Available online at http://www.journalijdr.com

IJDR

International Journal of
DEVELOPMENT RESEARCH

ISSN: 2230-9926

International Journal of Development Research
Vol. 06, Issue, 12, pp.10784-10788, December, 2016

Full Length Research Article

SIGNIFICANT CONTRIBUTION OF CHEMISTRY IN ANCIENT INDIAN SCIENCE AND TECHNOLOGY

***Chhavi Purwar**

Dept. of Chemistry, Pt. J.L.N. College, Banda (U.P.)

ARTICLE INFO

Article History:

Received 01st September, 2016
Received in revised form
18th October, 2016
Accepted 19th November, 2016
Published online 30th December, 2016

Key Words:

Chemistry,
Metal,
Metallurgy.

ABSTRACT

Ancient India, an important role in the development of chemistry was made by Ayurveda which used a variety of minerals. Science and technology in ancient and medieval India covered all the major branches of human knowledge and activities. In any, early civilization, metallurgy has remained an activity central to all civilizations from the Bronze Age and the Iron Age, to all other civilizations that followed. The Indus valley civilization was the earliest society, the story of early chemistry in India begins from here. Traces of cement had been ford in the era of Mohanjodaro. According to RigVeda, tanning of leather and dyeing of cotton was practiced during this period. After Vedas classical texts which give valuable information about the chemical activities of this period. The major chemical products of this period were glass, paper, soap, dyeing, cosmetics and perfumes, alcoholic lacquers, pharmaceuticals, gun powder and saltpeter. Nagarjuna (metallurgist) and Kanada were chemist of ancient period. Indian and Persian army used arrows tipped with iron. In the Gupta age metallurgical operations were found. Nataraja statue the god of dance is made of five metals Pancha Dhatu and Iron Pillar, Delhi is as a silent witness to assert the striking metallurgical skill of the Hindus. Paintings found on walls of Ajanta and Ellora also testify to the high level of chemical science achieved in ancient India.

INTRODUCTION

Ancient India, an important role in the development of chemistry was made by Ayurveda which used a variety of minerals. Chemistry in Ancient India was called Rasayan Shastra, Rasatantra, Rasa Kriya or Rasa Vidya roughly translating to 'Science of Liquids'. Science and technology in ancient and medieval India covered all the major branches of human knowledge and activities, including mathematics, astronomy, physics, chemistry, medical science and surgery etc. Ancient India was a land of sages, saints and seers as well as a land of scholars and scientists. Ancient India's contribution to science and technology include principles of chemistry did not remain abstract but also found expression in practical activities like distillation of perfumes, aromatic liquids, manufacturing of dyes and pigments and extraction of sugar. In any early civilization, metallurgy has remained an activity central to all civilizations from the Bronze Age and the Iron Age, to all other civilizations that followed.

****Corresponding author: Chhavi Purwar,***
Dept. of Chemistry, Pt. J.L.N. College, Banda (U.P.).

The basic idea of smelting reached ancient India from Mesopotamia and the near East. Coinage dating from the 8th century BC to the 17th century AD and numismatic evidence of the advances was made by smelting technology in ancient India. Much of chemistry grew out of the early efforts is to develop an elixir and to turn base metals into gold.

MATERIALS AND METHODS

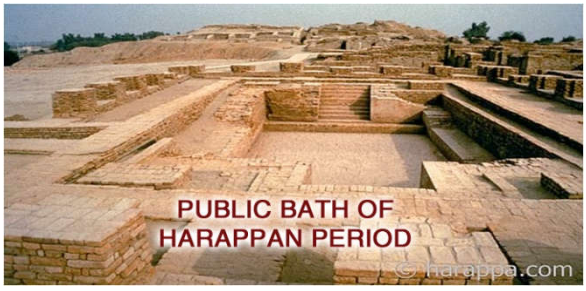
Data and evidences were collected from secondary sources which include books, articles, reference materials, wikipedia etc. from 2200 BC-1200 AD.

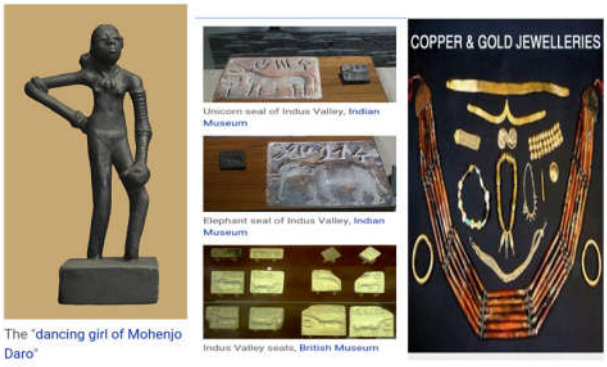
DISCUSSION

Indus Valley Civilization (2600-1900 BC)

The earliest urban civilization in India and in fact, one of the earliest civilizations in the world, was the Indus Valley Civilization, or the Harappan Culture. Archaeologists, findings showed a well developed urban system with public baths, streets, granaries, temples, houses with baked bricks, mass production of pottery and even a script of their own which depicted the story of early chemistry.

In pottery making chemical processes were carried out in which materials were mixed, fired and moulded to achieve their objectives. In the Rajasthan desert many pottery pieces of different shapes, sizes and colours were found. At Mohenjo Daro it was found that for the construction of a well, gypsum cement had been used which contained clay, lime, sand and traces of $CaCO_3$ and light grey in colour. Burnt bricks were manufactured on a large scale for making houses drains, boundary walls, public bath etc. Many useful products were plasters, hair washes, medicinal preparations etc. which had a number of minerals in them used by Indus Valley people. The Harappans made Faience, a sort of proto-glass which was used for ornaments. They forged and smelted a number of objects like lead, copper, silver and gold and they improved the hardness of copper for making artifacts by using tin and arsenic. The Indus Valley residents had access to gold and copper mining and the place was possibly a source of semi-precious stones. This can be seen in the jewelleries discovered in the area. The people made tools and weapons from copper and bronze but not iron.





Archaeologists like R.D. Banerjee and Sir John Marshal has rediscovered this historic set in the 1920's and gave the world a peek into ancient culture and civilization. The oldest preserved measuring rod is a copper alloy bar which was found by the German Archaeologist Eckhard Unger while excavating at Nippur. The bar dates from c. 2650 BC and he claimed it was used as a measurement standard. The earliest available swords of copper and bronze are recovered from the Harappan sites date back to 2300 BCE throughout the Gangas-Jamuna Doab region of India.

The Vedic age

According to Rig Veda shows that during this period tanning of leather and dyeing of cotton were practiced. During the period 1000-400 BC they made a particular kind of polished grey pottery known as painted Grey ware. The amazing golden gloss of the Northerns Black Polished Ware could not be replicated and is still a chemical mystery. These wares indicated the mastery with which the kiln temperatures could be controlled and later the skill with which the atmosphere could be reduced.

A vast number of statements and materials presented in the ancient Vedic literature can be shown to a agree with modern scientific findings and they also revealed a highly developed scientific content in these literatures. The great cultural wealth of this knowledge is highly relevant in the modern world. Copper utensils, iron, seals, gold and silver ornaments, and terracotta discs and painted a grey ware pottery have all been found in thirty five Archaeological sites in North India. Scientific dating of these artifacts corresponds to the non-aryan invasion model of Indian antiquity.

Brahmanas, Puranas and Upanishads throw light on the chemical activities of this period Kautilya's Arthashastra described collection of pearls, corals, diamonds, shells and production of salt from sea. Sushruta Samhita explained the importance of alkalies and classified it into three categories mrdu, tiksna and madhyama Varahamihira in Brihat Samhita wrote about alum and sulphate or iron as mordants for dyeing of textile fabrics. Various cement preparation and their types which were applied to temples and other buildings were also mentioned. The major chemical products of this period were-
Glass: Glass is a solid fused mixture of lime, alkali, sand and metallic oxides. They were coloured by adding colouring agents like metal oxides. The Ramayana, Kautilya's Arthashastra, Brihatsamhita mention glass being used. Evidences of glass slag and glazing are found in Hastinapur, Takshila, Nevasa Kolhapur, Maheshwar and Paunar.

Paper: Paper was known to India in the 7th century from the Chinese traveller 1-I sing's account. Paper making was practiced all over the country in places like Murshidabad, sialkot, Mysore, Ahmedabad, Zafarbad.

Soap: For washing clothes ancient Indians used certain plants and their fruits like the soap nuts of Ritha and sikakai. Indians definitely began to make proper soaps in the 18th century AD. In Gujarat, the oil of Eranda (Ricimus communis), seeds of plant Mahua (Madhuca indica) and impure calcium carbonate were used by them. These were used for washing but gradually soft soaps for bathing were made.

Dyeing: A number of classical texts like Atharvaveda (1000 BC) mentioned some dye stuffs. Synthetic dyes were made by mid nineteenth century. The principal dyeing materials were turmeric madder, sunflower orpiment, cochineal, lac and kermes. Some other substance having tinting properties were Kampillaka, Pattanga and Jatuka.

Cosmetics and perfumes: Varahamihira's Brihatsamhita gives references to perfumes and cosmetics. The Bower Manuscript (Navanitaka) contained recipes of hair dyes which consisted of a number of plants like indigo and minerals like iron powder, black iron or steel and acidic extracts of sour rice gruel. Gandhayukti gave recipes for making scents, mouth perfumes, bath powders, incense and talcum powder.

Table. Archaeological evidences of ancient India

Period of time	Cultural age	Objects
C 2000 BC	Neolithic	Terracotta jewellary of clay
1800 BC-1500 BC	Chalcolithic	
1400 BC-1050 BC	New chalcolithic	Copper bronze
2600 BC-1900 BC	Indus valley civilization (bronze age)	Traces of cement, baked bricks, seals, ceramic pots, signboard, necklaces, bangles,pottery,gold jewellary, dancing statue
1500 BC-1000 BC	Vedic civilization(Iron age)	Tanning of leather, dyeing of cotton, glass, paper, soap, cosmetics, perfumes, alcoholic lacquer, arrows
1000 BC-500 BC	Brahamanic age	
500 BC-200 BC	Epic age (rise of Mauryan dynasty	Arrows tipped with iron
240-554 AD	Gupta´s period	Iron pillar, gold coin,cave paintings, Nataraj statue
700-1600 AD	Rajputs Dynasty	Gold jewellary,sward, shield, arrow

Ink: Ink was used from the 4th century BC from excavations seen at Takshila. Rasaratnakara gives the recipe for ink which was made from nuts and myro balans. Colours of ink were made from a combination of different types of plants, resins and other materials. The Ajanta caves displayed some inscriptions that were written with coloured ink, made from chalk, red lead and minium. Paintings found on walls of Ajanta and Ellora which look fresh even after 1000 years, also testify to the high level of chemical science achieved in ancient India.

Alcoholic Liquors: Somarasa, which was mentioned in the Vedas, Kautilya's Arthasastra listed a variety of liquors such as Medaka, Prasanna, Asava, Arista, Maireya and Madhu. Barks of plants, stem, flower, leaves, woods, cereals, fruits and sugarcane were some of the sources for making these liquors. They were also used in dyeing, mixing and dissolving operations and for binding and distilling mercury. In Sushruta Samhita, alcoholic beverages were referred to as 'Khola' Designing of retorts was first done in India which was used to control the distillation of zinc which is a very volatile metal.
Pharmaceuticals: In the preparation of medicines from plant and animal extracts, a number of chemical processes like purification, extraction, distillation, sublimation, combustion, precipitation, dilution and decocting were required to be used. A member of medicines in later periods also used Mercury and gold.

Gunpowder and saltpetre: The discovery of saltpetre (i.e. potassium nitrate) and its chief application in gunpowder was a crucial factor in the history of chemistry. Firearms were mentioned in RigVeda, Atharva Veda, Kautiliya's Arthasastra and Manusmriti. Rasopanishada described the preparations of a gun powder mixture. Tamil texts also describe the preparation of fireworks using sulphur, charcoal, saltpetre, mercury, arsenic, camphor etc. Gun and Gunpowder are mentioned in sukracharya's sukra-Nitisara.

Metallurgy: Casting of metals, extraction of metals from their ores and smelting of metals was proficiently carried out by the Indian alchemists. The Ramayan and the Mahabharata mention weapons where the arrowheads were coated with a number of chemicals providing their knowledge of Alchemy. In India itself, certain objects testify to the higher level of metallgy achieved by the ancient Indians.

Nagarjuna (Metallurgist): Nagarjuna was a great Indian scientist who was born in Gujarat is 931 A.D. He was a reputed chemist, an alchemist, a metallurgist and a mediaireman. As an alchemist, he was adept in the art of transmulating base metals to look like gold. The Arabs learnt this technique from him and called it Alchemy. The most famous work of Nagarjun was Rasaratnakara, which deals with the formulation of rasa or mercury compounds. He has also discussed methods for extraction of metals like gold, silver, tin and copper.

Kanada: Kanada was a sage who lived in the 6th century BC. He was born in Prabhas Kshetra near Dwaraka of Gujarat. He was the first proponent of the 'atomic theory' and stated that the atom is indivisible and the world is made up of atoms. Kanada also added that there are varieties of atoms that are as different as the different classes of substances.

Persian and Greek Invaders

In 520 BC the Persian kings ruled many parts of India for about a century and a half. The Greek historian Herodotus has observed that Indian and the Persian army used arrows tipped with iron. Ancient Romans were using armor and cutlery made of Indian iron.

Chemistry and metallurgy under Gupta Empire

In the Gupta age no books dealing with chemistry and metallurgy are found. Nagarjuna is mentioned as a great chemist. The famous Iron Pillar near the Qutub Minar, Delhi stands as a silent witness to assert the striking, metallurgical skill of the Hindus. This pillar has not yet been rusted or corroded despite it being exposed to rain and sun for the last 1500 years. The use of mercury and iron in medicines shows that chemistry must have been practiced. Varahamihira was a scientist of many fields.

The iron pillar of Delhi (375—413).

Coin of Samudragupta (c. 350—375) with Garuda pillar. British Museum.

Ellora Caves

A painted panel showing the dancing Shiva (Nataraja) from the Kailasa temple at Ellora (Cave 19). One can still see a lot of the paint that once covered the entire temple.

Guptas minted different types of solid gold coins-standard, Archer, Battle Axe, Ashvamedha king and Queen Tiger slayer and Lyrist. The Gupta craftsmen distinguished themselves by their work in iron and bronze. Bronze images of the Buddha began to be produced on a considerable scale because of the knowledge the smiths had of advanced metal technology. Metallurgical science was far more advanced in this period.

Bronze Chola Statue of *Nataraja* at the Metropolitan Museum of Art, New York City.

Rajputs Period

On the whole, growth of the knowledge of science slowed down in this period science society became increasingly rigid, thinking was mostly confined to traditional philosophy and India developed as insular attitude cut off from the main currents of scientific thought outside India, science did not get proper scope or opportunity to develop.

Weapons, armour & Helmet of Rajputs Period

In Medieval period, gold making and elixir synthesis were the two main characteristic streams of alchemy. The Rasvidya or Indian Alchemy texts show the use of number of organic and Inorganic substances. These rasas or minerals were divided into subsidiary or Upa and Superior or Maha Rasas. In the Rasas shastra texts mercury is referred to as the king of Rasas though it is a metal. It was considered to possess divine properties and the most potent of all substances due to its heavy weight, fluidity, silvery white and shiny appearance and its property of combining with others substances readily. Before it could transform human body, mercury had to undergo 18 processes.

Conclusion

Ancient India′s development was found in a variety of practical activities. Metallurgical science was for more advanced in India during Gupta period. The wonderful iron pillar looks like polished stone of this period has not got rusted through centuries as of time, though exposed to rains and atmosphere. Modern metallurgists have not been able to produce iron of comparable quality. This pillar stands at mute testimony to the highly advanced scientific knowledge of metallurgy that was known in ancient India. Nataraja, the god of dance is made of five metals; Panch-Dhatu was evidence of the advances made by smelting technology in ancient India.

The list of inventions and discoveries of the Indus Valley Civilization refers to the technological and civilization and civilization achievements of this period. High level of chemical science has also been found in painting on walls of Ajanta and Ellora. Armour and cutlery made of Indian iron were used by Ancient Romans Ceaseless encouragement and understanding of the ancient chemistry of India will encourage people for further progress in field of chemistry.

Acknowledgement

Author is thankful to the Principal Pt. J.N.P.G. College, Banda (U.P.) for the suggestions given during the preparation of the manuscript.

REFERENCES

Wikipedia.com
Unitedindia.com
Chemistryinancientindia.blogspot.in
Indiaheritage.org
Crystalinks.com
www.indianscriplures.com>chemistry
www.infinityfoundation.com
www.indianpoll.in

****