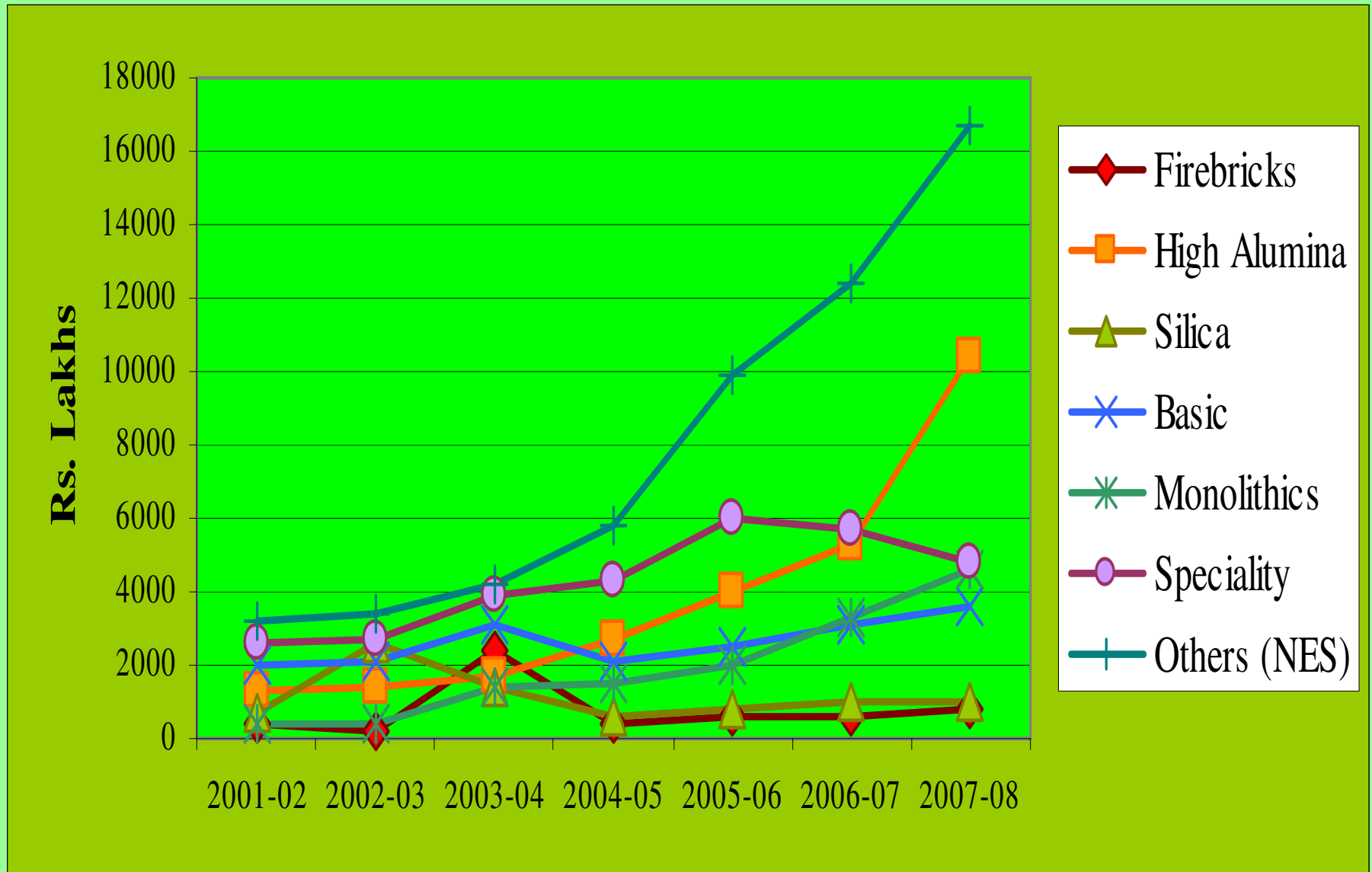
Speciality (incl. CC)



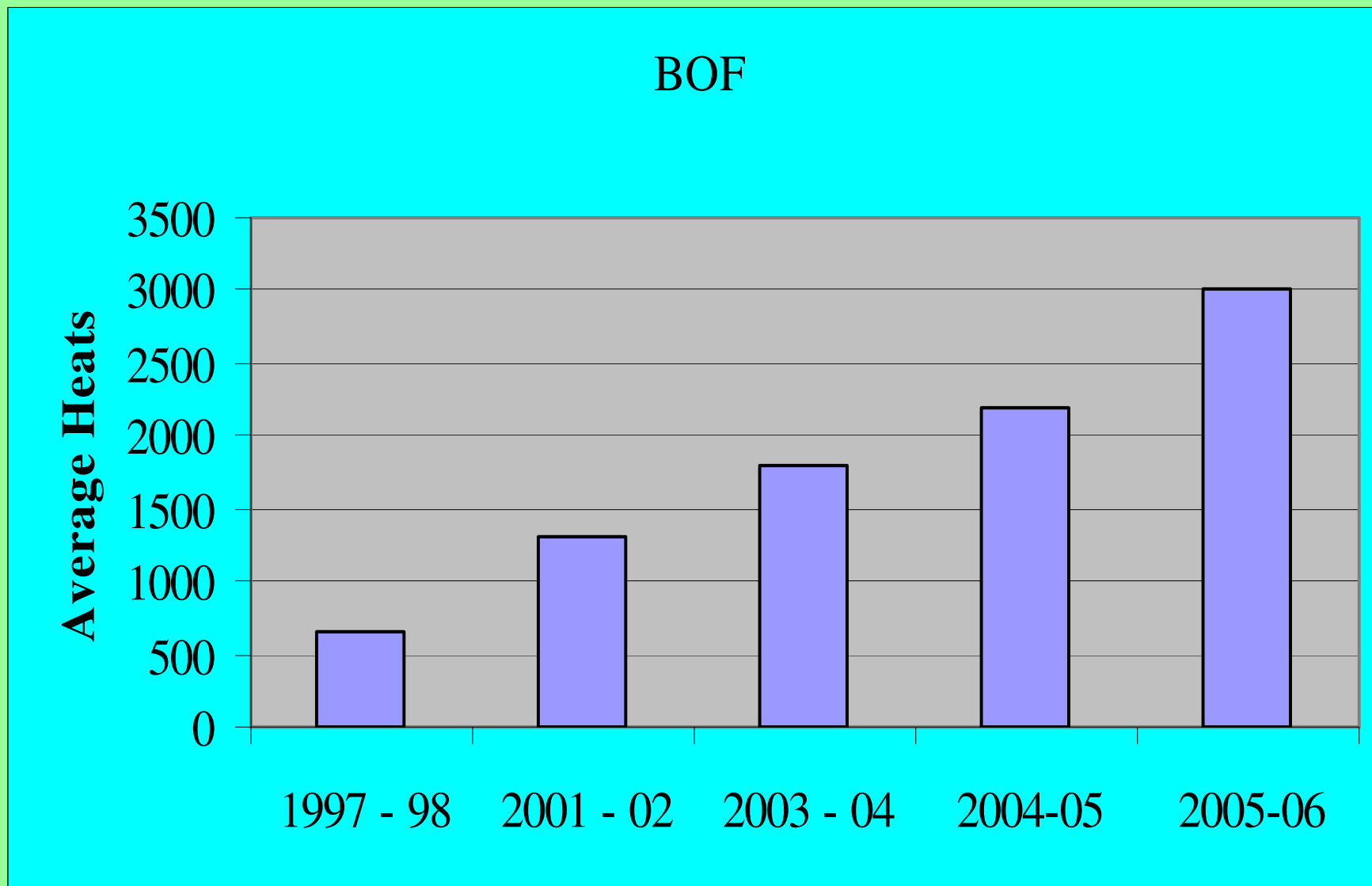
Refractories Production in India



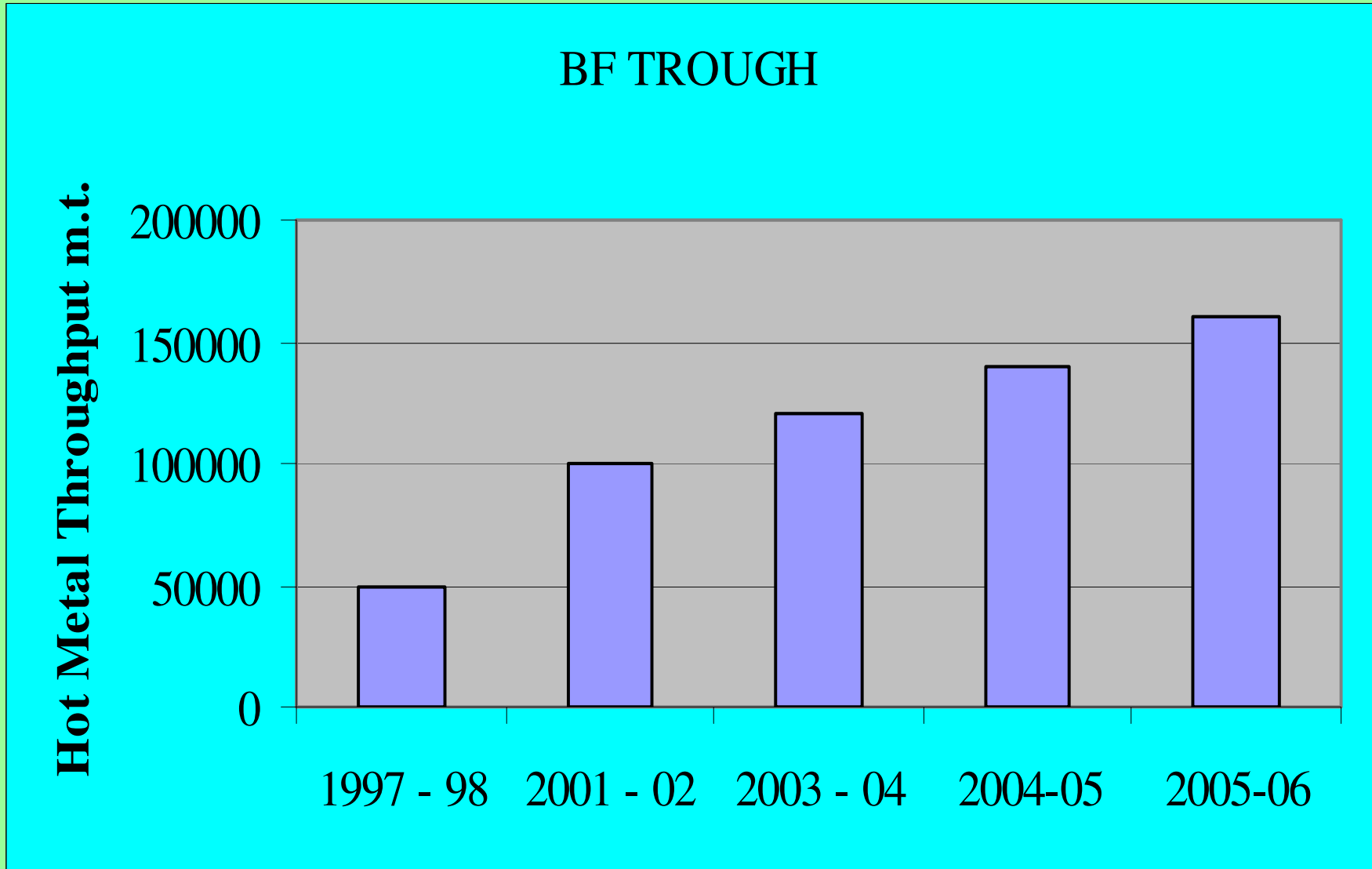
Refractories Export from India (category-wise)



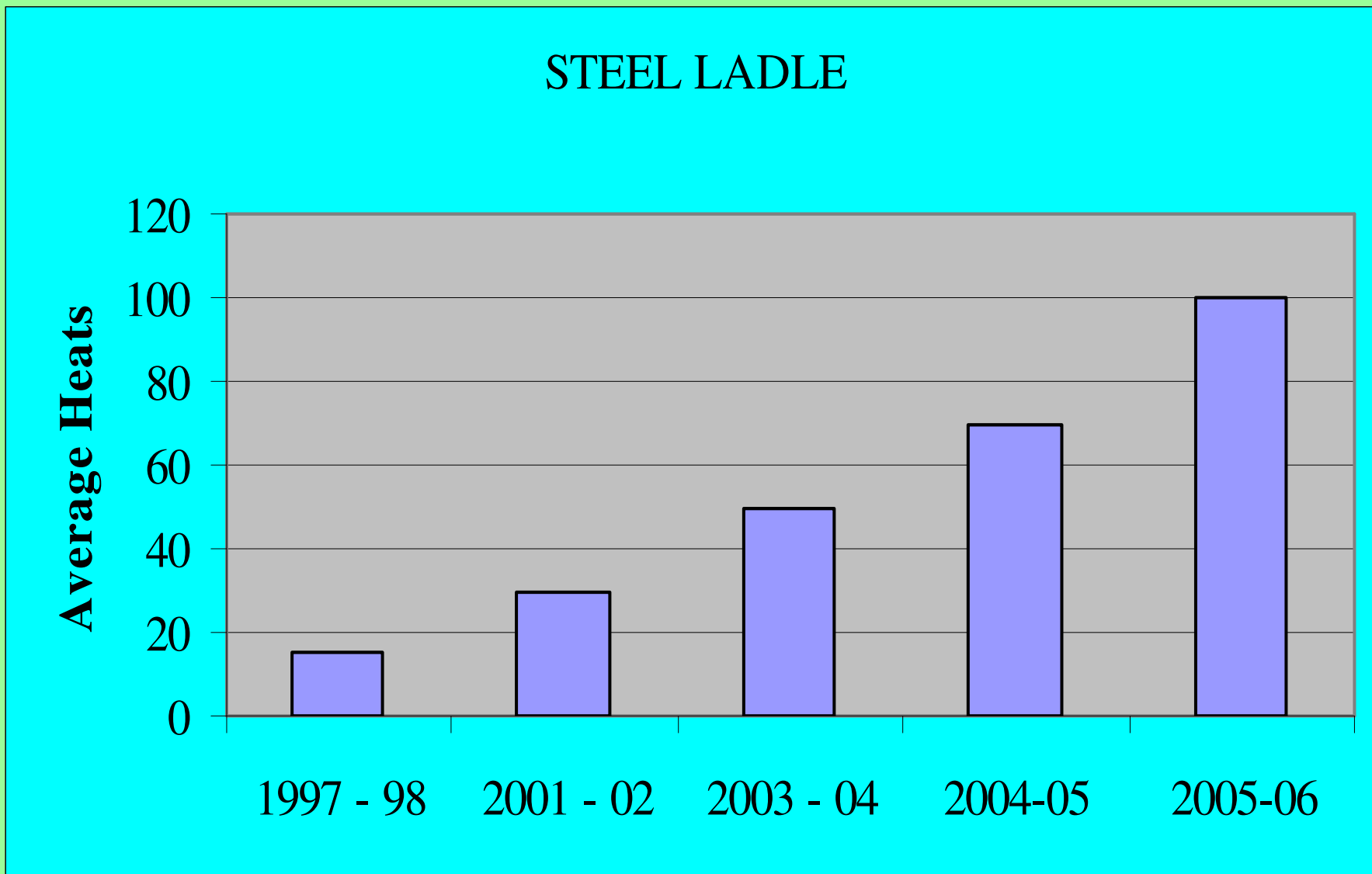
Improvements in Refractories Performance in India (BOF)



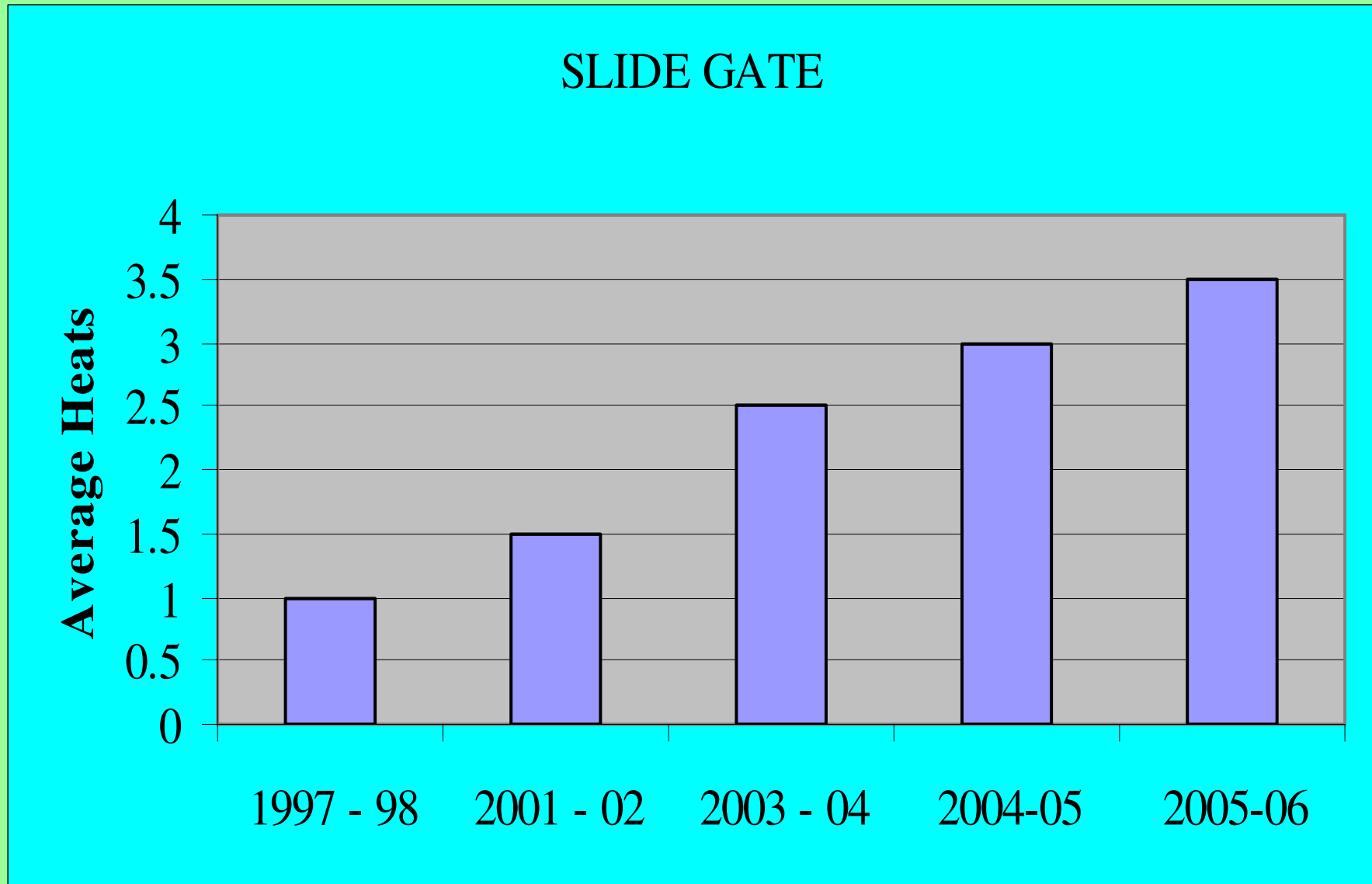
Improvements in Refractories Performance in India (BF Trough, with two repairs)



Improvements in Refractories Performance in India (Steel Ladle)



Improvements in Refractories Performance in India (Slide Gate)



Refractory Specifications

Blast Furnace Stack Lining	A	B	C	D
Al ₂ O ₃ %	39	42	54	42
B.D. (gm/cc)	2.2	2.25	N.A.	N.A.
A.P. %	19	16	23	12
CCS (kg/cm ²)	400	500	300	700
RUL (ta °C)	1450	1480	1480	1500
Refractoriness (°C)	1730	1760	1785	1750
PLC %	+/-0.5	+/-0.3	+/-0.5	+/-0.2
(at °C/2 hrs)	1450	1500	1500	1450

Refractory Specifications

Blast Furnace Bottom Lining	A	B	C
Al ₂ O ₃ %	62	63	62
A.P. %	15	15	15
CCS (kg/cm ²)	600	600	600
RUL (°C) 4kg/cm ²	1500	1500	1500
Refractoriness (°C)	1800	1800	1790
PLC % (at 1450°C/2 hrs)	+/-0.2	+/-0.2	+/-0.2

Refractory Specifications

Blast Furnace Tap hole	A	B
Al ₂ O ₃ %	72	70
SiC %	N.A.	13
A.P. %	17	14
CCS (kg/cm ²)	500	80
(at °C)	N.A.	400
RUL (°C) 4kg/cm ²	1650	N.A.
Refractoriness (°C)	1825	1650
PLC % (at 1500°C/2 hrs)	+/-0.5	N.A.

Refractory Specifications

Blast Furnace Trough	A	B	C	D
Al ₂ O ₃ %	70	70	70	71-73
SiC %	10-15	22	15	18-20
A.P. %	N.A.	13.7	N.A.	N.A.
B.D. (gm/cc)	2.8	3.1	2.9	2.8
(at °C/24 hrs)	110	1000	110	1500
CCS (kg/cm ²)	600	650	600	500
(at °C/3 hrs)	1400	1000	1450	1500
PLC %	+0.5	N.A.	+0.12	+0.8
(at °C/3 hrs)	1400	N.A.	1100	1500
MOR (kgcm ²) (110°C/24 hrs)	75	74	N.A.	N.A.
Refractoriness (°C)	N.A.	1650	1820	1700

Refractory Specifications

Blast Furnace Stove Checker	A	B	C	D	E
Al ₂ O ₃ %	70	62	62	63	0.7
SiO ₂ %	0	0	0	0	95
B.D. (gm/cc)	2.55	N.A.	N.A.	2.47	N.A.
A.P. %	18	24	24	20	21
CCS (kg/cm ²)	500	250	250	400	300
RUL (ta °C)	1700	1450	1500	N.A.	N.A.
Refractoriness (°C)	1800	1800	1690	N.A.	N.A.
PLC %	+/-0.2	+/-0.4	+/-0.4	+/-0.2	+/-0.2
(at 1500°C)	2 hrs	2 hrs	2 hrs	4 hrs	4 hrs
Creep (N/mm ² at 1500°C/ 20-50hrs)	N.A.	N.A.	0.2	0.2	N.A.
Spalling at 1300°C (cycles)	N.A.	N.A.	8	N.A.	N.A.

Refractory Specifications

Ceramic Burner Blocks	A	B
Al ₂ O ₃ %	53	64
Fe ₂ O ₃ %	1.7	1.5
B.D. (gm/cc)	2.35	2.5
A.P. %	20	22
CCS (kg/cm ²)	40	45
RUL (ta °C)	1350	1450
PLC % (at 1400 °C/2 hrs)	+/-0.1	+/-0.1
(at 1500 °C)/4 hrs		+0.2
MOR at room temp (Nmm ²)	15	15
Creep % (2kgcm ² /20-50 hrs)	0.2+0.03	0.2+0.03
(at °C)	1350	1500

Refractory Specifications

Coke Oven Silica	A	B
SiO ₂ %	95	94
Al ₂ O ₃ %	1	1.5
B.D. (gm/cc)	1.8	N.A.
A.P. %	19	17
CCS (kg/cm ²)	450	500
RUL (ta °C)	1670	1650
Refractoriness (°C)	1690	1700
PLC %	0.2	0.4
(at °C/2 hrs)	1500	1450
RTE % (at 1000°C)	1.3	N.A.

Refractory Specifications

Magnesite/MgCr bricks	A	B
MgO %	87	70
Cr ₂ O ₃ %	0	7-12
A.P. %	20	20
CCS (kg/cm ²)	400	350
RUL (ta °C)	1600	1580

Refractory Specifications

Mag Carbon/AMC bricks	A	B	C	D	E	F
MgO %	97	97	97	90	95	14
Al ₂ O ₃ %	0	0	0	0	0	75
FC %	5	18	12	8-10	10	6
A.P. %	6	5	6	4	6	6
B.D. (gm/cc)	3	2.85	2.9	2.92	2.9	2.8
CCS (kg/cm ²)	500	300	400	400	400	400
MOR at room temp kg/cm ²	150	100	N.A.	N.A.	N.A.	N.A.
MOR at 1400°C kg/cm ²	40	100	N.A.	90	40	N.A.

Refractory Specifications

Magnesite bricks for BOF/EAF	A	B	C	D
MgO %	87	91	85	40
Cr ₂ O ₃ %	0	0	0	18
A.P. %	18	18	22	24
CCS (kg/cm ²)	500	600	350	250
RUL (ta °C)	1600	1600	1550	1550
Refractoriness (°C)	N.A.	N.A.	1850	1850
PLC % (at 1600°C/2 hrs)	N.A.	N.A.	0.5	0.5

Refractory Specifications

Magnesite bricks for BOF/VAD/VOD Ladle	A	B
MgO %	96	60
Cr ₂ O ₃ %	0	15
A.P. %	17	22
CCS (kg/cm ²)	500	350
RUL (ta °C)	1700	1650

Refractory Specifications

Direct Bonded bricks for VOD/AOD	A	B	C
MgO %	60	66	65
Cr ₂ O ₃ %	15	13	15
A.P. %	18	18	21
CCS (kg/cm ²)	500	400	350
RUL (ta °C)	1740	1700	1650
Refractoriness (°C)	N.A.	N.A.	1920
PLC % (at 1600°C)	N.A.	N.A.	+0.5

Refractory Specifications

Steel Ladle	A	B	C
Al ₂ O ₃ %	70	70	70
Fe ₂ O ₃ %	3.5	3.5	2
B.D. (gm/cc)	2.5	N.A.	2.6
A.P. %	23	24	21
CCS (kg/cm ²)	400	400	600-700
RUL (ta °C)	N.A.	1470	N.A.
Refractoriness (°C)	1800	1800	1825
PLC %	+3.0	+/-3.0	+2.5
(at °C/2 hrs)	1500	1500	1600

Refractory Specifications

Slide Gate Refractories	A	B	C	D	E
Al ₂ O ₃ %	85-88	88	0	80	68
SiO ₂ %	10-12	0	0	0	0
ZrO ₂ %	0	0	0	5.5	0
MgO %	0	0	94-96	0	0
FC %	0	8	0	0	10
B.D. (gm/cc)	3	3	2.85	3	2.7
A.P. %	19	6	19	16	12
CCS (kg/cm ²) (at 110°C/24 hrs)	1000	N.A.	900	900	800
MOR (kg/cm ²)	100	175	100	95	N.A.
(at °C)	1500	1400	1500	1500	N.A.
PLC % (at 1600°C)	N.A.	N.A.	N.A.	+/-0.5	N.A.

Refractory Specifications

Electric Arc Furnace	A	B	C	D	E
Al ₂ O ₃ %	60	60	70	0.5	0
MgO %	0	0	0	91	97
FC %	0	0	0	0	12
B.D. (gm/cc)	2.4	N.A.	2.6	N.A.	2.9
A.P. %	23	24	23	20	5
CCS (kg/cm ²)	300	300	400	600	400
RUL (ta °C)	N.A.	1450	N.A.	1600	N.A.
Refractoriness (°C)	1780	1750	1790	1920	N.A.
PLC %	+/-3.0	+/-3.0	+/-3.0	+/-0.5	N.A.
(at °C/2 hrs)	1500	1500	1600	1600	N.A.
MOR (at 1400°C) (kg/cm ²)	N.A.	N.A.	N.A.	N.A.	30

Refractory Specifications

Continuous Casting Refractories	A	B	C	D
Al ₂ O ₃ %	45	78	85	0
FC %	35	17	3	0
ZrO ₂ %	0	0	0	95
B.D. (gm/cc)	2.4	2.72	3.1	4.8
A.P. %	12.7	11.9	6	10
CCS (kg/cm ²)	205	285	800	1000
MOR (at 1400°C) (kg/cm ²)	N.A.	N.A.	N.A.	N.A.
Thermal expansion (at 1000°C)	N.A.	N.A.	N.A.	N.A.

Refractory Specifications

Continuous Casting Refractories	E	F	G	H
Al ₂ O ₃ %	50	60	67	0
FC %	20	10	27	20
ZrO ₂ %	0	0	0	70
B.D. (gm/cc)	2.39	2.4	2.54	3.4
A.P. %	24	24	16	14
CCS (kg/cm ²)	N.A.	N.A.	250	260
MOR (at 1400°C) (kg/cm ²)	40	40	85	70
Thermal expansion (at 1000°C)	N.A.	N.A.	0.38	0.38

Refractory Specifications

Re-heating Furnace	A	B	C
Al ₂ O ₃ %	88	88	70
B.D. (gm/cc)	3	N.A.	2.65
A.P. %	18	16	N.A.
CCS (kg/cm ²)	900	900	1000
(at °C)	N.A.	N.A.	1550
RUL (ta °C)	1500	1650	N.A.
Refractoriness (°C)	1800	1800	1800
PLC %	0.5	+/-0.3	+/-1
(at °C/2 hrs)	1500	1500	1550

Refractory Specifications

Induction Furnace	A	B	C
SiO ₂ %	94	0	98
MgO %	0	70	0
Cr ₂ O ₃ %	0	8	0
A.P. %	25	N.A.	N.A.
CCS (kg/cm ²)	250	N.A.	N.A.
RUL (ta °C)	1670	N.A.	N.A.
Refractoriness (°C)	1700	1750	1690
PLC % (at 1450°C/2 hrs)	+1.0	N.A.	N.A.

Refractory Specifications

Pouring Refractories	A	B	C
Al ₂ O ₃ %	40	39	85
ZrO ₂ %	0	0	10
B.D. (gm/cc)	2	N.A.	2.7
A.P. %	24	18	N.A.
CCS (kg/cm ²)	N.A.	400	700
RUL (ta °C)	N.A.	1400	N.A.
Refractoriness (°C)	1730	1730	1750
PLC % (at 1500°C/2 hrs)	+/-0.5	+/-0.5	N.A.
MOR (at 1350°C) (kg/cm ²)	N.A.	N.A.	30

Refractory Specifications

Gas Purging Refractories	A	B	C	D
Al ₂ O ₃ %	85	0	90	96
MgO %	0	85	6	0
A.P. %	27-35	25-30	15	27
B.D. (gm/cc)	N.A.	N.A.	2.95	2.9
CCS (kg/cm ²)	400	200	550	600
Gas permeability (npm)	300	300	N.A.	N.A.
PLC % (at 1600°C/5 hrs)	N.A.	N.A.	N.A.	+/-0.3

Refractory Specifications

Low Cement Castables	A	B	C
Al ₂ O ₃ %	70	90	80
SiC %	0	0	0
Max service Temp. (°C)	1650	1800	N.A.
Grading (mm)	0-5	0-5	N.A.
B.D. (gm/cc)	2.8	2.9	2.93
PLC %	+/-0.5	+/-0.4	-0.18
(at °C/3 hrs)	1400	1400	N.A.
Refractoriness (°C)	N.A.	N.A.	1820
CCS (kg/cm ²) (at 110°C/24 hrs)	700	1000	860
MOR	N.A.	N.A.	1200
(at °C/3 hrs)	N.A.	N.A.	1550

Refractory Specifications

Low Cement Castables	D	E	F
Al ₂ O ₃ %	90	70	70
SiC %	0	15	0
Max service Temp. (°C)	N.A.	N.A.	1650
Grading (mm)	N.A.	N.A.	0-5
B.D. (gm/cc)	3.02	2.9	2.65
PLC %	+/-0.2	-0.12	+/-0.5
(at °C/3 hrs)	N.A.	800	1450
Refractoriness (°C)	1820	1820	1790
CCS (kg/cm ²) (at 110°C/24 hrs)	980	200	700
MOR	1290	40	N.A.
(at °C/3 hrs)	1550	800	N.A.

Refractory Specifications

Insulating Castables	A	B	C
Al ₂ O ₃ %	40	45	63
SiO ₂ %	42	42	26
B.D. (gm/cc)	1430	1600	1650
PLC % (at 1100°C/3 hrs)	+/-0.2	+/-0.2	+/-0.5
Refractoriness (°C)	1430	1430	1600
CCS (kg/cm ²) (at 110°C/24 hrs)	100	180	140
MOR (at 110°C/24 hrs)	18	90	40
Thermal conductivity (Kcal/m hr 500°C)	0.42	0.44	0.42

Refractory Specifications

Insulating Bricks	A	B	C
Al ₂ O ₃ %	40	70	72
A.P. %	60	N.A.	N.A.
B.D. (gm/cc)	1.1	1.2	1.35
PLC %	+/-1.0	0.8	-0.5
(at °C/5 hrs)	1350	1600	N.A.
(at °C/24 hrs)	N.A.	N.A.	1450
Refractoriness (°C)	1400	1825	N.A.
CCS (kg/cm ²) (at 110°C/24 hrs)	40	50	35
Thermal conductivity (Kcal/m hr °C)	0.35	0.42	0.64
(at °C)	500	500	1000

Refractory Specifications

Ceramic Fibre	A	B
Al ₂ O ₃ %	43-47	32-36
SiO ₂ %	53-57	44-48
ZrO ₂ %	N.A.	16.5-19.5
Temp. Limit (°C)	1260	1425
Tensile strength (128kg/m ³) (Kpa)	30-60	30-60
Linear shrinkage (%)	2.4-3.2	<3.5
(at °C/24 hrs)	1200	1400
Sp.Heat capacity at 980°C (kj/kg°K)	1.07	1.07
Thermal conductivity at 800°C (W/mK)	0.18	0.17

Refractory Specifications

SiC refractories for heat treatment furnaces	A	B
SiC %	33	58
Al ₂ O ₃ %	35	30
A.P. %	25	N.A.
B.D. (gm/cc)	2.3	2.4
CCS (kg/cm ²) (at 110°C/24 hrs)	500	450
Thermal conductivity (Kcal/m at 1000°C)	7.24	N.A.
MOR (kg/cm ²)	80	80
(at °C/24 hrs)	1250	110
Refractoriness (°C)	N.A.	1710

Refractory Specifications

High Alumina Castables	A	B	C
Al ₂ O ₃ %	70	60	80
ZrO ₂ %	10	0	0
B.D. (gm/cc)	3	2.2	2.65
PLC %	+0.12	-0.12	+/-0.12
(at°C/24 hrs)	1000	800	800
Refractoriness (°C)	N.A.	1710	1800
CCS (kg/cm ²)	500	280	600
(at°C/24 hrs)	1000	500	110
MOR (kg/cm ²)	60	65	85
(at°C/24 hrs)	1000	110	110

Refractory Specifications

Refractories for Copper industries	A	B	C
MgO %	87	65	72
Cr ₂ O ₃ %	0	15	12
A.P. %	18	21	19
B.D. (gm/cc)	N.A.	2.9	2.98
CCS (kg/cm ²)	500	350	450
Refractoriness (°C)	N.A.	1920	1920
RUL (ta °C)	1600	1650	1700
Spalling (1300°C) cycles	N.A.	5	N.A.
PLC % (at 1600°C/2 hrs)	N.A.	0.5	N.A.

Refractory Specifications

Refractories for Aluminium Industries	A	B	C	D
Al ₂ O ₃ %	47	58	44	78
A.P. %	15.1	13.9	N.A.	N.A.
B.D. (gm/cc)	2.3	2.56	2.25	2.86
PLC %	+/-0.5	+/-0.5	0.16	N.A.
(at °C/24 hrs)	1000	1450	1400	N.A.
CCS (kg/cm ²)	955	870	440	N.A.
RUL (ta °C)	1560	1650	1520	N.A.
MOR (kg/cm ²) (24 hrs)	177	147	N.A.	N.A.
Spalling (cycles)	15	15	30	N.A.

Refractory Specifications

Refractories for Aluminium Industries	A	B	C	D
Creep % (2kgcm ²)	0.004	0.035	N.A.	N.A.
(at °C/14-24 hrs)	1280	N.A.	N.A.	N.A.
(at °C/20-50 hrs)	N.A.	1350	N.A.	N.A.
Refractoriness (°C)	N.A.	N.A.	1730	N.A.
Thermal conductivity (W/mK) (at 1100°C)	1.15	1.42	1.32	N.A.
Open Porosity %	N.A.	N.A.	N.A.	21.8
Closed Porosity %	N.A.	N.A.	N.A.	2.4

Recent Milestones in Refractories Development

- 1990 Direct Bonded Mag-Chrome Bricks
Unidirectional Gas Purging Elements
Alumina Carbon Ladle Bricks and Slide Gate Refractories
- 1991 Dense Silica Shapes for Blast Furnace Stoves
- 1993 Alumina Carbon Continuous Casting Refractories
Mullite Bricks for Blast Furnace & Stoves
Dry Basic Ramming Mass, Gunning materials for Converters,
Spraying Mass for Tundish
- 1994 Ultra Low Cement Castables/Monolithics
Pitch-Bonded Tempered Dolomite Bricks
- 1995 Spinel-Based Ladle Monolithic Lining
Alumina Carbon Silicon Carbide BF Trough Mass
- 1998 Alumina-magnesia-carbon bricks and shapes for Rotary Kilns and Ladles
Alumina Zirconia Slide Gate and CC Refractories
Pumpable Refractories
- 1999 Self-flow castables
- 2000 Concept of Refractory Management Service in Steel Plant
- 2001 Magnesia spinel and Alumina spinel shapes and monolithics
Nitride-bonded silicon carbide products
- 2003 Si-alon and gel-bonded products
- 2005 Dry vibratable mass for tundish

Latest Advances in Refractories Applications

- Advances in installation and repairs of Monolithic Refractory lining
- Development of Hot Repair and Patching materials and facilities
- Progress in Application engineering with growing use of zoned lining and multi-component products (e.g. MC, A-MC, Al-SiC-C, Al-Zr-C, MgO-Al-Zr)
- Total Refractories Management and Solutions

Refractories Development

- Spinel based formulations, both Monolithic and Shapes
- Mechanised gunning repair of BF stack
- Ultra low cement and Cement less castables
- New systems like $\text{Al}_2\text{O}_3\text{-SiC}$ and $\text{Al}_2\text{O}_3\text{-Si}_3\text{N}_4$
- Self-bonded Silicon carbide
- Alumina-carbon-zirconia, Magnesia-zirconia
- Gel-bonded Refractories Castables

To Summarize

- Indian Refractories Industry is equipped with latest machineries & facilities.
- With the liberalisation of imports we have ready access to all necessary raw materials.
- Application engineering with design, installation and maintenance skills have very much improved.
- Some of the latest hardware facilities for hot repair techniques need development.
- Drive for Total Refractories Solution.



Thank You for your attention



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