Development of embedded systems to control toxic compounds in textile industries

Jahnavi KRM	Lecturer, Department of Physics, BVK PG college, Visakhapatnam, Andhra Pradesh
Raghavendra Rao K	Professor, Department of Physics, Sri Krishnadeveraya University, Anantapur – Andhra Pradesh
Padma Suvarna R	Associate Professor, Department of Physics, Jawaharlal Nehru Technological University, Anantapur, Andhra Pradesh

ABSTRACT

The Textile Sector in India ranks next to Agriculture. Textile is one of India's oldest industries and has a formidable presence in the national economy in as much as it contributes to about 14 per cent of manufacturing value-addition, accounts for around one-third of our gross export earnings and provides gainful employment to millions of people. The textile industry occupies a unique place in our country. This review discusses genetic hazards associated with the production and use of textile dyes throughout India. Heavy metals such as lead (Pb), chromium (Cr), cadmium (Cd) and copper (Cu) are widely used for production of colour pigments of textile dyes. Textile dyes pollutants are being released to the environment at various stages of operation therefore it is necessary that the pollutants are to be quantified using any embedded system. In this article embedded systems for the analysis, monitoring and controlling the heavy metals and toxic chemicals used in fabric dyes are reviewed.

INTRODUCTION
Growth of textile industry in India
India's dye industry produces every type of dyes and pigments. Production of dyestuff and pigments in India is close to 80,000 tonnes. India is the second largest exporter of dyestuffs and intermediates developing countries, after China. The textile industry accounts for the largest consumption of dyestuffs, at nearly 80%. The textile industries are to satisfy the ever-growing demands in terms of quality, variety, fastness and other technical requirements. However, a recent study conducted under the National Biodiversity strategy and Action Plan (BSAP) has revealed that chemical colors have all but wiped out India's wonderful vegetable dyes. The Indian textile industries now predominantly use synthetic organic dyes like direct dyes, processing dyes, reactive dyes, etc. The large variety of dyes and chemicals used in an attempt to make more attractive popular shades of fabrics for a competitive market render them very complex [1].

Effects of textile dyes on health
During the last decade, environmental issues associated with dyestuff production and application have grown significantly and are indisputably among the major driving forces affecting the textile dye industry today. Considerable amounts of dyes have been noticed in these textile wastewaters, due to their incomplete use and washing operations. The dyes disposed off, can be found in dissolved state or in suspension in the wastewater. These dyestuffs are highly structured polymers and are very difficult to decompose biologically [2]. The most obvious impact of the discharge of dye colored effluent is the persisting nature of the color. It is stable and fast, difficult to degrade, toxic, rendering the water unfit for its intended use. Further, the color removal is also not adequate by the conventional chemical and biological treatment. Such dyestuffs can reach the aquatic environment, primarily dissolved or suspended in water, since the conventional treatment of wastewaters from textile mills and dyestuff factories are unable to remove most of the azo and other dyes effectively. The resulting dye effluents may contain some components or moieties that could be toxic, carcinogenic or mutagenic to aquatic life [3]. Ecological and toxicological problems due to the discharge of textile wastewaters, in natural water bodies, have been one of the most important water pollution problems in India.

Since large quantities of dyes are used, such pollution due to dyes may occur on a significant scale. The International Agency for Research on Cancer (IARC) has classified various dyes like Benzidine as being associated with cancer in humans [6]. Benzidine is known to be carcinogenic to a variety of mammalian species, including humans. A number of dyes have been tested for mutagenicity of DNA. Several of them have been found to be carcinogenic [4-6]. Because of the wide spread use and poten-

tial carcinogenicity of certain dyes, there has been a growing interest in assessing the hazards associated with dyes available in local markets. Most of such dyes, being openly sold in the markets have no information regarding their chemical nature, purity, toxicity or possible mutagenicity.

Recommendations of controlling authorities
Unlimited and uncontrolled use of the dyes can lead to grave consequences in terms of human health and ecological balance Central Pollution Control Board has listed the dye and dye intermediates industry as one of the heavily polluting industries. Assessment of genotoxicity of dyes is therefore of utmost importance [7-10].

The textile industry has been condemned as being one of the world's worst offenders in terms of pollution because it requires a great amount of two components:
- Chemicals: as many as 2,000 different chemicals are used in the textile industry, from dyes to transfer agents; and
- Water: a finite resource that is quickly becoming scarce, and is used at every step of the process both to convey the chemicals used during that step and to wash them out before beginning the next step.

The water becomes full of chemical additives and is then expelled as wastewater; which in turn pollutes the environment:
- by the effluent's heat;
- by its increased pH;
- and because it's saturated with dyes, de-foamers, bleaches, detergents, optical brighteners, equalizers and many other chemicals used during the process.

Traditionally produced fabrics contain residuals of chemicals used during their manufacture—chemicals that evaporate into the air we breathe or are absorbed through our skin. Some of the chemicals are carcinogenic or may cause harm to children even before birth, while others may trigger allergic reactions in some people.

Water Usage:
The textile industry is one of the most chemically intensive industries on earth, and the No. 1 polluter of clean water (after agriculture). It takes about 500 gallons of water to produce enough fabric to cover one sofa. Half a billion people already live in regions prone to chronic drought, and by 2025, that number is likely to have increased five-fold, to between one-third and one-half of the entire world population. Global consumption of fresh water is doubling every 20 years.

Water Pollution:
Mills discharge millions of gallons of effluent each year, full of

chemicals such as formaldehyde (HCHO), chlorine, heavy metals (such as lead and mercury) and others, which are significant causes of environmental degradation and human illnesses. The mill effluent is also often of a high temperature and pH, both of which are extremely damaging.

Heavy metals in fabric dyes

Because of positive and negative effects and the toxicity of trace heavy metals on human health and the environment, many researchers have studied the analysis of the trace metal contents of the environmental and industrial samples including textile products [10-14]. Textile is one of the main industries in developing countries. Quality of textile productions is very important for export. People want to be able to buy clothing, bedding and household textiles that have been tested and are not dyed in any way with harmful substances [15-18]. Textile products contain some organic and inorganic substance including trace metal ions. Especially, reactive and pigment dyes contain trace heavy metals at high level. Trace metals may be health risks for human even at low concentrations in textile products [19]. Traces of heavy metals are often present in different textile process such as metal complex dyes, dye stripping agents, oxidizing compounds, antifungal, odor-preventive agents and mordant reactive [20]. Toxic and allergic metals including cadmium, copper, nickel, zinc, and chemicals like formaldehyde and chlorinated hydrocarbons can exist in natural structures of textiles or they can penetrate into the textiles during the production, dying process or via the protection agents used for the storage of these textiles [21,22]. The most important standard in Europe is Oeko-Tex Standard 100 [23]. Trace metal contents of textile samples including cotton, polyester, etc., have been studied in the literature [24-27]. Studies on the trace heavy metal contents of Turkish textile products are limited. The determination of trace heavy metals in textile productions is very important not only for the safety of consumers but also for the textile industry. The reliability of trace heavy metals determination in its complex matrices mainly depends on the dissolution process used. Both the wet and dry ashing procedures are slow and time consuming. In recent years, microwave digestion procedures in closed vessels have been developed as a rapid and reproducible sample preparation method for a great variety of complex matrices [28-34]. Instrumental techniques like inductively coupled plasma-optical emission spectrometry (ICP-OES) and inductively coupled plasma-mass spectrometriy (ICP-MS) are used for the determination of metal ions in real samples at traces levels [35-37]. Atomic absorption spectrometry including flame or graphite furnace techniques is also the most widely used technique, because most of the concentrations of metals in the environmental and textile samples are determined using this technique [36]. To detect the quality and quantity of heavy metals and toxic chemicals in fabric dyes, design of embedded systems will be useful for manufacturers to control the toxicity.

EMBEDDED SYSTEMS IN TEXTILE INDUSTRIES

Embedded systems are used to control a wide variety of dynamic and complex applications, ranging from non-safety-critical systems such as cellular phones, media players, and televisions, to safety-critical systems such as automobiles, airplanes, and medical devices.

Embedded systems are also being produced at an unprecedented rate, with over four billion units shipped in 2006 [37]. As a prominent example of an embedded system, consider the drive-by-wire systems that are emerging in modern automobiles [38]. In an automobile using a drive-by-wire system, mechanical components such as actuators and cables are replaced by sensors, wires, embedded computers, and software components.

Relying on these, the automobile can perform properly regardless of the surrounding environment and operator expertise. Clearly, systems such as these must be sufficiently dependable; however, there is ample evidence that often they are not. Toyota Corporation has admitted that a "software glitch" is to blame for braking problems in the 2010 Prius, in which cars continue to move even when their brakes are engaged. In addition, a power train control software system used in the 2004/2005 Prius has programming errors that can cause the cars to stall or shut down while driving at highway speeds. Other faults occurring in embedded systems, such as Ariane [39] crash due to operators environment change; The Therac-25 Tragedies [40], the Mars Pathfinder [41] failures and many other smaller incidents [42]. There are, however, different classes of embedded systems. Embedded systems can be classified into hard real-time and soft real-time depending on their requirements. Hard real-time embedded systems perform tasks such as digital signal processing and controlling avionics. These systems are often deployed in challenging computing environments, and they have strict temporal requirements. Much of the research on validating hard real-time embedded system has focused on these temporal requirements. On the other hand, soft real-time embedded systems are not required to satisfy hard real-time constraints. Examples of these systems include mobile phones, digital cameras, and personal digital assistants. In these systems, timing issues are less important; non-temporal behaviors are also prone to failures, and yet, have been subject to far less research. There has been a great deal of work on verifying properties of both hard and soft realtime embedded systems using non-testing based approaches. Static analysis is used to enhance the overall quality of software while reducing run-time costs (e.g., [45]). Formal verification techniques are also used (e.g., [46]) by researchers, but these do not address the practical problems and situations that existing in the great majority of industrial settings. In fact, in many industrial settings, testing takes on great importance. There has been some research on techniques for testing for soft real-time embedded systems. Some efforts focus on testing applications without specifically targeting underlying software components, and without observing specific underlying behaviors (e.g., [47]) while others focus on testing specific major software components (e.g., real-time operating kernels and device drivers) that underlie the applications (e.g., [48]). Certainly applications must be tested, and underlying software components must be tested.

CONCLUSION

Embedded systems cover a large range of computer systems from ultra small computer-based devices to large systems monitoring and controlling complex processes. The overwhelming number of computer systems belongs to embedded systems: 99% of all computing units belong to embedded systems today.

Most of such embedded systems are also characterized as real time systems, which mean that the real-time properties such as response time, worse case execution time, etc., are important design concerns. These systems usually must meet stringent specifications for safety, reliability, availability and other attributes of dependability. Due to small size and requirements for mobility, but also extremely low production costs these systems require small and controlled resource consumption, and have limited hardware capacity. The increased complexity of embedded real-time systems leads to increasing demands with respect to requirements engineering, high-level design, early error detection, productivity, integration, verification and maintenance, which increases the importance of an efficient management of life-cycle properties such as maintainability, portability, and adaptability.

REFERENCE

1. CPCB, (1995) : Pollution control, acts, rules and modifications issued their under Central Pollution Control Board, New Delhi | 2. Debruim, A. 1976. In : Biochemical toxicology of environmental agents. Amsterdam | 3. Goel, PK (1997): Water pollution, causes, effects and control. New Age International (P) Ltd., publishers, New Delhi: 269. | 4. Jamuna, S. (2008).Treatment of sewage waste water using aquatic plant, water hyacinth- Eichhornia sp. And its reuse for culture, growth, histopathology and Biochemistry of fish, Tilapia mossambica, B.Sc., Dissertation, university of Madras. | 5. Kumaraguru, A.K. 1995. Water pollution and fisheries., Ecol. Environ and Contan., 1(1-4) : 145-150. | 6. Lowry, O.H., Rosebrough, N.J., Farr, A.H. and Randall, R.J. 1951. Protein Measurement with the folin phenol reagent, J. Biol. Chem., 193 : 265-275. | 7. Mohan Rao, G. 1998. Application of treated effluent for irrigation. Water world, Department of Engineering, Rec, Trichy: 4-13. | 8. Muthuswamy, A., and Jayabalan, N. 2001. Effects of factory effluents on physiological and biochemical contents of Gossypium hirsutum L.J. Environ. Biol. 22 (4) : 237-247. | 9. Revathy, K. 1995 Physico-chemical characteristics of tannery effluent from a chrome leather tanning industry and its effects on the physiology and biochemistry of two larvivorous fishes, Gambusia affinis and poecillia reticulate. Ph.D. Thesis. submitted to the University of Madras. | 10. Roe, H.H. 1955. The determination of sugar in blood and spinal fluid with anthrone reagent, J. Biol. Chem., 212:335-343. | 11. Shobana, J. 2008. Degradation of sewage waste water, biabsorption of heavy metals – copper and zinc and anatominal study of affected parts of aquatic plants, water hyacinth- Eichhornia sp. B.Sc., Dissertation, University of Madras. | 12. Singh, H. and Singh, T.P. 1980. Short-term effect of two pesticides on lipid and cholesterol content of liver, ovary, blood serum during prespawning phase in the fresh water teleost, Heteropneuses fossilis (Bloch). Environ Poll., 20(3) : 65-67. | 13. Singh, S.M., Varshneya, I. and Nagarkoti, M. 1998. Assessment of physico-chemical parameters of effluents of three factories of bareilly district and their possible effects on grazing animals and cereals. J. Environ. Biol. 19(3) : 271-274. | 14. Somnath, V. 2002. Toxicity of tannery effluents to some aquatic animals J.Ecotoxicol. Environ. Monit. 12(4): 277-284. | 15. Tiwari, P.K. 1994 . An agenda for pollution control in dairy industry. Indian dairy man. 46 (10) : 617-624. | 16. Ware, G.M. 1980. Effects of pesticides on non target organisms. Res. Rev., 76: 173-201. | 17. Mock, G. N. "Seventy-five years of change in dyeing and finishing," in Book of Papers of International Conference & Exhibition, American Association of Textile Chemists and Colorists, September 15-18, 1996, Nashville, Tenn., USA, pp.419-431. | 18. Moore, S. B.; R. A. Diehl; J. M. Barnhardt; and G. B. Avery, "Aquatic toxicities of textile surfactants," Textile Chemist and Colorist 19, 29-32 (1987). | 19. Naylor, C. G., "Environmental fate and safety of nonylphenol ethoxylates," Textile Chemist and Colorist 27, 29-33 (1995). | 20. Nemerow, N. L.; and A. Dasgupta, Industrial and Hazardous Waste Treatment, Van Nostrand Reinhold, New York, 1991. | 21. Nettles, J. E., Handbook of Chemical Specialties - Textile Fiber Processing, Preparation, and Bleaching, John Wiley & Sons, New York, 1983. | 22. Nordberg, G., "Chapter 5 – Use of Toxicity Data on Single Chemicals to Predict the Effects of Mixtures," in Methods for Assessing the Effects of Mixtures of Chemicals, edited by V. B. Vouk, G. C. Butler, A. C. Upton, d. V. Parke and S. C. Asher, John Wiley & Sons, Chichester, 1987, pp.99-114. | 23. Norman, P. I.; and R. Seddon, "Pollution control in the textile industry - the chemical auxiliary manufacture's role," Journal of the Society of Dyers and Colourists 107, 215-218 (1991). | 24. Novatex Machinery Inc., information on incoming material inspection and testing, 840 Ellingham, Montreal, Quebec, H9R 3S4, Tel: (514) 695-3149, Fax: (514) 695-3320. | 25. Olson, E. S., Textile Wet Processes volume 1: Preparation of Fibres and Fabrics, Noyes Publications, Park Ridge, New Jersey, USA, 1983. | 26. O'Neill, C.; F. R. Hawkes; D. L. Hawkes; N. D. Lourenco; H. M. Pinheiro; and W. Delee, "Review - Colour in textile effluents – sources, measurement, discharge consents and a review," Journal of Chemical Technology and Biotechnology 74, 1009-1018 (1999). | 27. Poulios, I.; and I. Aetopoulou, "Photocatalytic degradation of the textile dye reactive orange 16 in the presence of TiO2 suspensions," Environmental Technology 20, 479-487 (1999). | 28. Ramalho, R. S., Introduction to Wastewater Treatment Processes, Academic Press, New York, 1977. | 29. Reddig, W., "Complex market demands made on reactive dyes – a challenge for an innovative dyestuff producer," Melliand International Textile Reports 78, E190-E191 (1997). | 30. Regent Textile Machinery Canada Ltd., information on chemical recovery systems with vacuum technology, dyehouse supervising system, and low liquor dyeing machines, 1415 Pitfield, Montreal, Quebec H4S 1G3, Tel: (514) 333-1415, Fax: (514) 333-1112. | 31. Rucher, J. W.; and D. M. Guthrie, "Reduction of salt requirements in dyeing cotton with fiber reactive dyes," in Book of Papers of 1997 International Conference & Exhibition , American Association of Textile Chemists and Colorists, September 28-October 1, 1997, Atlanta, GA, USA, pp.329-336. | 32. J. L. Lyons. ARIANE 5, flight 501 failure. http://www.ima.-umn.edu/ arnold/disasters/- ariane5rep.html, July 1996. | 33. S.S. Muchnick and N.D. Jones. Program Flow Analysis: Theory and Applications. | Prentice-Hall, Englewood Cliffs, NJ, 1981. | 34. Madanlal Musuvathi and Shaz Qadeer. Iterative context bounding for systematic testing of multithreaded programs. In Proceedings of the 2007 ACM SIGPLAN conference on Programming language design and implementation, pages 446–455, 2007. | 35. Mayur Naik, Alex Aiken, and John Whaley. Effective static race detection for java. | SIGPLAN Not., 41(6):308–319, 2006. | 36. Gleb Naumovich, George S. Avrunin, and Lori A. Clarke. Data flow analysis for checking properties of concurrent java programs. In Proceedings of the 21st international conference on Software engineering, pages 399–410, 1999. | 37. T. J. Ostrand and M. J. Balcer. The category-partition method for specifying and | generating fuctional tests. Commun. ACM, 31:676–686, June 1988. | 38. Hemant D. Pande and William Landi. Interprocedural def-use associations in c programs.In Proceedings of the symposium on Testing, analysis, and verification, TAV4,pages 139–153, 1991. | 39. Chang-Seo Park and Koushik Sen. Randomized active atomicity violation detection | in concurrent programs. In Proceedings of the 16th ACM SIGSOFT International | Symposium on Foundations of software engineering, pages 135–145, 2008. | 40. Sandra Rapps and Elaine J. Weyuker. Selecting software test data using data flow | information. IEEE Transactions on Software Engineering, 11:367–375, April 1985. | 41. Stuart C. Reid. An empirical analysis of equivalence partitioning, boundary value | analysis and random testing. Software Metrics, IEEE International Symposium on, | 0:64, 1997. | 42. Thomas Reps, Thomas Ball, Manuvir Das, and James Larus. The use of program profiling for software maintenance with applications to the year 2000 problem. SIGSOFT Softw. Eng. Notes, 22:432–449, November 1997. | 43. Stefan Savage, Michael Burrows, Greg Nelson, Patrick Sobalvarro, and Thomas Anderson. Eraser: a dynamic data race detector for multithreaded programs. ACM | Transactions on Computer Systems, 15(4):391–411, 1997. | 44. Koushik Sen. Race directed random testing of concurrent programs. In Proceedings | of the 2008 ACM SIGPLAN conference on Programming language design and | implementation, pages 11–21, 2008. | 45. Abraham Silberschatz, Peter Galvin, and Greg Gagne. Applied Operating System | Concepts. John Wiley & Sons, Inc., New York, NY, USA, 1st edition, 2001. | 46. S. Sinha, M. J. Harrold, and G. Rothermel. Computation of interprocedural control | dependencies. ACM Transactions on Software Engineering and Methodology, 10(2):209–254, April 2001. | 47. Bjarne Steensgaard. Points-to analysis in almost linear time. In Proceedings of the | 23rd ACM SIGPLAN-SIGACT symposium on Principles of programming languages, pages 32–41, 1996. | 48. Scott D. Stoller. Testing concurrent java programs using randomized scheduling. | Electronic Notes in Theoretical Computer Science, 70(4):142 – 157, 2002. |