

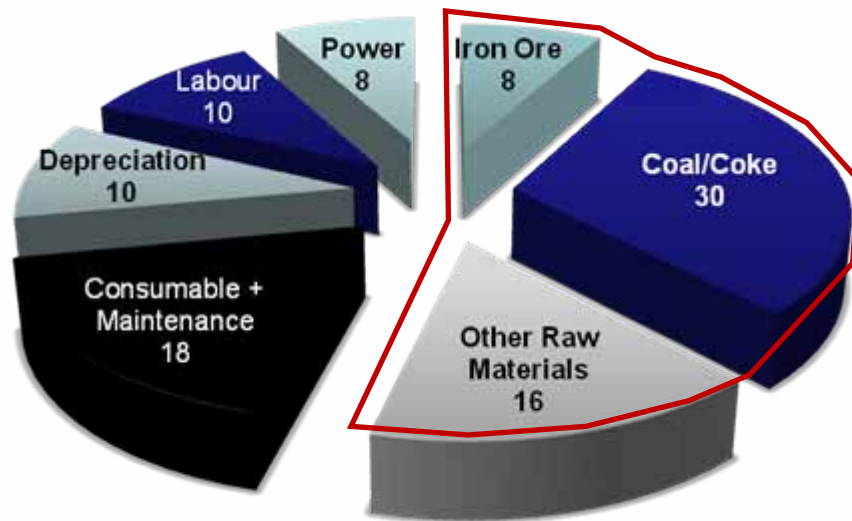
Utilization of lean grade material like Jhama coal to enhance mine life at Jharia division of Tata Steel

P R Ray

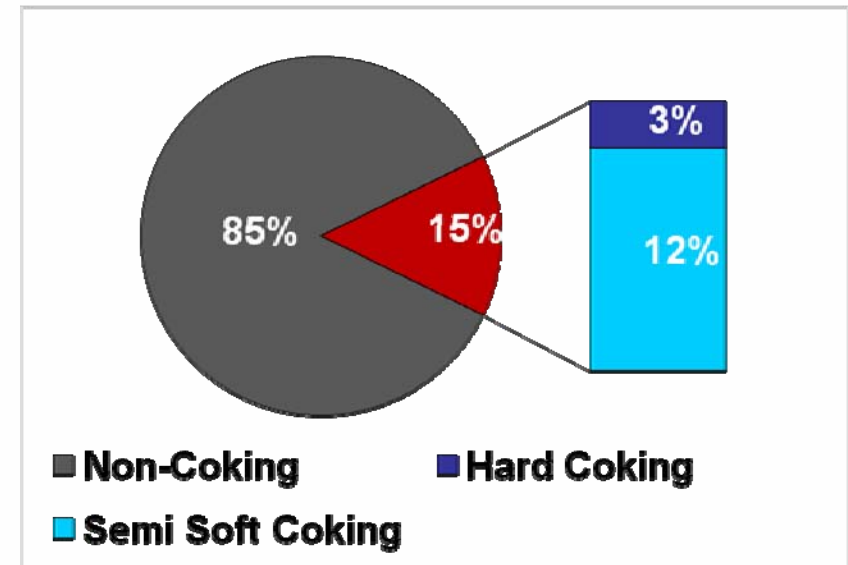
Tata Steel
15th.July 2009

Background

- Tata Steel has its own collieries (at West Bokaro and Jharia).
- There is a substantial deposit (40 million ton) of inferior minerals, Jhama (poor Quality Coal) in Jharia which was going as a Waste
- India has large reserve of coal but very limited Hard Coking Coal Deposit

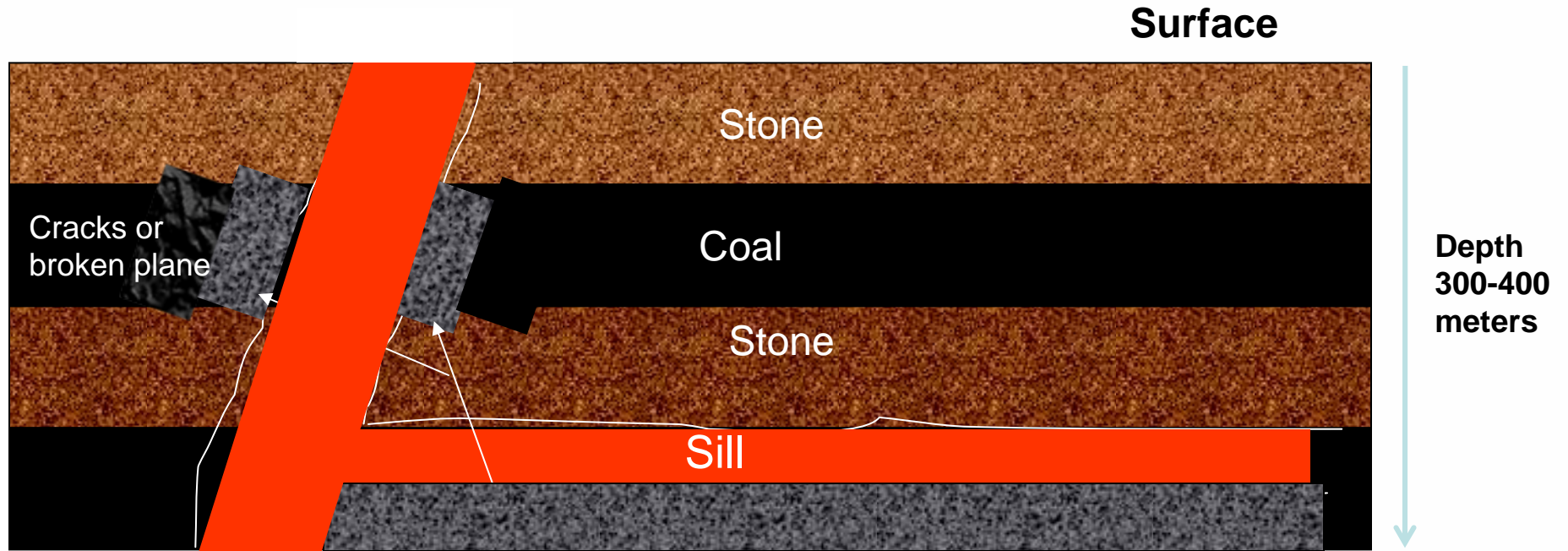


Raw materials constitute about 53% of steel making costs for Tata Steel



Coal Reserve in India

Geological Formation of Jhama Coal



Jhama is very hard material difficult to break due to volcanic intrusion



Fig1.
**Jhama coal showing
Tortoise back structure filled up
with hard rock**



Fig.2
Coal showing columnar structures

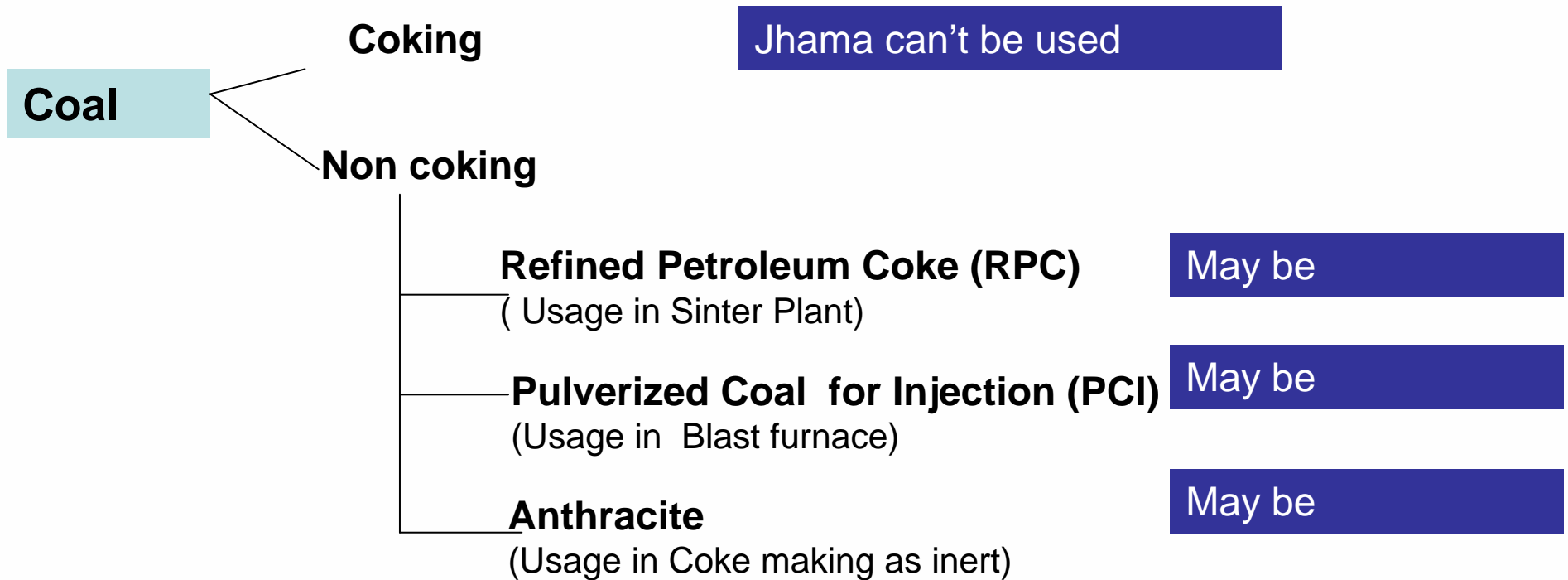
Comparison of quality of different categories of coal

Specification	Desired	Coking coal (Jharia)	Pulverized Coal for Injection (Imported)	Refined Petroleum Coke (Imported)	Anthracite (Imported)	Jhama (Jharia)
Fixed Carbon	More than 50%	62-65%	72-75%	94%	81.2	65-67%
Volatile Matter	4% - 8 %	20-22%	18-20%	3-4	8-10	5-10
Ash	Less than 20 %	15-17%	8-10%	2	10-12	27-29%
Sulphur	Less than 0.5 %	0	0.38	0	0.64	0
Phosphorous	Less than 0.10 %	0.17	0.04	0	0.08	0.112
Usage		Coke plant	BF	Sinter	Coke oven	Scrap

Good Amount of Fixed carbon getting wasted

Jhama can be used in place of Refined Petroleum Coke (RPC) if ash % is reduced

Potential areas of application for Jhama in Tata Steel



In FY08, Jharia, therefore initiated to find out usage of Jhama in iron making process which can result in

- Increased life of mine
- Unlock potential worth 2.5 Billion USD

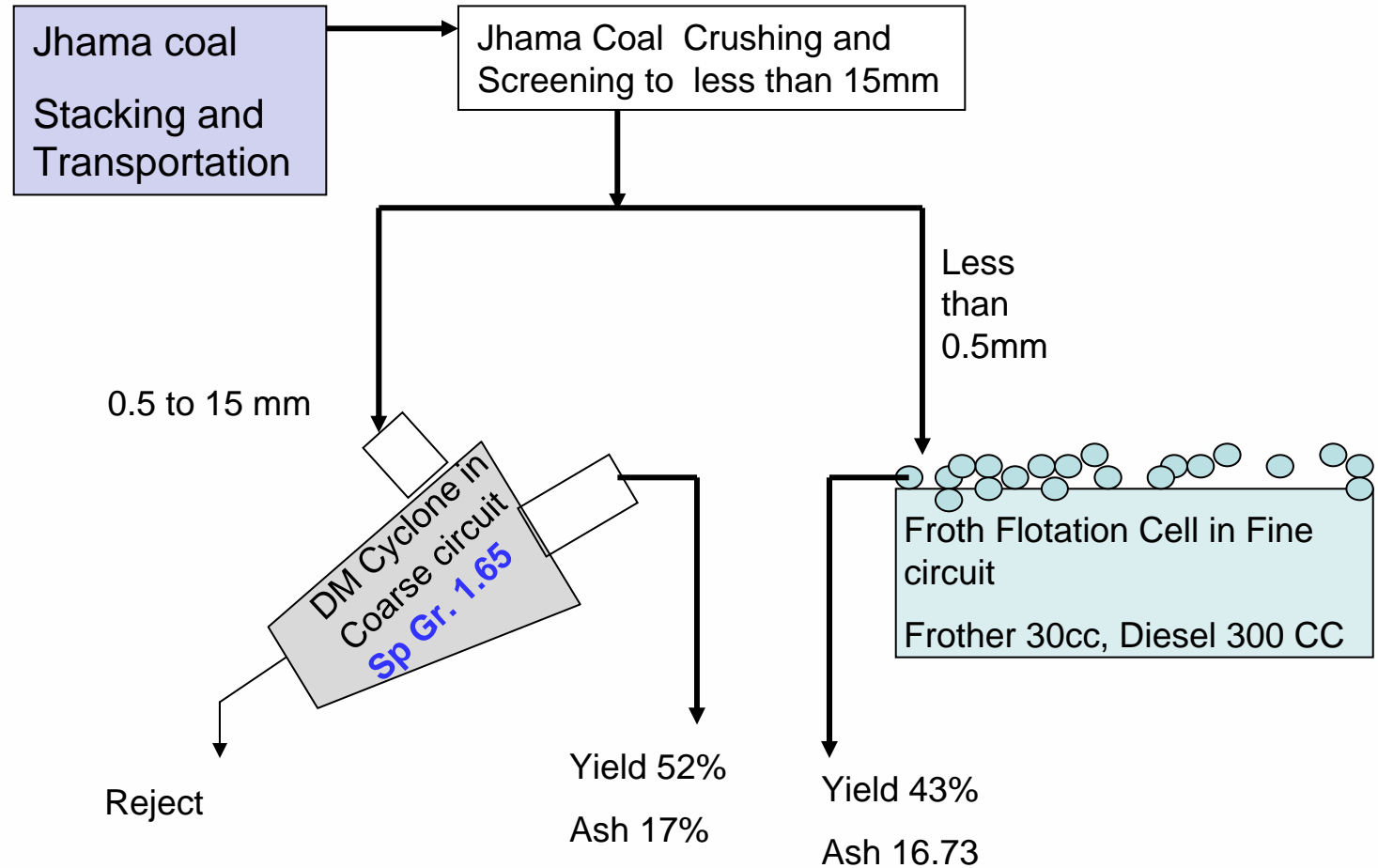
- **Studies carried out in Tata Steel to establish washing of Jhama to remove ash in Laboratory study.**
- **It indicated that Jhama (ash of raw Jhama) can be washed with a theoretical yield of 52% with 17% ash quality.**
- **Conducted workshop at Sinter Plant for use of Jhama in which customer (Sinter Plant) agreed to use Jhama if ash % can be brought down to less than 17 %.**

Process Flow Diagram for Washing of Jhama to remove ash

Basic Idea

1. The process is same as the washing of coking coal
2. Stacking of Raw Material in dump area and shifting coal on the day of Washing
3. Operating Condition for Jhama Washing

1. Specific Gravity for DM Cyclone: 1.65 gm/cc
2. Frother in Froth Flotation cell : 30 cc/min
3. Diesel in Froth Flotation cell : 300 cc/min



Plant Experiment 1

Purpose : To establish whether Jhama can be treated in the existing Plant.

1. Trial of 3000 Tons of Jhama Coal
2. Time of Experiment 24Hrs
3. Yield target : 50%
4. Ash target : 17%
5. Stoppage of Normal Production

Results

1. Yield 41.2 %,
2. Ash 16.9%
3. Observations: Fines generation increased from 6% input to 20% during handling and crushing.

**Washing Established
but Yield is Low**

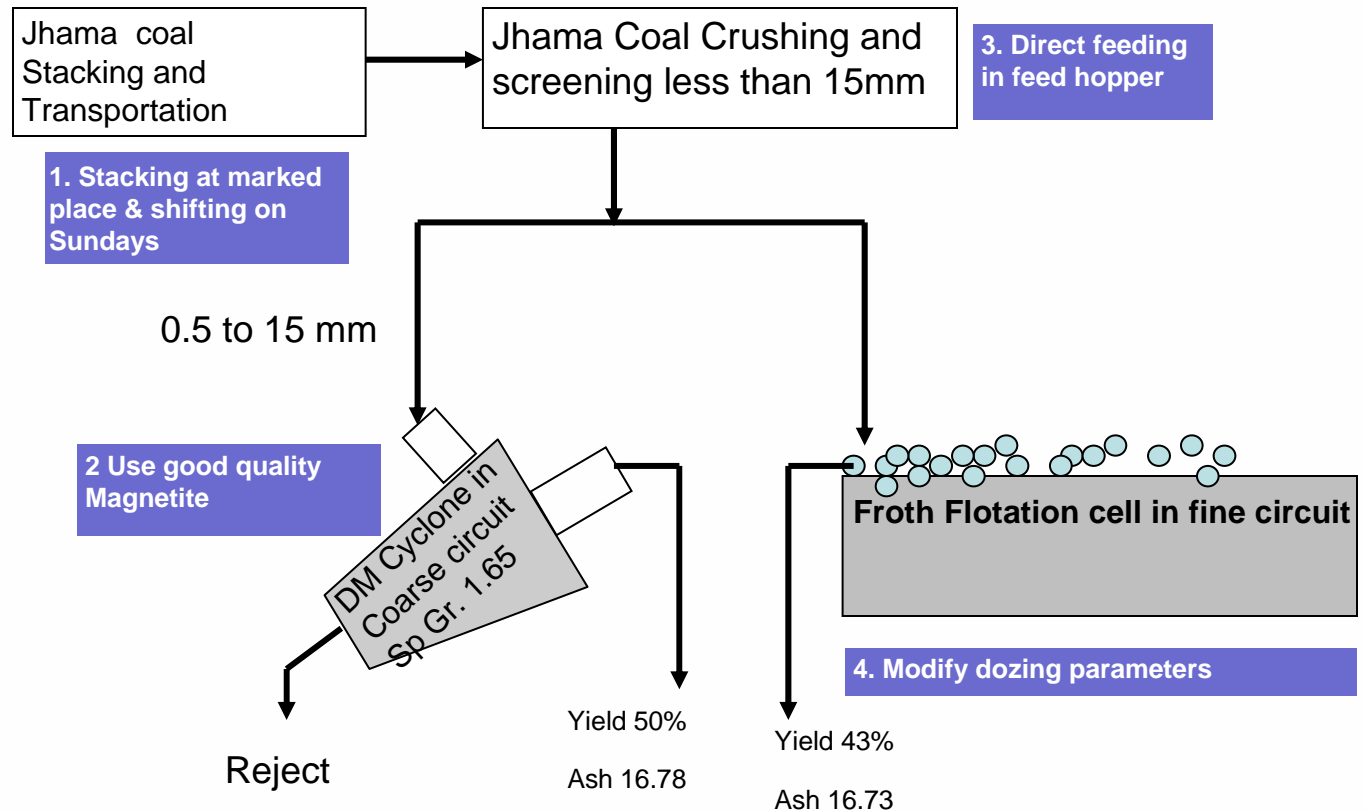
Remaining Problem :

1. Low Yield : 41.2 % against the Target of 50%
2. Fines generation increased from 6% input to 20% during handling and crushing.

Process flow diagram with Counter measure to Improve Yield %

Basic idea

- 1) **Stacking of Raw Material to avoid Mixing**
- 2) **Use of good quality magnetite to reduce gravity build up time**
- 3) **Direct feeding of Jhama to bunker**
- 4) **Operation Condition in Flotation Changed**



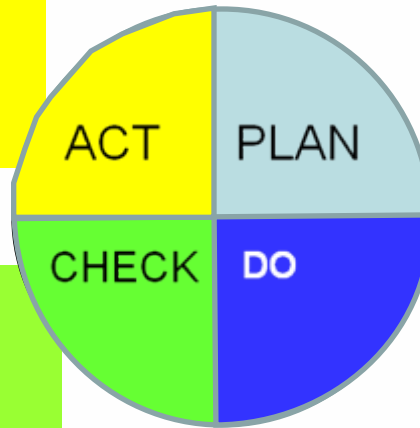
Changes in Parameter

Purpose : To Improve Yield

1. VM from the coarse circuit 8.4%
2. VM in fines circuit is 15.4 %
3. Jhama operating regime standardized

1. Yield : 49.7 %,
2. Ash : 16.9%
3. Customer feedback :
Volatile Matter (VM) : 14.2% to high VM

**Though yield and ash is as desired
Volatile Matter is high**



Remaining Problem :

1. Volatile Matter in Clean Jhama is too high

1. 3000 ton of Jhama trial
2. Use of good quality for reducing the high build up time .
3. Avoid mixing by shifting the coal to feed hopper on Sunday Avoiding fines generation by direct dumping in the hopper
4. Frother dosing changed
5. Stoppage of Normal Operation for 24 hrs

1. Training of Persons in the raw coal receiving section and secondary crushing section about revised coal stacking arrangement & FF cell.
2. 3000 Tons Jhama treated with the Change setup.

Process flow diagram with countermeasure for reducing Volatile Matter

Basic Idea

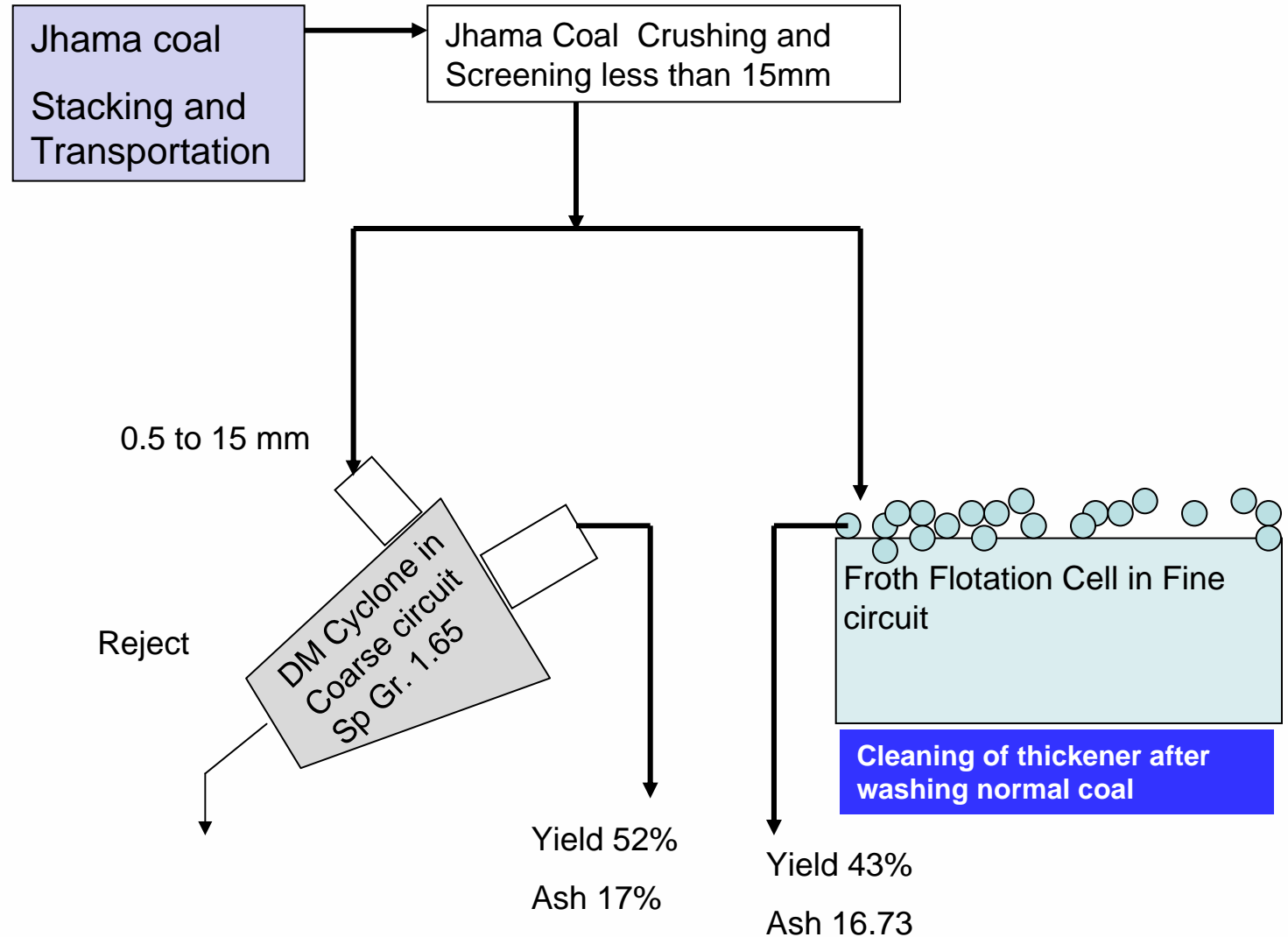
1. Avoiding mixing of clean coal by cleaning of Thickener after washing normal coal for 3 hrs

2. Operating Condition for Jhama Washing

1. Specific Gravity for DM Cyclone: 1.5-1.7 gm/cc

2. Frother in Froth Flotation cell : 40 cc/min

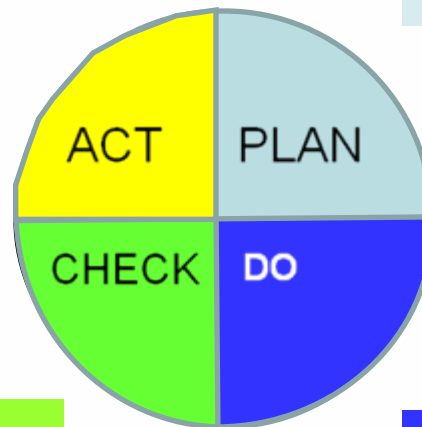
3. Diesel in Froth changed



Purpose : To reduce Volatile Matter (VM) of Jhama Coal

1. Revised the SOPs

1. Avoiding mixing of clean coal by cleaning of Thickener after washing normal coal

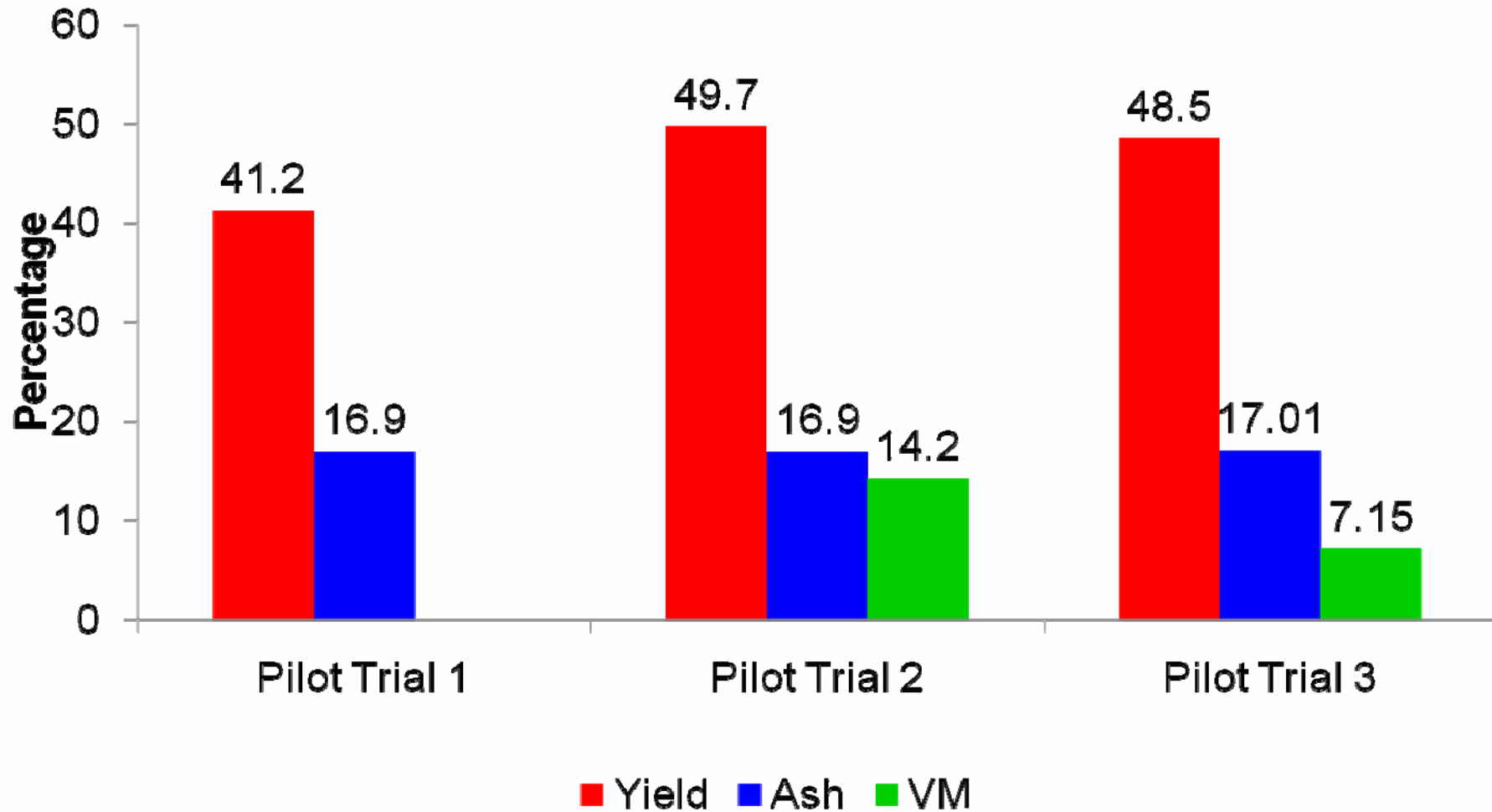


1. Yield 48.5 %,
2. Ash 17.01%
3. VM – 7.15%

1. Training of Persons in Thickener and FF Cell area.
2. 5000 Tons Jhama treated with the Change setup.

Yield, Ash and VM as per specification of the Customer

Results of Pilot Trials



Trial and Analysis in for Sinter making: Lab trial

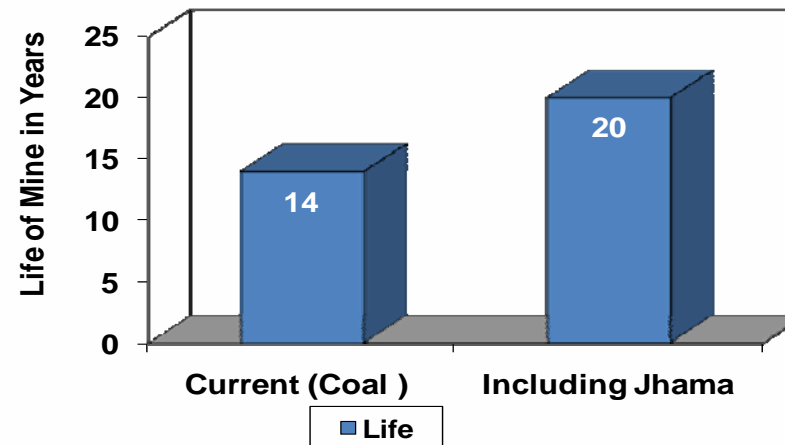
Table 4.2-5 : Pot sinter Trial Results						
Property	Unit	Indicator	Range	Jhama trial at different proportion		
				Base Case	10% Jhama	20% Jhama
Tumbler Index	Number	Good	Greater than 65	69	68.3	67.7
Mean Size	Mm	Good	Greater than 18	19.6	20.4	18.8
Cum +10MM	Percentage	Good	Greater than 61	64	63	63
RDI	Number	Good	Less than 26	25	24.4	23.4

Sinter Plant trial results:

	MEAN_SIZE	TI	Cum + 10mm	RDI	RI
Base 1% RPC	18.60	77.57	66.93	27.83	69.51
10% % Jhama	18.44	77.89	66.72	26.92	68.08
20% Jhama	18.26	77.62	66.09	29.19	68.80

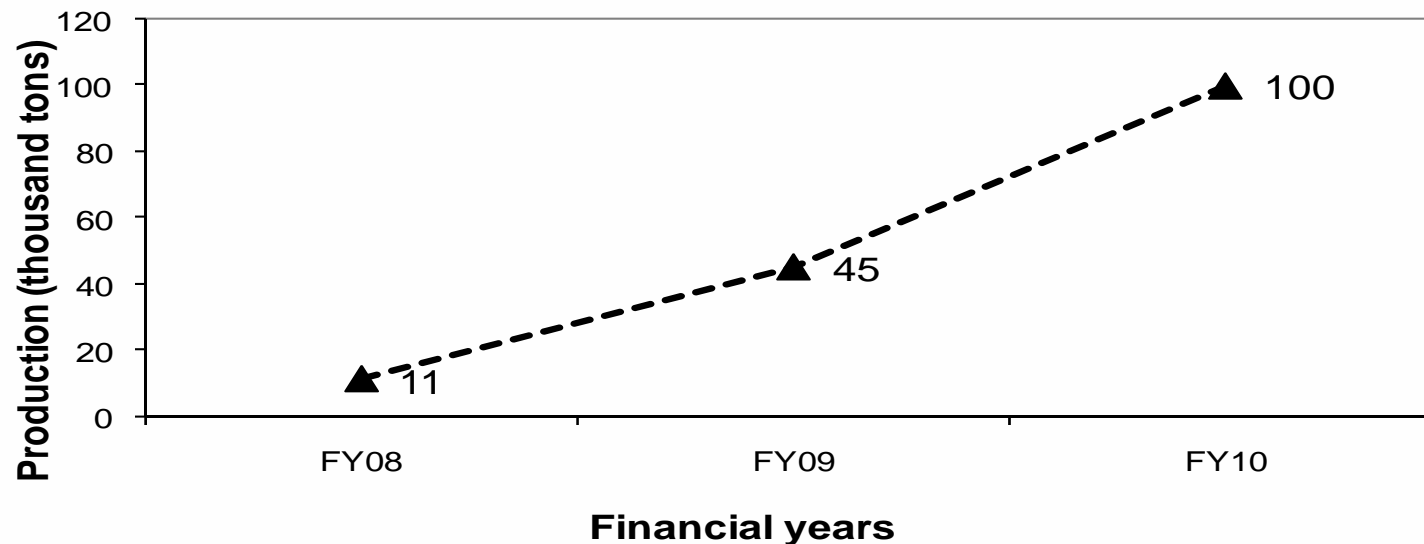
This showed that the Sinter quality is suitable and within the acceptable limit.

- ***Successfully established commercial use of Jhama in sinter making***
 - ❑ Encouraged with the pot sinter trial, testing in the Sinter plant was conducted.
 - ❑ The results showed that the Sinter quality was suitable and within the acceptable limits.
- ***Increased life of mine of Jharia***
- ***Having successfully established the usage of Jhama in Sinter Plant in place of RPC, Jharia is now exploring other usage of Jhama.***



- *Trial in Pulverized Coal for Injection (PCI) at Blast Furnace,*
- *Trial to replace Anthracite at Coke Making*
- *Optimisation of floatation by using improved frother. Lab-scale trials are underway.*

Production Plan of Jhama Coal



Conclusion

- **Successfully established commercial use of Jhama in sinter making**
- **Increased life of mine**
- **Future plans for trial in PCI, Anthracite**

THANK

YOU



Chemical Analysis of Sinter during trial

AL2O3	CAO	FE	FEO	K2O	MGO	MNO	SIO2	P
2.24	9.28	57.31	9.55	0.03	1.63	0.03	4.39	0.11
2.21	9.44	57.24	10.33	0.04	1.59	0.04	4.37	0.10
2.18	9.25	57.65	9.82	0.04	1.54	0.04	4.06	0.11

Chemical Analysis of Sinter during trial

Test	Waste gas Analysis		
	CO,%	CO ₂ ,%	H ₂ ,%
Base	2.4	0.04	0
0.6% Jhama	4.9	0.1	0
1.8% Jhama	9.2	0.2	0

Properties of Jhama Coal

PARAMETERS	Jhama Coal	
1. Inherent Moisture	1.93	
2. <u>Proximate Analysis (db), %</u>	16.83	
Ash	11.70	
VM		
4. Phosphorus, %	0.112	
6. <u>Ash Constituents, %</u>		
CaO	0.55	
SiO ₂	9.22	
Al ₂ O ₃	4.32	
MnO	N.T	
MgO	0.26	
TiO ₂	0.36	
Total Fe	0.65	
8. <u>Audibert - Arnu Dilatometry</u>		
Max. Contraction		
, %	3	
Max. Expansion ,		
%	Nil	
9. Crucible Swelling Number	1	