

COLUMN FLOTATION TECHNOLOGY FOR THE BENEFICIATION OF COKING & NON-COKING COAL FINES

By

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Issues involved in Coal Processing

- **30 Million tonnes of coal is washed every year in Indian coal washeries.**
- **20 - 30% of coal in the form of fines are produced and are being lost as tailings.**
- **Very few washeries have the facilities to treat these coal fines.**
- **The standard existing coal beneficiation techniques are not effective to recover fine coal from these coal washery tailings.**
- **Less overall coal recovery due to loss of fines with tailings**
- **Environmental pollution generated in the downstream.**



Importance of flotation in coal processing

- Modern mining methods increase fines in coal
- Coal fines (< 500 microns) consisting 20-30% of feed
- Conventional methods – heavy media separation, shaking tables, cyclones not effective for fine coal processing
- Flotation is the best alternative
- Approx. 145 million tonnes are beneficiated by flotation world wide annually
- Flotation is the only process which alters the surface properties of coal particles leading to separation



Advantages of flotation column.....

- Less entrainment and entrapment through froth washing
- Independent control of operating variables
- Flotation of coarse and slimes particles
- Used as roughers and scavengers

Reduced running costs as a result of

- No moving parts
- Lower reagent consumption
- Lower energy consumption (40 - 50% lower)
- Reduced downtime
- Low maintenance and inventory requirements.



Comparison of the costs for an iron ore flotation project utilizing two different types of equipment
mechanically agitated cells and column cells.

Investment Requirements: Mechanical Cells Vs. Column Cells (Salim, 1996)

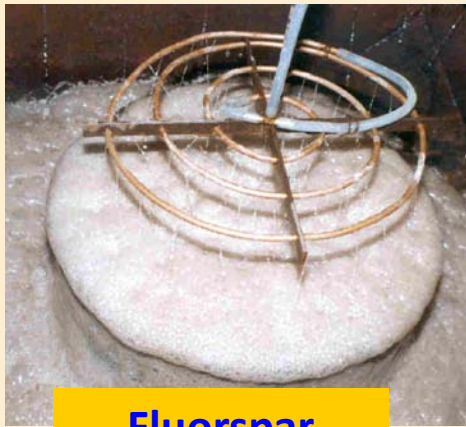
Description		Mechanical Cells		Column Cells	
		Quantity	Cost (\$ US)	Quantity	Cost (\$ US)
Equipment	Flotation Cells	44	1,760,000	4	380,000
	Compressor	-	-	3	240,000
Metal Structure (Fabrication & Erection)		200t	500,000	65t	162,000
Civil Works	Concrete	416m ²	232,000	416m ²	240,000
	Foundations	144t		83t	
Total			2,492,000		915,000



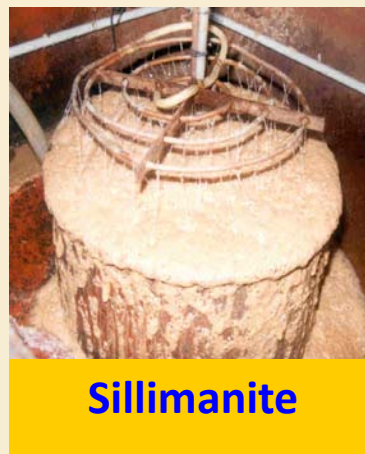
Stages of flotation column development at NML

1987	Exploratory project on fine particle processing by new techniques
1988	Development of 3 types of cells – conventional column, electro-column & combination.
1989-91	Design & development of fully automated flotation column with state-of-the instruments
1992-93	Amenability studies at Malanjhand copper project – copper ore
1993-94	Feasibility studies at Kudremukh Iron Ore Company Ltd.
1994-95	Fluorspar beneficiation at Gujarat Mineral Development Corpn.
1995-96	Column flotation of Pb-Zn ore at Agucha, HZL
1996-97	Column flotation of Pb-Zn ore at Dariba, HZL
1997-98	Beneficiation of multi metal ore at Ambaji, GMDC – Cu-Pb-Zn ore
1998-99	Amenability studies at Bharat Gold Mines Ltd. – Gold ore
2000	Design & development of semi-commercial, 0.5m dia column with automatic controls.
2000-01	Demo of 0.5M dia flotation column for gold ore beneficiation at BGML
2001-02	Field testing of 0.5M dia column at Kadipani, GMDC, for fluorspar beneficiation
2002-03	Column flotation of sillimanite beneficiation at OSCOM, Orissa
2003-04	Demo of 0.5M dia flotation column for the beneficiation of Limestone at Salem
2004-05	Column flotation of iron ore fines at Fomento, Goa
2005-06	Design and commissioning of 1.30M dia commercial column – OSCOM. IREL
2006-07	Design and commissioning of 1.20M dia commercial column – Limestone, Salem
2006-07	Amenability studies at JSW Steel Ltd. 0.5M dia semi-commercial column
2007-08	Design and commissioning of 1.25M dia commercial column – IREL, Chavara





Fluorspar



Sillimanite



Gold ore

TESTING METHODOLOGY

Lab Flotation Cell (Denver)

- Selection of reagents.
- Optimization of Process parameters.

Lab Flotation Column (75mm dia)

- Optimization of operating parameters.
- Scale-up data collection.

Pilot Scale Flotation Column (500mm dia)

- Erection of pilot flotation column
- Onsite Demonstration.

Demonstrations (0.5m dia column)

S.No	Plant	Ore
1	Bharath Gold Mines Ltd. K.G.F., Karnataka	Gold ore
2	Gujarat Mineral Development Corpn. Ltd., Kadipani	Fluorspar
3	Indian Rare Earths Ltd., Orissa Sands COMplex, Chatrapur	Sillimanite
4	Fomento, Goa	Iron ore
5	Calpro Mineral Technology India (Pvt) Ltd., Salem, Tamilnadu	Limestone
6	Indian Ocean Garnet Sands, Tuticorin, Tamilnadu	Garnet
7	JSW Steels Ltd., Jindal Vijayangar, Karnataka	Iron ore
8	TATA Steel Ltd., (Joda East Iron Mines, Orissa)	Iron ore



Commercial Installations

- 1 Indian Rare Earths Limited, OSCOM, Chatrapur
(Beneficiation of Sillimanite)
Commissioned in November 2005**
- 2 Calpro Mineral Technology India Pvt Limited, Salem
(Beneficiation of Limestone)
Commissioned in December 2006**
- 3 Indian Rare Earths Limited, Chavara, Kerala
(Beneficiation of Sillimanite)
Commissioned in July 2010**
- 4 Andhra Barytes & chemicals Ltd, AP (Beneficiation of
Baryte)
Commissioning in progress**



150tpd flotation column at OSCOM



Spargers Arrangement



Specification of Column

Column diameter:	1.25 m
Column height:	8.0 m
Column cross sectional area:	1.23 m ²
Column volume (including sparger section):	9.85 m ³
Collection zone height (sparger to feed point):	5.25 m
Cleaning & froth zone height (feed point to column lip):	2.25 m
Compressor settings:	Max. 9.5 kg/cm ²
No. of spargers	a) 260mm 16 nos. b) 500 mm 12 nos. c) 600 mm 4 nos.

Control valve pressure settings: I/P converter (4 kg/cm²)
Actuator (1.2 kg/cm²)

Column Controller settings/definitions:

Controller calibrated for 0-2000mm water column

SV (Set Value)-0-2000mm

PV (Process Variable)-0-2000mm

Froth zone height in= 2000 mm – SV/PV

MV (Manipulated Variable i.e. discharge valve opening in (%))

Wash water system - 200 rpm, max, can be varied through VFD

Solids feed rate, maximum 8 tons/hr on dry basis

Slurry feed rate, maximum 40 m³/hr



Limestone beneficiation at Calpro Mineral Technology India Pvt. Ltd., Salem



Column flotation studies on Non-Coking coal supplied by GE, Bengaluru

Diesel : 2.87 kg/t; MIBC : 0.65 kg/t

Product	Non coking Coal (Head ash: 34.6%)			
	Yield, %	Ash, %	Ash Dist., %	Comb. Rec., %
Float	61.44	12.98	21.75	84.4
Tailings	38.56	74.41	78.25	
Float	70.78	14.50	31.48	89.8
Tailings	29.22	76.45	68.52	

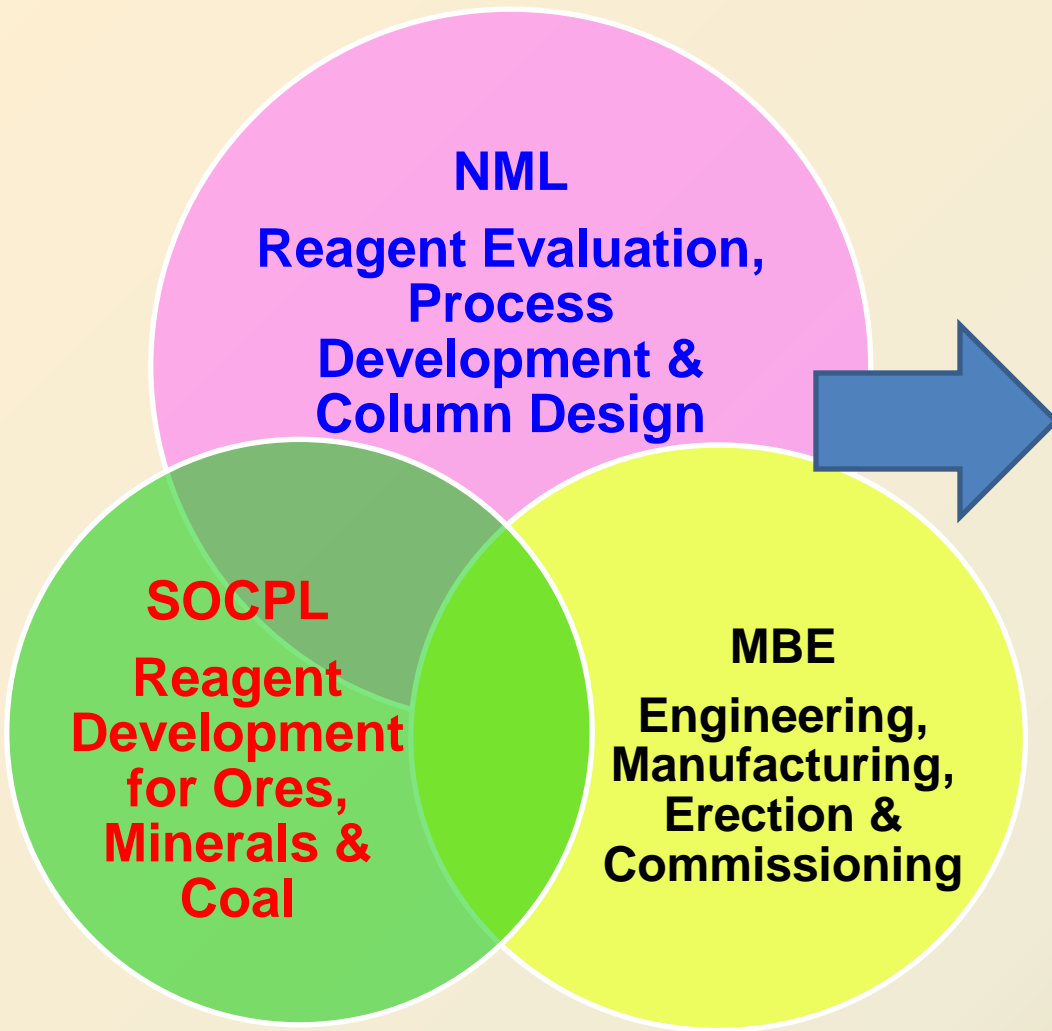


Column flotation studies on Coking coal fines supplied by M/s TATA Steel, Jamadoba

Diesel : 1.067 kg/t; NF : 0.069 kg/t

Product	Coking Coal (Head ash: 26.75%)			
	Yield, %	Ash, %	Ash Dist., %	Combustibles Rec., %
Float	58.98	14.41	34.62	68.92
Tailings	41.02	39.12	65.38	

OUR COLLABORATIONS



*Column Flotation Technology is a
potential & effective method for
Processing of coal fines*

Thank You

