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ELECTRA CLEAN

POLLUTION CONTROL DEVICE FOR AUTOMOBILE

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Abstract **:** Air pollution from automobile exhaust, particularly due to particulate matter (PM2.5 and PM10), has become a major concern in urban areas. These fine particles cause respiratory and cardiovascular diseases, making emission control a top priority. *ELECTRA CLEAN* is an innovative device that uses **Electrostatic Precipitation (ESP)** to filter out particulate matter from exhaust gases. Unlike conventional filters, ESP technology charges particles and collects them on oppositely charged plates.

Designed to be **compact, self-cleaning, energy-efficient**, and easy to retrofit, ELECTRA CLEAN is ideal for cars, two-wheelers, diesel generators, and more. Experimental results show up to **70% reduction in PM emissions**, confirming its effectiveness and potential in real-world applications.

1. INTRODUCTION

Air pollution poses a major environmental risk, especially in cities where the emissions from automobiles are one of the main causes of fine particulate matter. PM2.5 and PM10 particles are harmful and penetrate lungs deeply, leading to asthma, bronchitis, heart disease, and even death.

The traditional systems such as Diesel Particulate Filters (DPFs) and catalytic converters are widely utilized for emission control. Nonetheless, they have issues such as clogging, being expensive, and being inefficient at low exhaust temperatures.

This has created a demand for a low-cost, effective, and low-maintenance emission control product. ELECTRA CLEAN was imagined to address this problem through electrostatic

precipitation (ESP)—a method universally practiced in manufacturing but yet to be embraced widely in vehicles.

Electra Clean Fig. 1

ESP provides benefits like:
• Low pressure drop
• No maintenance required
• Capture of fine particles without clogging

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2. LITERATURE REVIEW

2.1 Background

Vehicular exhaust emissions include:
• Particulate Matter (PM2.5, PM10)
• Carbon Monoxide (CO)
• Hydrocarbons (HC)
• Nitrogen Oxides (NOx)

Chronic lung disease, cancer, and cardiovascular disorders are associated with long-term exposure to PM

2.2 Existing Emission Control Technologies

Method	Advantage	Limitation
Diesel Particulate Filter (DPF)	Filters large soot particles	Clogs, expensive, frequent maintenance
Catalytic Converter	Converts harmful gases	Ineffective for PM, needs high temp.
Scrubbers	Industrial use	Not feasible for vehicles

2.3 Electrostatic Precipitation (ESP)

Working Principle:

1. Ionizes PM in exhaust with high voltage
2. Charges the particles
3. Draws them to oppositely charged plates
4. Clean gas is emitted

Advantages:

- No consumable filters
- Captures sub-micron particles
- Low maintenance

3. METHODOLOGY

3.1 Design and Components

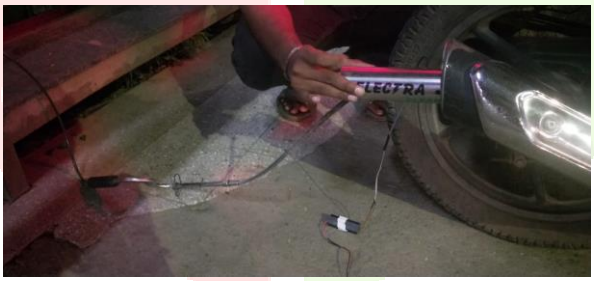
- **Ionizing Electrodes:** Stainless steel wires
- **Collector Plates:** Aluminum or mild steel
- **Power Source:** Step-up circuit (12V to 400 kV)
- **Casing:** Heat- and corrosion-resistant material
- **Self-Cleaning Mechanism:** Vibrator or scraper

3.2 Simulation & Fabrication

- CAD software used for 3D modeling
- Flow simulations optimized internal layout
- Tested in lab exhaust rigs simulating engine exhaust

3.3 Testing Setup

- PM2.5 & PM10 sensor
- Exhaust gas analyzer
- Thermocouple (to measure temperature)
- Power meter (to measure energy draw)
- Smoke opacity meter



Testing With Electra Clean Fig 2.

Testing Without Electra Clean Fig 3.

4. RESULTS AND DISCUSSION

4.1 Performance Comparison

Table 1: Emission Data Comparison

Operating Conditions	Carbon-Monoxide (Percentage %)	HydroCarbon (ppm)
Without Electra Clean	0.31	1863.0
With Electra Clean	0.04	507.0

4.2 Key Observations

- **Highly Efficient** in PM capture (>68%)
- **Energy Efficient** (only 4.2W from vehicle battery)
- **No Engine Backpressure**, ensuring performance
- **Thermally Stable** up to 500–600°C
- **No clogging or degradation** over time

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5. CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

ELECTRA CLEAN successfully demonstrates that **ESP can be integrated into automotive exhaust systems** to drastically reduce PM emissions. The system is:

- **Compact** and **energy efficient**
- **Self-cleaning** and **retrofit-friendly**
- Capable of meeting **BS-VI**, **Euro 6**, and **EPA** norms

5.2 Future Developments

- **IoT-Based Sensors:** For smart monitoring
- **Hybrid Solutions:** Combine ESP with catalytic converters
- **Heavy-Duty Use:** Scale for trucks and generators
- **Advanced Materials:** Use nanocoatings for better performance
- **Commercialization:** Partner with auto OEMs and municipalities

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