



Lead in Printing ink

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ABSTRACT

Lead is poisonous heavy metal which is widely used in industries because of its properties. Lead poisoning is one of the rising problems caused by industrialization. Lead can cause neurological disease, gastrointestinal diseases, and infertility in men and even death in high exposure. Lead and lead compounds are widely used in inks, paints and other surface coating agents as colouring agents and adhesive agents. In India, use of lead and lead compounds in ink, paint and other surface coating agents are regulated by Bureau of Indian Standards. Permissible level of lead in ink is 1000 ppm (0.1%) according to BIS and 600 ppm (0.06%) according to US regulations. In this study, widely used offset printing inks of 6 manufacturers are collected and analysed for lead content (4 colours of each company, CMYK). It was found that international companies have much lower amount of lead compared to Indian manufacturers. Indian companies have very high level of lead in it and they did not meet the specification given by BIS. As an extension of study, BLL of printing press workers were examined, it was found that workers who handle these Indian company inks have very high level of lead compared to workers who handle international company inks.

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Introduction

Lead poisoning is one of the most common and preventable paediatric health problems all over the world today. The situation in which large amount of lead is present in the body is known as lead poisoning. Lead poisoning may be acute (from intense exposure for short duration) or chronic (from repeated low level exposure over a prolonged period) [7]. Acute lead poisoning shows typical neurological symptoms like pain, muscle weakness, paraesthesia [5] and gastrointestinal problems such as constipation, diarrhoea, poor appetite or weight loss. Exposure to large amount of lead over short period of time can cause shock due to loss of water from gastrointestinal track. [2] Also damage to kidney can be occurring. People who survive acute poisoning often go on to display chronic poisoning. [2] Chronic lead poisoning shows symptoms with multiple systems [3] like gastro-intestinal, neuromuscular and neurological. [5] Fatigue, headaches, slurred speech, stupor and anemia are also found in chronic lead poisoning. [5] Occupational exposure is a common cause of lead poisoning in adults and one of the major threats to children is lead paint that exists in many homes, especially older ones. Adults who work in battery or surface coating agents like paints or inks are more prone to lead exposure. [6]

Each time when we pick up a newspaper or a packet of biscuits we are looking at examples of printing. Ink is an invention that is thousands of years old and is a part of many aspects of daily life, from simple pen ink to inks for computer printers. Ink is a liquid or paste that contains pigments or dyes and is used to colour a surface to produce an image, text, or design. Commercial offset printing press uses four basic ink colours: CMYK. Cyan (C), magenta (M), yellow (Y) and black (K). CMYK colour system is used in printing inks for paper. [1] Heavy metals can be present in printing inks in the form of metal-based pigments, driers or through impurities and contaminants in the raw materials used in the formulation

process. Lead is added to ink to speed drying, increasing durability, retain a fresh appearance, and resist moisture that causes corrosion. Lead is used as pigment, with lead chromate (PbCrO_4 , "chrome yellow") and lead carbonate (PbCO_3 , "white lead") being most common. Lead chromates are often used to produce yellow, orange, red and green paints and inks. White lead (basic lead carbonate) is a superior ink pigment, has a high affinity for ink vehicles and a tremendous hiding power. [4] Printing inks possessing heavy metals like lead, cadmium and barium can cause environmental problems. This heavy metal can easily enter into the soil and ground water, which can cause serious health hazards. Fumes of the heavy metal produced in printing press can seriously damage workers' health.

The paint and another surface coating agent industry are regulated by the Bureau of Indian Standards. According to BIS, the paints and another surface coating agents shall not contain more than 0.1 percent by mass (as metal), of any toxic metals such as lead, cadmium, chromium. According to U.S. Environmental Protection Agency (EPA) Standards for paint and similar surface coatings, and certain consumer products, the maximum allowable total lead content is 0.06% based on the total weight of the non-volatile portion of the paint (which is equivalent to 600 ppm).

In this study, offset printing ink samples of Indian and international manufacturers were analysed for lead content. And the blood lead levels were analysed to observe the effect of lead exposure on printing press workers.

Materials and methods

Sampling Methodology

Ink Sample

Twenty-four offset printing ink samples (4 colors i.e. Cyan, magenta, yellow, Black of 6 companies) are collected from printing press situated in Maharashtra during the month of February-March 2013, which are widely used in Indian printing

industries. Out of 6 companies 5 were international companies and 1 was Indian Ink Manufacturer Company. These samples are collected in plastic sampling tubes and stored carefully.

Blood Sample-

Blood samples were collected from six workers, working in Offset printing press for more than two year. The blood sample was collected in Heparin tube and kept in cold condition (10^0 to 35^0 C).

Sample Preparation:

Ink Sample

The wet ink was applied on clean glass plate using glass rods and dried in hot air oven for 72 hours. Every time glass rods are washed for preventing cross contamination. After drying, these samples were scraped carefully from glass plate using sharp and clean scalpel. Scrapped ink samples were made in powder form by using motor and pestle. The powder ink samples were kept in plastic bags for analysis under XRF.

Blood Sample-

The whole blood sample (24 hours fresh) is used directly for testing.

Equipment's:

➤ **XRF- x-ray fluorescence spectrophotometer (INNOV-X Systems):** XRF is an analytical method to determine the chemical composition of all kinds of materials. The materials can be in solid, liquid, powder, filtered or other form. XRF can also be used to determine the thickness and composition of layers and coatings.

➤ **Lead Analyzer (Lead care II):** The lead care II blood lead analyser uses electrochemical process that detects and measure level of lead in blood sample.

Inform Consent of Subjects:

Since the study is on blood samples of human subjects, the proposal for the study was passed by the Institutional ethical committee, T. John College. An inform consent of the subjects was taken before conducting the study. For confidentiality of data, the names of subjects and the names of printing presses & Ink manufacturing companies are not revealed.

Result and discussion:

Out of 24 samples, 4 colours each of 6 widely used companies, lead was detected in 23 offset ink samples. 83% (20/24) ink samples were having lead content less than 600 ppm these samples met the specification for the lead content prescribed by the BIS limit of 0.1% (1000ppm) and US regulations for consumer product safety limit of 0.06% (6 ppm) for paint and similar surface coating agents like ink. 17% (4/24) ink samples did not meet the specification by BIS and US regulations for consumer product safety & U.S. Environment Protection Agency (EPA).

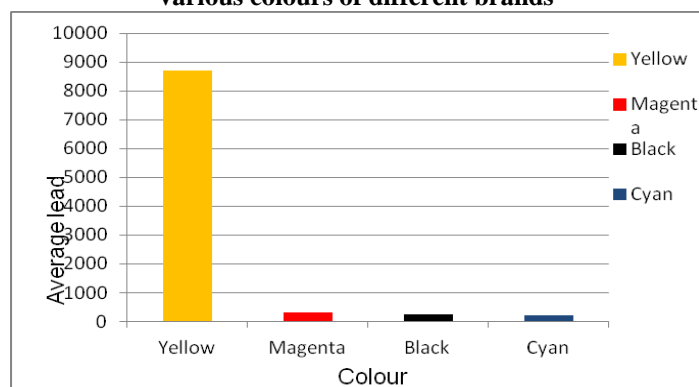
The average concentration of lead in all the 24 offset printing ink samples ranged from zero to 51269 ppm. Lead was not detected in cyan color ink of company B. The highest concentration of lead (51269 ppm) was detected in yellow colour ink of company F. lead concentration in different colours of offset printing ink in decreasing order is shown as follows: Yellow > Magenta > Black > Cyan

Out of 6 companies 5 companies which are international manufacturer have much lower amounts of lead compare to Indian local manufacturer. F Company which is Indian manufacturer of ink shows incredibly high lead content.

Table I: Amount of lead in offset orienting ink.

Company	Colour				Standard Deviation
	Cyan	Magenta	Yellow	Black	
A	37	19	131	34	51.11
B	ND	116	163	26	76.26
C	18	158	194	41	86.36
D	170	60	376	35	155.33
E	24	40	78	20	26.45
F	1108	1392	51269	1297	125001.95
Average	226	298	8702	242	

Graph 1: Average lead content in offset printing ink of various colours of different brands



As these companies showing high concentrations of lead, study conducted to observe exposure of lead on a printing press employs by analysis of blood.

Table II: Blood Lead Level: This table is showing the Blood lead level content of the workers from different companies.

Sam ple	COMPA NY	Workers age (years)	Years of exposure	BLL(μ g/dl)	Comm ent
I	A	56	35 Years	10	High
II	A	52	15 Years	14.7	High
III	E	47	22 Years	3.3	Low
IV	E	50	30 Years	4.5	Low
V	F	29	8 Years	10.7	High
VI	F	24	2 Years	28.2	Very high

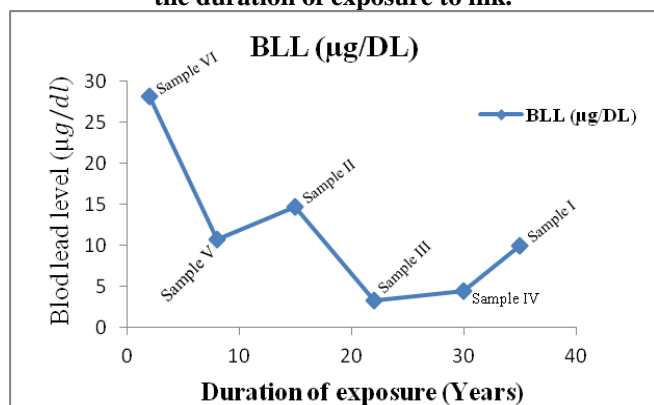
For establishing standard values of blood lead level in exposed employees, company A and E offset printing ink handling workers were selected. Ink samples of company A and E has very low lead concentration and their values are significant so employees handling this inks were selected. Maximum exposed employees to these company inks were compared with the minimum exposed employees to company F ink.

It was seen that even though employees who were handling company F ink were exposed to lead having printing ink for very less duration, then also they had very high BLL But the employees handling company A and E ink samples who were more exposed to lead in printing ink, they show low BLL.

These values were extrapolated to F Company in order to understand the statistical significance. When the blood lead level vs period of exposure graph was plotted it was observed that blood lead level of printing press employee did not correlate with the period of exposure to lead congaing printing ink. But it is depending on the both period of exposure and concentration of lead in printing ink.

In this course of study it was also observed that these all workers were suffering from muscle pain, nausea, skin problem, high blood pressure, gastrointestinal problems. And children's of some of these employees were also suffering from hypersensitivity problems.

Graph II: Line graph representation of blood lead level with the duration of exposure to ink.



Conclusions:

Out of 24 offset printing ink samples 83% samples were having lead level lower than the maximum lead level prescribed by BIS (Less than 1000 ppm) and US regulations for consumer product safety & U.S. Environment Protection Agency (EPA). (ny600 ppm) And 17 % samples did not meet the specification given BIS and US regulations. All the four colour samples of company F were having lead level higher than the prescribed by BIS and US regulation for consumer product safety & U.S. Environment Protection Agency (EPA).

Out of 4 colours, yellow colour found with high lead content and cyan colour found with very low lead content. Lead was not detected only in one ink sample i.e. cyan colour of company B. lead concentration in different colours of offset printing ink in decreasing order is shown as follows:

Yellow > Magenta > Black > Cyan

In this study it was observed that only Indian ink manufacturer companies have high lead content in their products. So, Indian Company does not follow regulations given for the use of lead and other heavy metals in production ink.

After analysis of blood samples of employees of company A, E & F it was observed that employees of company F were exposed to less period of time to lead containing ink, then also

they have very high Blood lead level compared to employees who were exposed to lead containing ink for a very prolonged period of time. So this high BLL was observed because company F has very high lead concentration. So, BLL is depending on exposure time and lead concentration of product to be handled.

Increased BLL in printing press workers shows symptoms of lead poisoning. As many of them have health problems like muscle pain, nausea, high blood pressure and gastrointestinal problems. Even children's of some of these workers were suffering from hypersensitivity which is a primary symptom of lead poisoning.

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