TATA MOTORS

STELLANTIS

CHIP SEPARATION IN BLOCK MACHINING

Fiat India Automobiles Private Limited

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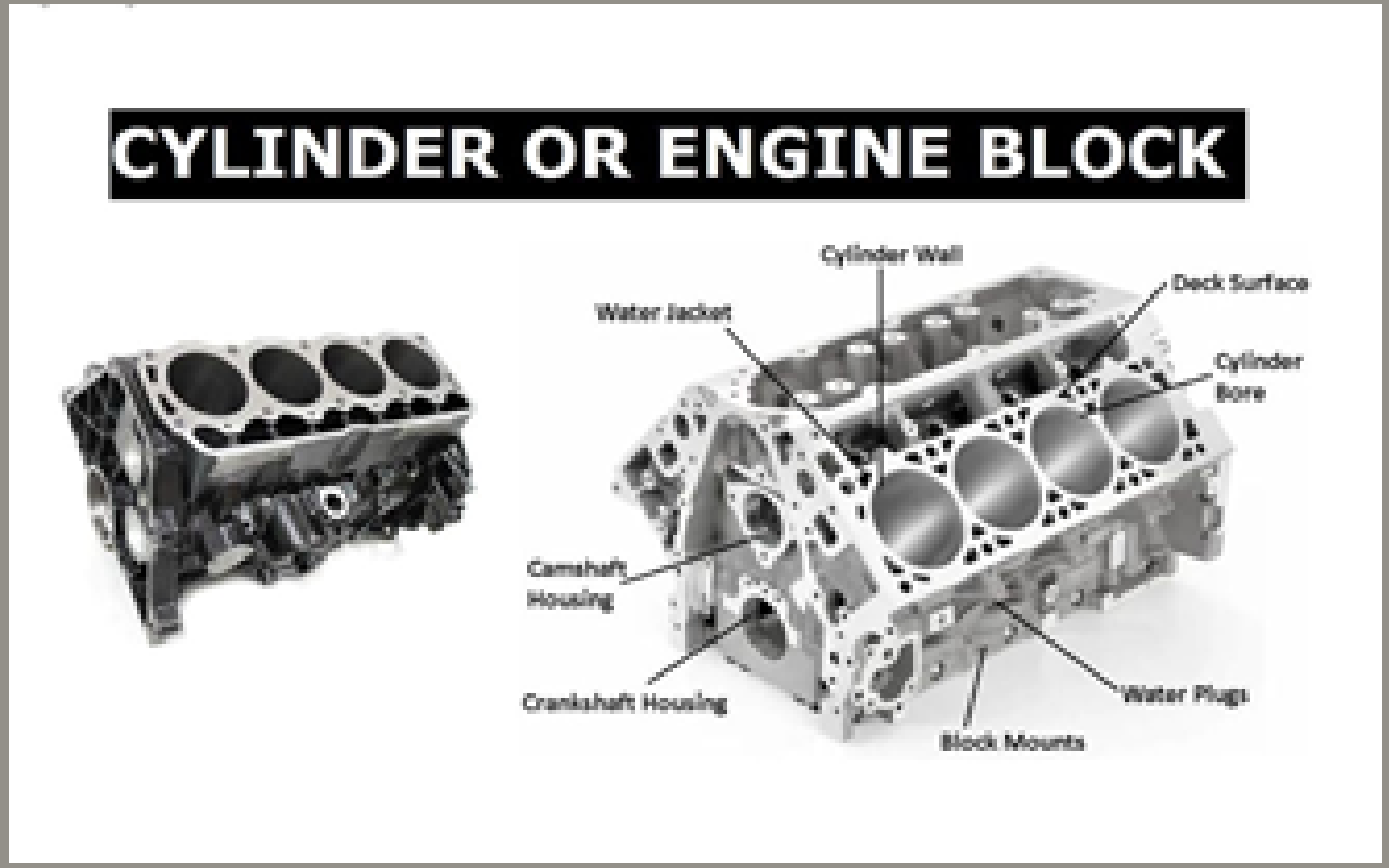
OVERVIEW

BLOCK MACHINE

A cylinder block machine is a specialized, computer-controlled system designed to manufacture, process or recondition engine blocks, which serve as the foundation for internal combustion engines. This industrial machining transforms raw cast engine blocks into high-quality components ready for assembly



The cylinder block machine precisely machines the cylinder bores, creating surfaces for the pistons to operate. The cylinder block, also referred to as the engine block, is a crucial component of internal combustion engines. It supports the cylinders, houses the crankshaft and valve train, and accommodates various engine accessories. Its robust construction allows it to withstand extreme temperatures and pressures, significantly impacting engine performance, stability, longevity, and fuel efficiency, thereby acting as the backbone of the internal combustion engine.

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PROCESS FLOW

The Hydro-Vac Central Coolant Filtration System is a fully automated, vacuum-assisted system designed to continuously filter and recirculate coolant in cylinder block machining. It ensures clean, cool, and particle-free coolant with zero downtime.

COLLECTION OF DIRTY COOLANT AND PRE-SEPARATION

- Coolant mixed with metal chips and oil from the machining station flows into the central system via inlet distributors.
- The flow enters the pre-separator, where large chips settle to the bottom and are mechanically removed from the coolant using a gravity settling method. This is accomplished with a conveyor equipped with flight bars, which drops them into a dirt bin.
- The large solid contaminants (chips) are dropped into a dirt bin while the coolant flows onward to the Hydro-Vac filters.

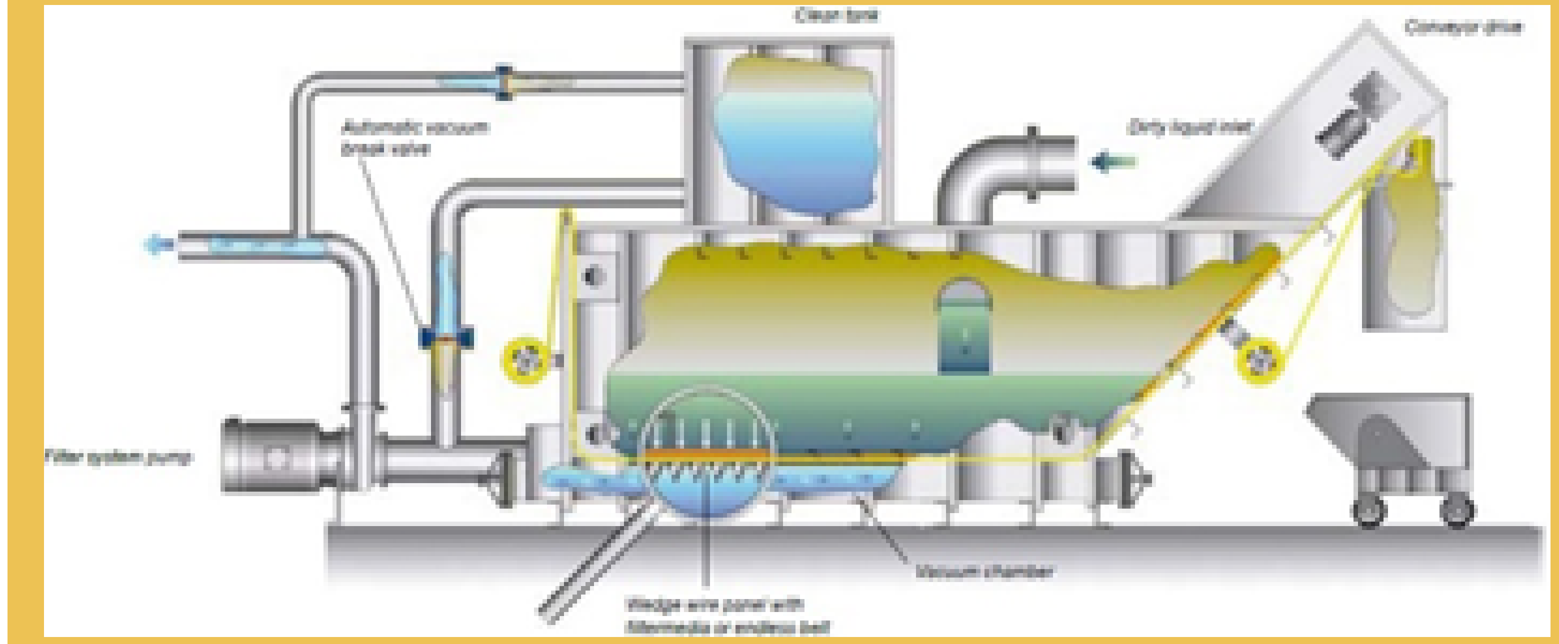
PROCESS FLOW

MAIN FILTRATION (HYDRO-VAC FILTERS)

The coolant enters one of the Hydro-Vac filters (Filter 1 or Filter 2)

FILTRATION PROCESS:

- Dirty coolant flows over a filter media (non-woven polytherm paper) supported by wedge wire screens.
- A vacuum chamber located below the filter media draws the coolant through the media, trapping fine particles and forming a filter cake.
- The clean coolant is then collected in a tank located above the filter



FILTER MEDIA HANDLING:

- As dirt accumulates on the filter medium, the vacuum pressure increases.
- When a preset vacuum level is reached, a vacuum break valve opens, allowing clean coolant to flow into the vacuum chamber, thereby releasing the vacuum.
- The filter's drive motor advances the filter media, moving dirty media to a rewinder and exposing fresh media for filtration.

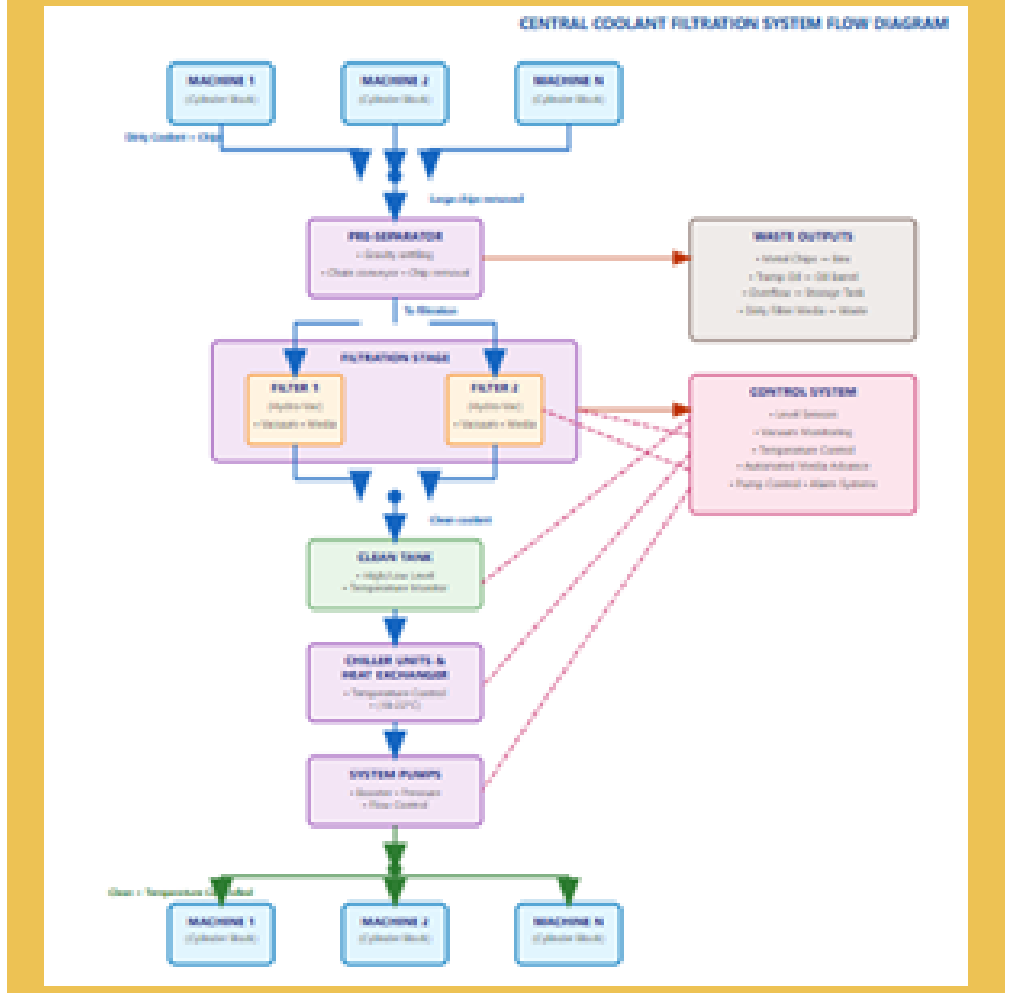
PROCESS FLOW

CLEAN COOLANT STORAGE AND SUPPLY

- Clean coolant collects in a vacuum chamber and moves to the Clean Tank.
- The system pumps and booster pumps draw coolant from the clean tank, delivering it back to the machines at the required pressure and flow rate.
- The system includes chiller units and a plate heat exchanger to maintain coolant at the optimal temperature.
- If the clean tank reaches a minimum level, the system halts to prevent air entry or pump damage.
- There are provisions for adding water or oil as needed, and for draining waste oil or excess coolant to storage or waste tanks.

AUTOMATED SYSTEM RENEWAL

- As filter cake builds up, the vacuum in the filter increases.
- When the preset vacuum is reached, the vacuum break valve opens allowing clean coolant to enter the vacuum chamber and release suction.
- A drive motor activates a chain/flight bar system to move the soiled media forward.
- The clean tank ensures an uninterrupted coolant supply to machines during media changes, enabling zero downtime.



PROCESS FLOW

WASTE HANDLING

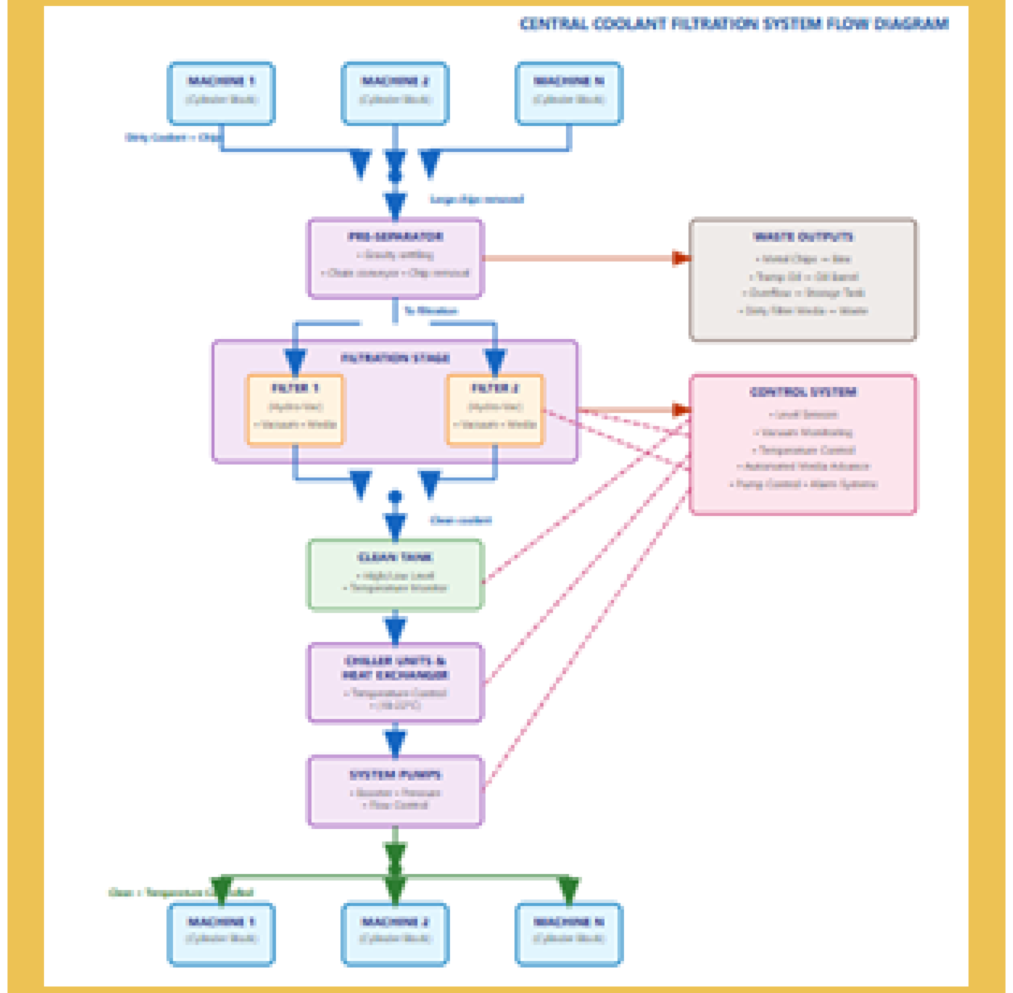
- Floating oil is separated from the coolant and directed to an oil barrel.
- Overflow coolant and sludge are diverted to storage or waste tanks using valves and drain pumps for proper disposal.

ENDLESS BELT OPTION

- Fresh media is unrolled, and dirty media winds onto a rewinder (with sensors for tear detection or full roll).
- For endless belt systems, a beater knocks off dirt, nozzles wash the belt, and sensors scan for damage.

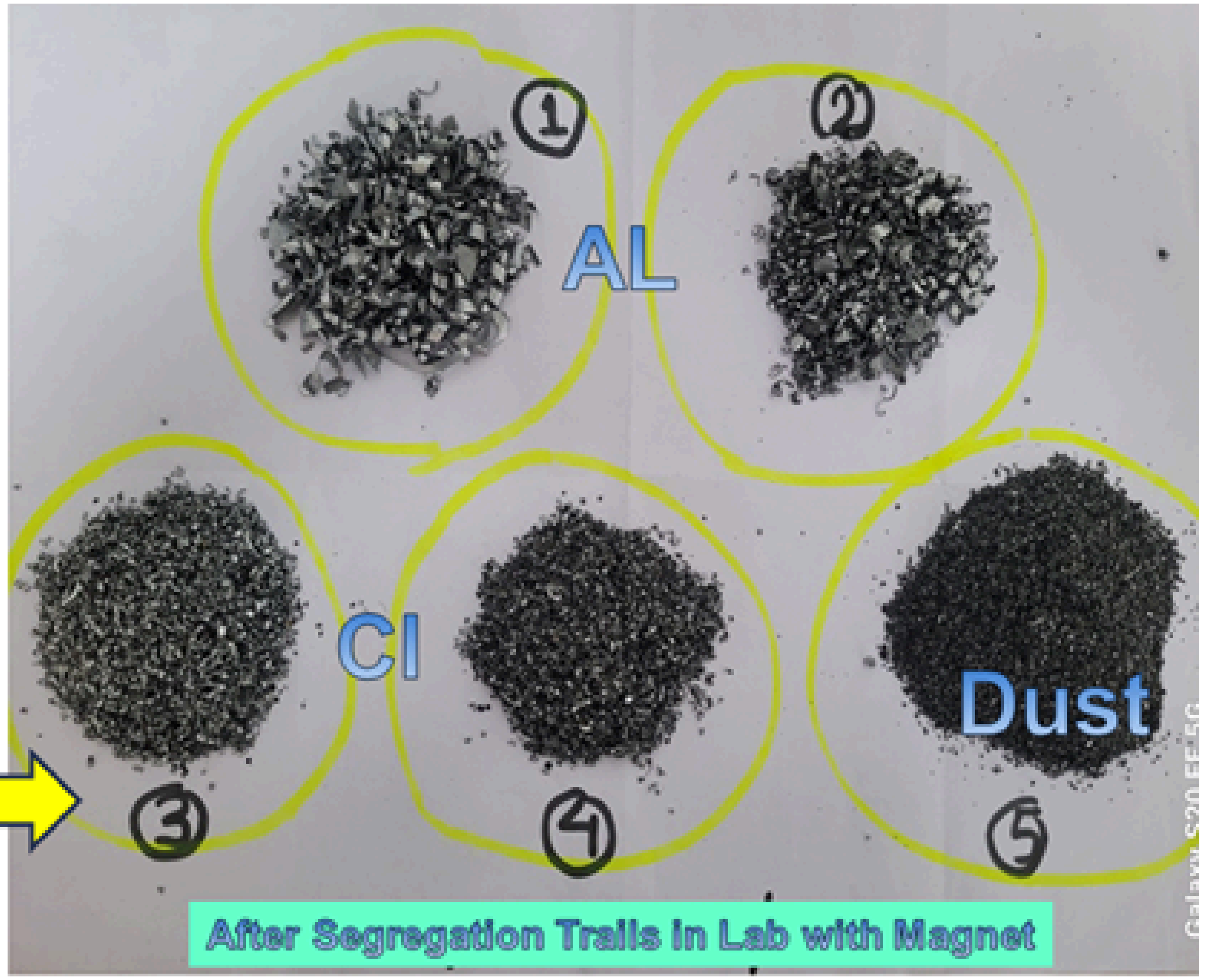
SYSTEM PUMPS AND AUTOMATION

- Centrifugal pumps move filtered coolant from the clean tank to machining stations through a manifold.
- These pumps are equipped with pressure gauges, non-return valves, and compensators for steady flow.
- Sensors monitor tank levels (max, min, overflow) and filter media status (end of roll, breakage).
- Automated controls manage pumps, conveyors, and valves with alarms signalling any faults or maintenance needs, ensuring reliable operation.



PROBLEM
STATEMENT

"The central coolant filtration system currently extracts mixed aluminum and cast iron chips generated during the machining of 1.2L cylinder blocks. These mixed chips, if not removed within a few days, undergo degradation due to an exothermic reaction between the two materials. The task is to design and implement a cost-effective method to separate the aluminium chips from the cast iron chips. This separation will facilitate material recovery and recycling, helping to reduce waste disposal costs and create potential revenue streams from the separated metals."



BACKGROUND
JUSTIFICATION

Machining chips are carried with coolant and collected in the pre-separator and filtration unit tanks via an underground velocity trench. The 1.2L Cylinder Block is made of aluminium with cast iron liners, resulting in mixed chips during machining. If not segregated and disposed of quickly, mixed chips deteriorate due to exothermic reactions, lowering their scrap value. Laboratory experiments have demonstrated that segregating aluminium from cast iron chips enables higher-quality, deterioration-free scrap, presenting an opportunity for increased revenue.

IMPLEMENTATION
ROADMAP

Given the chip size (up to 1–2 cm), material types (aluminium and cast iron), and industrial context (from a central coolant filtration system), the best approach for separation should meet these criteria:

- Efficient at industrial scale
- Low operating cost
- Simple to maintain
- Compatible with wet or dried chips

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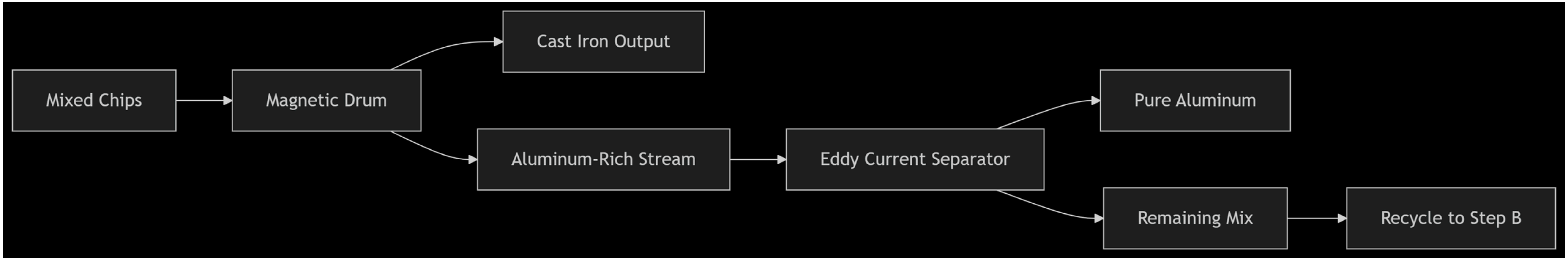
IMPLEMENTATION



PRE-TREATMENT (CRITICAL FIRST STEP)

- Install centrifugal dryer after pre-separator which reduces coolant carryover by 95%
- Add a vibratory screen to remove fines/swarf that hinder separation

CENTRIFUGAL CHIP DRYER:

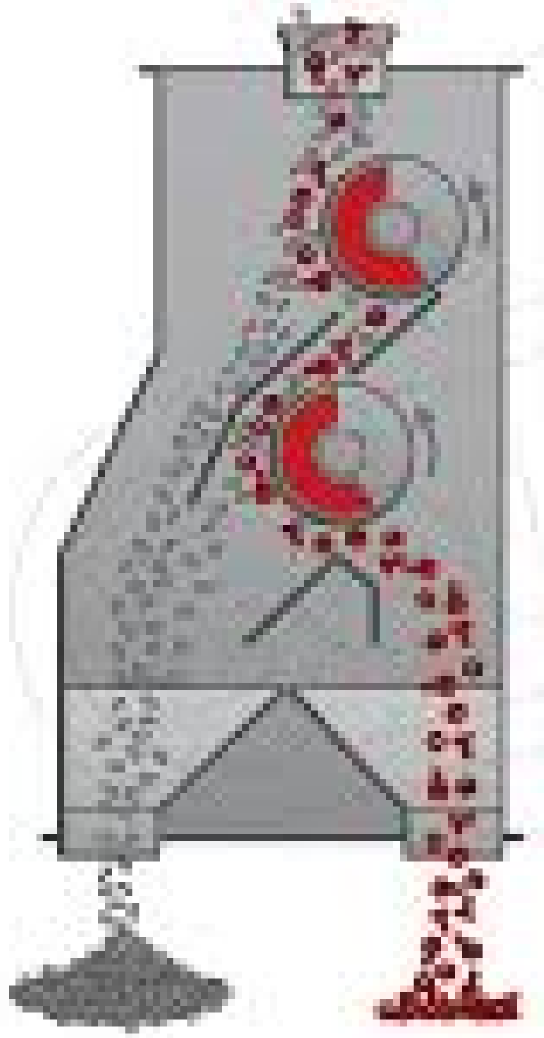
- Removes 90%+ coolant (reclaim to system)
- Throughput: 20-25% above current volume
- Output: Damp chips with 10-15% moisture
- Specs: 304 stainless steel, 5-10 HP motor

IMPLEMENTATION

PRIMARY MAGNETIC DRUM SEPARATION

Equipment: Install a double magnetic drum separator with Neodymium magnets
How it works: The drum separator comprises a rotating non-magnetic outer cylinder with a permanent magnet array fixed inside.
Material flow: Chips drop into a hopper or flow across the rotating surface.

- *Ferromagnetic (cast iron) particles:* Attracted to the magnetic field, stick to the surface of the drum and carry upward. Removes 85–90% of cast iron chips via strong magnetic force.
- *Non-ferrous (aluminium) particles:* Fail to respond and drop immediately.
- *Output:* Cast iron chips: 95–97% purity, ready for recycling. Aluminium chips: ~5-6% iron contamination.



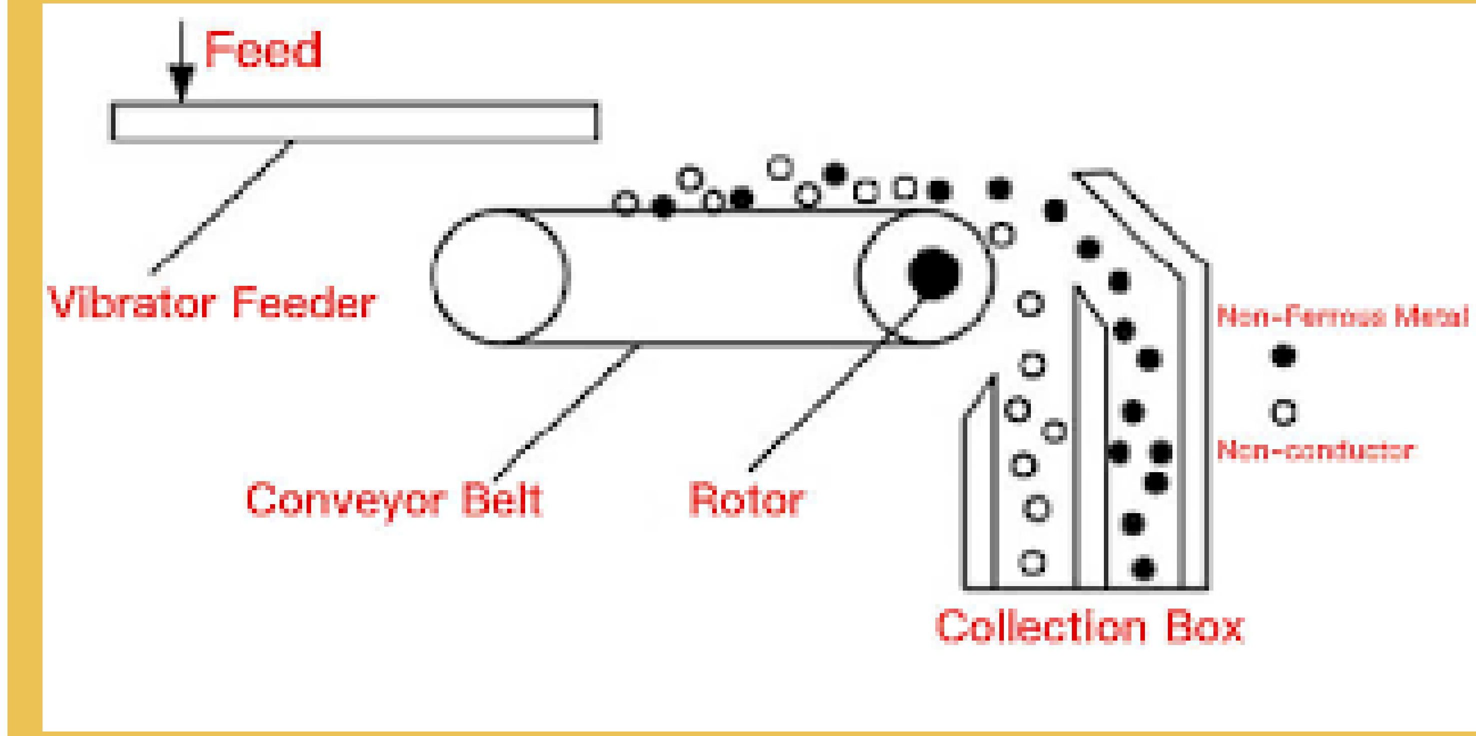
IMPLEMENTATION

EDDY CURRENT SEPARATOR

Equipment: Add an eddy current separator downstream.
Function: Repels aluminium chips from non-metallic debris (if present).
How it works: Aluminium experiences repulsive eddy currents and is thrown away from the path, while non-conductive residues or missed cast iron fall vertically.

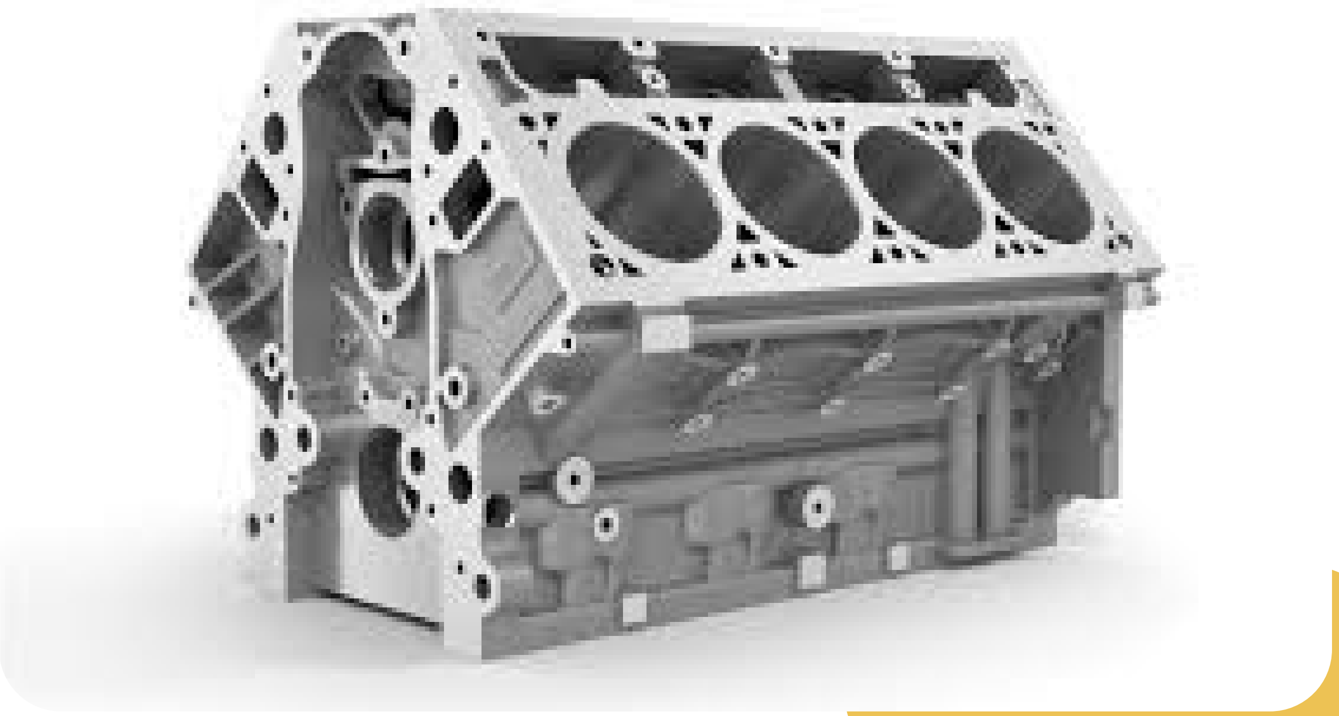
- *<u>Cost</u>: Moderate to high (one-time setup)*
- *<u>Maintenance</u>: Moderate*
- *<u>Condition</u>: Best for dry chips*
- *<u>Integration</u>: Easy to place post-pre-separator or pre-waste bin.*

- *Vibratory Feeders: Ensure even distribution*
- Ensure 200-300mm separation distance between aluminium and iron collection points
- Cast iron bin: Lined with wear-resistant rubber
- Aluminium bin: Sealed to prevent oxidation



WHY THIS WORKS BEST

- Continuous operation with minimal maintenance - highly efficient for small metal chips
- No complex chemical or fluid handling required
- Easily scalable and automatable
- Cost-effective with proven reliability
- Can process high volumes typical of machining operations
- Enables clean material recovery and resale



EXPECTED RESULTS

- Cast iron recovery: 95-98% purity
- Aluminum recovery: 92-95% purity (98%+ with secondary eddy current)
- Coolant recovery: 95%+ for reuse

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COST ESTIMATIONS

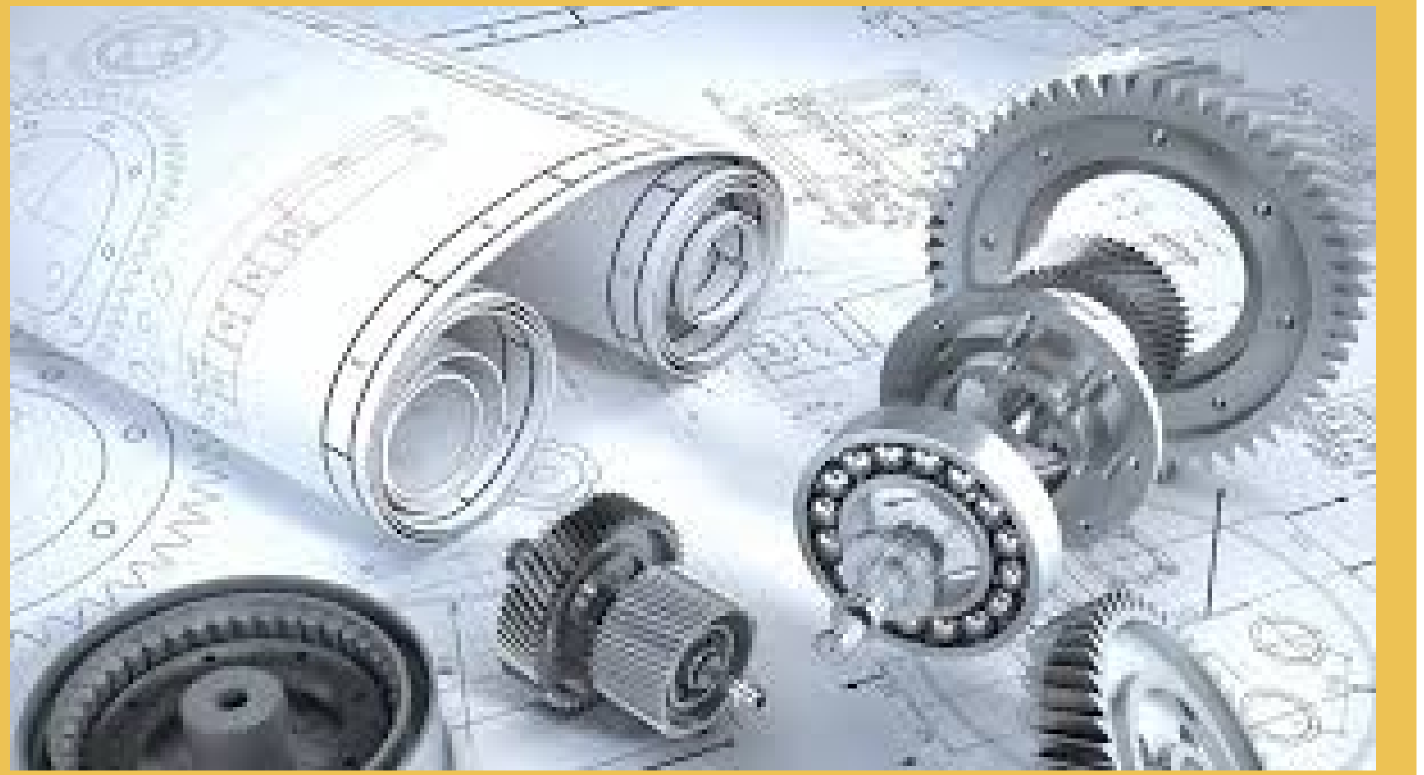
BREAKDOWN

Cyl Block Line TATA 1.2L						
Actual Production 1.2 L NA	**17610**	**16250**	**18430**	**16039**	**16299**	**14503**
Chips Generation @ 1.689 Kg/piece	29761	27463	31147	27106	27545	24510
Actual Production 1.2 L TC	**6630**	**3109**	**4150**	**5788**	**3574**	**3462**
Chips Generation @ 2.75 Kg/piece	18233	8550	11413	15917	9829	9521
Total Chips Generated MIX - (AL +CI)	**35843**	**24800**	**29843**	**31956**	**26128**	**24024**
TOTAL VOLUMES	**24240**	**19359**	**22580**	**21827**	**19873**	**17965**

Techno commercial working

	2025-26	
Budgeted Cyl Block Volumes Nos	225000	
Weight of Chips Generated @ 1.79kg/Com for CI+AL Mixed (Kg)	402750	
Scrap disposal Rate for CI+AL (Rs)	Rs 40/KG	
Total Annual Scarp Revenue expected with CI+AL disposal (Rs) - (A)	16110000	
Proposed CI & Al Chips separation by Magnetic Separator Machine by Weight %	CI	AL
	75%	25%
Weight in Kg of Chips Cast iron and Aluminium in Kg	302063	100688
Scrap disposal Rate for separate Cast-iron & Aluminium	Rs 40/KG	Rs 140/KG
Total Annual Scarp Revenue expected with CI & AL after separation (B)	12082500	14096250
	26178750	
Annual Savings expected after CI & Al Metal Scrap chips separation through Magnetic Conveyor: S1 = (B)- (A)	10068750	
Miscellaneous recurring Expenses for Magnetic Separator Operation and Maintenance /Annum (E1) - Rs	1200000	
Net Savings Annual: S2 = S1 - E1	8868750	
Chips separation machine Cost for the 1.2 L Cylinder Block (E2) - Rs	5447490	
ROI of the Proposal (E2/S2) in Years (Months)	0.61 Yrs (7.4 Months)	

DESIGN DETAILS
BREAKDOWN

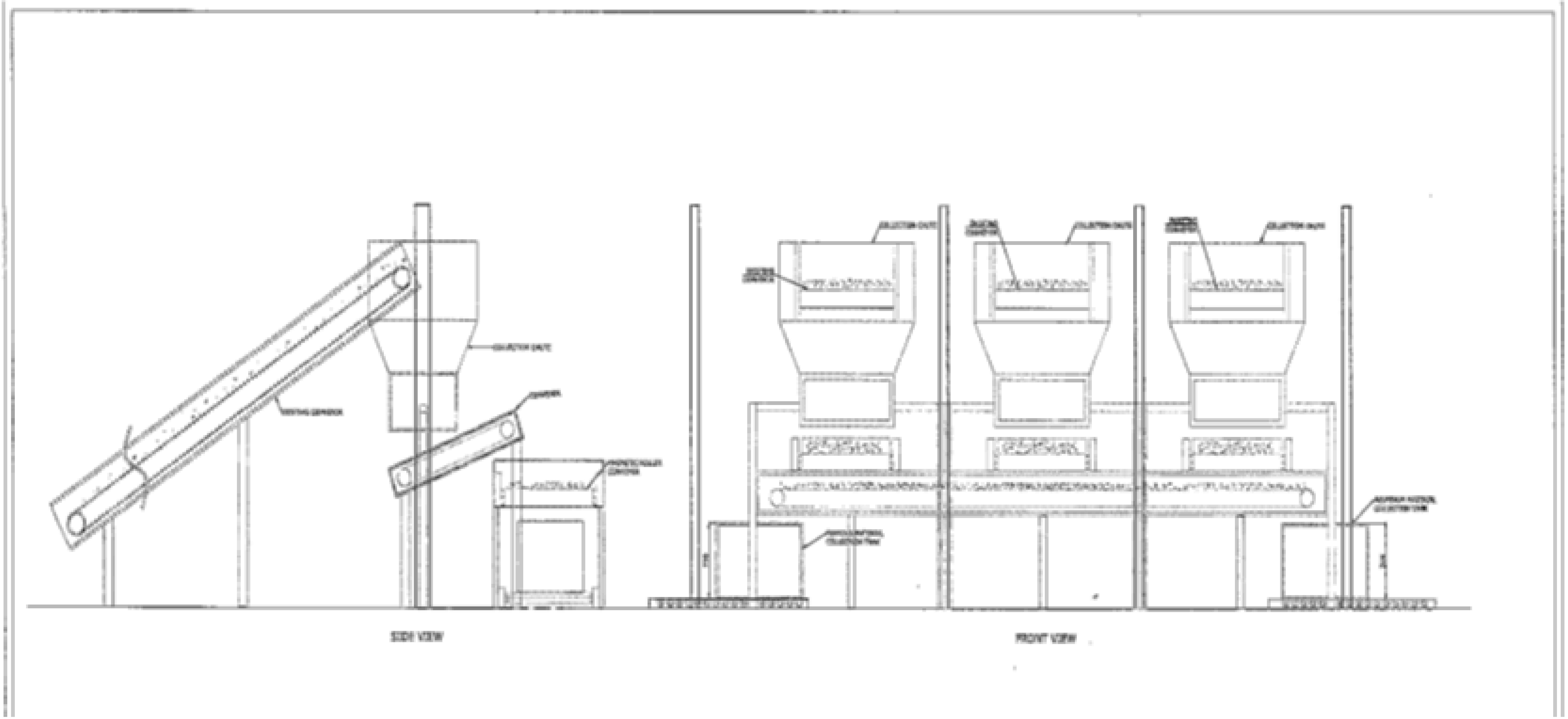


Roller Size: 100mm D x 1200mm L
Magnet Area: 1100mm (L)
Number of rollers: 3 No.
Capacity: 3.5 TPH
Magnet: Rare Earth N d Fe B
Magnet Grade: N-48
Strength: 12000-13000 Gauss on Roll Surface by Gauss Meter
Belt: 01 Set of 0.1mm thick
Feeder: 01 Set with ½ HP Vib Motor
Body: Total Dust Closed Body
Drive: 1 No. of 1HP, 3HP, 440V, 440 RPM Crompton make Ele. Motor with Radius

- Three belt conveyor for carrying material to the magnetic separator
- Multistage belt required to have maximum separation.
- Separate bins required
- Auto ON - OFF running signals required
- Incoming power connector should be within 10metre radius

DESIGN DETAILS

BREAKDOWN



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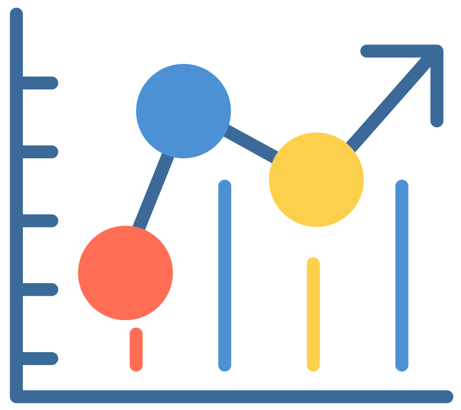
COST ESTIMATIONS

BREAKDOWN



Sr. No.	DESCRIPTION	AMOUNT (INR)
1	DESIGN DEVELOPMENT CHARGES PROTOTYPE	₹66,350
2	SITE MODIFICATION (Y CHUTE MODIFICATION)	₹1,67,600
3	MULTISTAGE MAGNETIC BELT SEPARATOR SYSTEM	₹37,47,600
4	Belt Conveyor – 3 nos.	₹9,80,000
5	Electric Control Panel & Cable	₹80,340
6	TRANSPORTATION	₹30,600
7	INSTALLATION TRIAL	₹3,75,000
	TOTAL AMOUNT	**₹54,47,490**

THANK YOU

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