From Chemistry to Democracy
The Story of India's Indelible Ink

The year is 1950. India, a fledgling democracy, grapples with the challenge of ensuring free and fair elections. One major concern looms large: preventing fraudulent voting. Traditional methods of identification prove inadequate, opening the door to manipulation and electoral fraud. In this climate of uncertainty, the Council of Scientific and Industrial Research (CSIR) steps up, tasked with finding a scientific solution to safeguard the democratic process.

At the National Physical Laboratory (a constituent laboratory of CSIR) in New Delhi, the Ink Development Unit (IDU), led by Dr. Salimuzzaman Siddiqui, initially manufactures postal stamping ink and printing inks. IDU supplies about 6.8 tons of stamping ink to Posts and Telegraphs in the year 1949. Later, the Chemistry Division is set up at NPL with dedicated scientists like Dr. M L Goel, Dr. B G Mathur, Dr. V.D. Puri, and several other young chemists. By the year 1951, this team develops and manufactures indelible ink, a mark that proudly proclaims a citizen's participation in the electoral process while simultaneously preventing any attempts at double voting. The scientists delve into research, experimenting with various chemical compositions, searching for the perfect formula.

For the first two general elections, the Ink Development Unit at CSIR-NPL manufactured and supplied about 3 lakh litres of indelible ink, each time, to the Election Commission of India.

Before the 1962 general elections, the know-how and the ink formula was transferred to Mysore Paints & Varnish Ltd. (MPVL), a public undertaking. MPVL has since been supplying the ink for every election.

Their efforts culminate in a breakthrough - a unique concoction based on silver nitrate. This ingenious solution, upon contact with the skin and exposure to ultraviolet light, leaves a stubborn stain, a deep purple mark that refuses to be washed away. It becomes a symbol of democratic participation, a badge of honour worn on the left forefinger of every voter.

The success of the indelible ink is immediate and resounding. News of this innovative solution travels beyond India's borders, attracting the attention of other nations grappling with similar challenges.

Soon, MPVL ramped up production, and lakhs of 10 ml vials are dispatched to over 35 countries around the world. From Canada to Ghana, from Mongolia to South Africa, the indelible ink becomes a universal symbol of free and fair elections, a testament to Indian scientific ingenuity.

Subsequently, several attempts are to improve the formulation to make the ink dry faster, stay resistant to wide range of solvents, and stay sufficiently longer. Years turn into decades, and the indelible ink formula remains largely unchanged, a testament to its effectiveness and the foresight of its creators.

Exploring Other Areas of Application

Researchers at CSIR-NPL envision a future where this technology extends beyond elections, offering solutions in diverse fields. The team explores the potential of luminescent inks in anti-counterfeiting measures, marking valuable goods and documents with an invisible signature that only reveals itself under UV light. This could be a game-changer in combating the trade of counterfeit pharmaceuticals, electronics, and luxury goods, protecting both consumers and businesses. The invisible ink, for example, while invisible in day light, emits a vibrant red colour under a 365 nm ultraviolet light.

Further, researchers delve into the medical applications of these specialised inks. The team explores the possibility of using biocompatible luminescent dyes for advanced medical diagnostics. Imagine a scenario where the ink, injected into the bloodstream, could illuminate specific cells or tissues under UV light, aiding in early disease detection and targeted drug delivery.

The potential extends even further, into the realm of forensics. Invisible ink could be used to mark crime scene evidence, ensuring its authenticity, and preventing tampering. It could also be utilised for discreetly marking and tracking stolen property, aiding in its recovery. Almost on the edge of the science fiction, the integration of the ink with biometric systems could create a multi-layered authentication process for different security applications. The possibility of incorporating microchips or QR codes within the ink itself paves the way for a future where a single drop could hold a wealth of information, further enhancing the security.

Meanwhile, the original indelible ink continues its global journey, adapting to the specific needs of different nations. In some countries, it is applied with a brush, while in others, it is dispensed through nozzles. The ink's formula is also tweaked to cater to varying climatic conditions, ensuring its effectiveness in humid or arid environments.

The journey of the indelible ink, from its humble beginnings to its high-tech evolution, is a story of science serving society, of innovation safeguarding democracy. It is a testament to the dedication of scientists who work tirelessly behind the scenes, their efforts often unseen but their impact undeniable. As long as elections are held, the indelible ink will continue to play its crucial role, ensuring that every vote counts, and every voice is heard. It is a mark not just on the finger, but on the very fabric of democracy.

Contributed by: Science Media Communication Cell (SMCC), CSIR-NIScPR, New Delhi.

INTERVIEW

Prof. Venu Gopal Achanta
Director, CSIR-NPL

Q: How did the 1962 elections influence the research and production of the indelible ink?

A: The 1962 elections underscored the critical need for an indelible ink that not only resisted removal but also dried quickly. While various salt-based formulations were initially explored, the final composition adopted a water-based solution containing 10-25% silver nitrate, along with additional pigments to impart the characteristic violet coloration upon exposure to light. This formulation effectively addressed the challenges identified during the earlier elections and has since served as the foundation for subsequent refinements.

Q: Without revealing proprietary information, could you describe the general chemical properties that make the indelible ink so effective?

A: Extensive research and development efforts, particularly between 1949 and 1951, led to the incorporation of a higher concentration of silver nitrate, enhancing the ink's photo-responsiveness. Subsequent attempts to modify the formulation were rigorously evaluated and ultimately rejected to maintain the established efficacy and safety standards. The ink's interaction with human skin has been meticulously studied and we are still using the near original formulation which was developed around 1950.

Q: How does CSIR-NPL cater to the diverse needs of the international market?

A: The indelible ink developed by CSIR-NPL is currently exported to 35 countries. To efficiently cater to the diverse needs of these international markets, the technology was transferred to Mysore Paints through the National Research Development Corporation (NRDC). CSIR-NPL maintains a role as a technical consultant, providing expertise and support to ensure the formulation's adaptability and effectiveness in meeting the specific requirements of global customers.

Q: Can you elaborate on the new research and technologies currently being developed by CSIR-NPL?

A: CSIR-NPL remains at the forefront of innovation, with ongoing research focusing on the development of advanced pigments not only for indelible ink applications but also for enhancing the security features of currency notes, stamp papers, and passports. These specialised pigments exhibit unique properties, such as the ability to emit multiple colours under different light sources. For instance, when exposed to UV or blue light, these pigments can transition from green to red, providing an additional layer of security. Further research is exploring the development of invisible inks, detectable only under specific light conditions, offering highly specialised applications for document and currency authentication.