Tackling Delhi’s Air Pollution Problem

Prachi Patel

Reducing pollution will take a mix of technology and political will.

Among the sea of cars, motorcycles, and three-wheeled auto rickshaws at some of the busiest intersections in India’s capital of Delhi sit refrigerator-sized machines hopelessly chugging away. They suck in the brew of pollutants belched from the vehicles and pump out fresh air.

The machines, installed at 54 intersections this past autumn by the federal Central Pollution Control Board (CPCB), pass air through three filters to remove particulates and dust. Ultraviolet lamps sitting in an inner chamber trigger photocatalyst-coated charcoal particles to oxidize small, toxic organic compounds that make it past the filters, transforming them into, relatively speaking, innocuous carbon dioxide and water. The machine’s developers at the Council of Scientific & Industrial Research’s National Environmental Engineering Research Institute say a single filtration machine can purify air over an area of 500 m² and that larger devices capable of covering 10,000 m² are in the works.

Critics aren’t so sure about the machines or the 26 million Indian rupees (about $370,000) that they cost. “Their effectiveness outdoors is questionable,” says Polash Mukerjee, a senior researcher with the Delhi-based Centre for Science and Environment. The quoted areas over which they can purify air are based on lab measurements, rather than real-world ones, he contends. “They do work, but the area of impact is very limited. In an ambient outdoor atmosphere, it could be 2–3 m² around the machine.”

But even if the machines clean the area they are supposed to, the pollutants they would remove would be a blip in the haze enveloping Delhi, rated by the World Health Organization as the most polluted of the world’s large cities. Average levels of the most dangerous airborne particles—those less than 2.5 μm in diameter (PM2.5)—are 14 times as high as the WHO’s recommended limit. And on its current trajectory, the city’s massive pollution problem is going to only get worse. Already straining at the seams with a population of 29 million, Delhi is on target to pass Tokyo to become the world’s largest city by 2028, according to the United Nations.

Pollution in Delhi spikes in the winter, owing to a mix of cultural practices involving burning and meteorological factors. A thick, noxious mix of smog and dust obscures the sun and chokes lungs, forcing schools to close and citizens who can afford breathing masks to don them. Under pressure to do something, the CPCB is testing a few other technologies this winter in addition to filters at intersections. Thirty smaller air filters have been placed atop public buses. The CPCB also plans to sprinkle magnesium chloride and cement powder on roads and construction sites; these hygroscopic materials absorb water from the air, making the ground moist and keeping dust from flying up. And in late November, the agency announced a cloud-seeding project that, according to those in charge, should generate artificial rain to wash away pollution.

“These are Band-Aid solutions, not permanent or sustainable solutions,” says Sandeep Dahiya, campaign manager at the grassroots advocacy group Help Delhi Breathe. “Just political stunts to show that the central government is trying something.”

Instead of expensive machines that try to clean heavily polluted air, what the city needs is a sound, long-term plan.

Published: January 14, 2019
to curb pollution at its source, he and others say. But that might prove harder to do in Delhi than anywhere else in the world. Megacities like Beijing, Cairo, Los Angeles, and Mexico City all face pollution challenges. Like those cities, pollution comes from several sources and varies by season and meteorological conditions. In Delhi, though, this problem is compounded by an exploding growth in population and a lack of information, education, sound policies, and law enforcement. Antipollution measures have so far fizzled, but solutions are simple and obvious, experts say, and much boils down to political and social will.

■ WHAT’S IN THE AIR?

The eye-stinging pollution that Delhi residents try to keep out of their throats with breathing masks is a mix of gases and tiny particulates. Most of it comes from various types of burning: the biggest sources are exhaust from power plants and transportation, smoke from innumerable fires that rural inhabitants and poor city dwellers burn for warmth and cooking, piles of refuse burned on curbsides for easy disposal, and methane-triggered landfills fires. This burning spews a toxic brew of carbon dioxide, carbon monoxide, sulfur dioxide, and nitrogen oxide gases.

Particles—both PM$_{2.5}$ and those less than 10 $\mu$m in diameter known as PM$_{10}$—are the biggest health concern because they can penetrate the lungs and cardiovascular system. The smaller, PM$_{2.5}$ particles are especially deadly, increasing the risk of asthma, heart disease, strokes, and lung cancer. Dust kicked up on roads and from construction sites adds particles to the load generated from burning. About 30,000 deaths every year in Delhi are due to air pollution, according to Help Delhi Breathe, making it the fifth leading cause of death in India.

The first step in effectively curbing pollution is to understand how much comes from where, experts say. But this task is difficult in India because official numbers are rife with error and it is impossible to count smaller sources of pollution such as fires set by individuals. A government-funded report released in August 2018 by the Energy and Resources Institute (TERI) and the Automotive Research Association of India provided the most comprehensive analysis to date but used chemical analysis of air samples combined with modeling to apportion pollution to its sources. The study is the “first to use two different modeling approaches, which derive the same conclusions,” says Sumit Sharma, director of earth science and climate change at TERI.

In one approach, the team collected particulate samples at 20 locations—9 in the city and 11 in neighboring states (collectively called the National Capital Region)—during one winter and one summer in 2016–17. The researchers analyzed the samples and categorized their compositions into species like ions, metals, and carbon compounds, and then used computer simulations to trace them to sources like transportation exhaust, power plant emissions, road dust, and diesel generators.

The other approach involved starting with various sources of particulates in the National Capital Region, as well as pollutants transported from outside, and then using meteorological and chemical modeling to simulate how they would disperse and react. Comparing the results with pollution measurements allowed the team to determine the most likely profile of sources.

Both approaches show that, in the winter, vehicles are responsible for about 30% of Delhi’s PM$_{2.5}$ pollution. Industries, including power plants, contribute about 30%; the burning of biomass in kitchens and agricultural fields results in 14−23%; and dust kicked up by vehicles and from the region’s unchecked construction boom contributes another 17%. During the summer, the transportation sector’s share of particulate pollution goes down considerably while that of dust doubles.

Total particulate levels rise as winter approaches. In the cool season, farmers in Delhi’s neighboring agricultural states of Haryana, Punjab, and Uttar Pradesh burn crop residue such as rice or wheat stalks before reseeding their fields, and millions of people set off fireworks for several days for the Hindu festival of Diwali, which falls in October or November. Conditions peak in the winter when cold-air inversions trap particulates close to the ground, and lower wind speeds deposit dust from Gulf countries and neighboring Afghanistan, adding to northern India’s dust. Average winter concentrations of both PM$_{2.5}$ (168 $\mu$g/m$^3$) and PM$_{10}$ (314 $\mu$g/m$^3$) are double those in the summer.

■ THE PATH TO BLUER SKIES

Under public pressure, government officials are starting to act. Much of the focus so far has been on reducing vehicle and power plant emissions. The Delhi government has announced plans to clean up the transportation sector by introducing 1,000 electric public transport buses to its 5,500-strong fleet and meeting a goal for 25% of private vehicles to be electric by 2023. Other government proposals, such as banning private vehicles, have been met with protest and ridicule. “If you ban private vehicles you need a public transport system to meet demand,” Dahiya says. “We don’t have that system.”

The biggest positive step taken by the Delhi government was to permanently shut down the old, polluting Badarpur
coal-fired power plant in the southeastern outskirts of Delhi, Dahiya says. The plant, a major cause of the Capital Region’s air pollution, had been shut down every winter for the past three years as a way to scale back pollution. The CPCB has recently mandated that all highly polluting industrial plants install automatic emission-measurement stations, which will send data to the CPCB in real time to better enable enforcement of pollution rules.

Meanwhile, India’s state-run power producer, the NTPC, announced plans in October to start burning agricultural residue along with coal at its power plants near Delhi and eventually across the country. This co-firing should provide double benefits by avoiding the particulate pollution from directly burning crop waste and cutting power plant emissions, since agricultural residue can burn cleaner without the mercury and sulfur that are released with burning coal, Sharma says.

Other programs by regional and commercial entities are aiming to provide similar incentives. The Haryana state government is experimenting with providing farmers a machine called a Happy Seeder, which converts agricultural residue to fertilizer. In November, Swedish furniture giant Ikea announced plans to buy crop residue from farmers to use in products.

A PROBLEM OF COMPLIANCE

The government is taking steps to improve air quality, but they are still small and scattered. According to TERI, several concerted, combined measures could cut particulate pollution in Delhi by half. Turning agricultural residue into profitable products could reduce PM$_{2.5}$ levels in the winter by 12%. A more reliable supply of grid electricity to avoid running diesel generators and more clean-burning liquefied petroleum gas cooking stoves to replace biomass burning would cut levels by 13.7%. Enforcing pollution standards for industries and introducing 8,000 electric buses would cut another 10.5%.

But a giant hurdle to fixing India’s pollution is the implementation of existing rules, the Centre for Science and Environment’s Mukerjee says. “There are several policies and laws already in place but that are not being met on the ground.” Fireworks bans have not stopped people setting off fireworks. Vehicle emissions test centers are notorious for giving fraudulent compliance certificates. Construction companies do not suppress dust as required by using strategies such as setting up barriers, covering debris, or sprinkling building materials with water for storage and transport.

Uncontrolled fires at landfills are also a result of policies being ignored. Garbage dumps in Delhi have officially been shut since 2009 because they are already at capacity, but around 80% of the 10,000 metric tons of waste the city generates every day is still dumped in these sites, he says. The buildup of methane from the organic waste deep in the landfill leads to large spontaneous fires that can last for days because they are hard to douse.

The other glaring problem is political. Delhi, a city as well as a federally governed territory, gets caught between national, state, and local governments, all with different electoral interests to serve. The governments of Delhi and neighboring states point fingers at each other. State pollution control boards languish from a lack of funds and personnel. “Nobody is taking a regional approach to pollution,” Mukerjee says. Unless actions are taken jointly in Delhi and neighboring states, nothing will happen. “Air doesn’t know any political boundaries.”

Yet it is the politicization of the pollution issue that also gives experts hope. “People are suffering, and they will be more aware and will hold politicians accountable,” Dahiya says. “Bureaucrats will be forced to work on it...If they don’t act on it, it can backfire on them.” Grassroots efforts to make the public aware of air pollution levels and their health...
impacts, as well as education on personal antipollution steps, seem to be helping, he says.

Sharma points to even simpler solutions that would have a big near-term impact: proper waste management to avoid refuse and landfill fires, fully paved roads with curbs and landscaping so vehicles don’t stir up dust, construction-dust control, and the promotion of clean fuels and renewable energy. Those measures would have to work in concert with stringent standards and improved enforcement. “It’s not a hopeless situation,” Sharma says. “Models clearly show that you can achieve ambient air quality standards in Delhi...if you put the right technology and the right management in place.”

Prachi Patel is a freelance contributor to Chemical & Engineering News, the weekly newsmagazine of the American Chemical Society.