METALS AND ALLOYS DURING THAKKUR PHERU'S PERIOD, 1290-1318 A. D.

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Many authors[1] have attempted about the history of chemical knowledge in India in the past. Mention has been made therein of Charaka, Sushruta, Nagarjuna, Vrinda, Bhikshu Govind, Somdev, Bagbhata and others for their contributions in this field. However, Ugradityacharya of eighth century and Thakkur Pheru of fourteenth century do not find any mention, though they have given account of existing chemical knowledge including that of chemistry of mercury in their books Kalyan Karaka and Dravya Pariksha respectively. An account of chemistry in the first has already been reported and the chemical contents of Thakkur Pheru's book are reported here. It is found that during the beginning of 14th century, purification of metals, preparation of coins and many other chemical compounds find mention in his book. Many of the processes described therein are the same as those practised today.

Thakkur Pheru and his books

According to the references given by Pheru himself in his books, he was the son of Chanda of ghanghia gotra of Shrimal family living in Kannana near Mahendragarh of today. Though his date of birth is not given, but it is said that he composed eight books during 1290-1318 AD in the days of Sultan Alauddin and Qutubuddin. He worked as minister of Treasuries in Delhi in this period and obtained chemical knowledge about the processes and materials used in coin making. He has mentioned himself to be Jain and accompanied Jin Chandra Suri in 1318 for sacred journeys details of which are not known. Assuming that he must have been about 25 when he joined services in Delhi, and that he must have lived about ten years in munisangha, his life tenure could be safely taken to be between 1265-1330 AD. He seem to be a highly religious and scholarly man as before joining the services, he lived with a Jain scholar Rajshekhara at Kannana. This is also clear from the fact that his first book is related with the main Acharyas of Khartargachcha after Mahavira. This is written in Apabhransha language in Chaupai form composed in 1290 AD. He has composed seven more books but they are in Prakrit. Out of them only six are available and their subject is concerned with the useful or worldly knowledge like mathematics, architecture, examination of gems and diamonds, metals and materials, astronomy and geology. Their details are given in Table 1.

Table 1. Books of Thakkur Pheru

S. No.	Name of the book	composing year	subject	form
1.	Yugapradhāna Chatuṣpadī	1290	Khartar Ācāryas	Chaupai and Chhappaya
2.	Gaṇita Sāra	—	Mathematics	311 gāthās
3.	Vāstu sāra	1315	Architecture	—
4.	Jyotiṣa Sāra	1315	Astronomy	242 gāthās
5.	Ratnaparīkṣā	131 ›	Gem examination	132 gāthās
6.	Dravya Parīkṣā	1318	metals and coins	149 gāthās
7.	Dhātūtpattiḥ	1318	preparation & properties of metals and compounds	57 gāthās
8.	Bhūgarbha Prakāśā*	—	geology	—

* not available

A compendium of first seven books has been found containing sixty pages and handcopied during 1346-47 i. e. 20 years after they were written. This was accidentally found in a Jain Gyanbhandar in Calcutta in 1946. MD Desai has referred these books in his History of Jain Literature in Gujarat. Muni Kantisager and BL Natha have also reported about these books in Viśwavāṇī (1960) and Viśāla Bhārata (1961). This was published in original in 1961 by Rajasthan Oriental Academy, Jodhpur. But it seems it did not attract attention. Out of these seven books, books numbering 5, 6 and 7 are of interest to chemists. These were written by T. Pheru for the benefit of his brother and Hempal. They have now been separately published with translation. Nahta Bros. Calcutta published book number 4 in 1963 while books no 6-7 have recently been published by Vaiśāli Research Institute in 1976 in a single volume. This paper deals with book nos. 6 and 7 only.

Chemical Processes in Dravyaparīkṣkā

This book consists of 149 gathas and describes production and purification of coinage metals and composition of various coins used during 13-14th. century AD in India. This has a large number of technical words used in those days in these chemical operations. These terms need proper clarification for their evalution. Some meanings, however, may be assigned to them with reference to the processes involved. Dhavadia, Kemmans powder, Chasni, Gahi, Ris etc. are such terms. Even this book gives Dhatu a meaning of current use while the metal itself has been called "mahādhātu".

Extraction of silver :—Silver occurs in soils. It is extracted with the help of ashes obtained by burning bones, trees and dried cowdung. The ashes are mixed with the silver ore and heated under a blowpipe flame on Dhavadia coals.

The impure product is then cupelled for further purification. This method is the same as described in Nāgārjuna's Rasratnākara of 700 AD. This is also equivalent to the mixed amalgamation and cupellation processes of today.

It is also mentioned that lead is desilverised by liquation and crystallization. The lead thus obtained will contain about 2% Ag which, we know, cannot be removed due to the formation of eutectic mixture. However, silver so obtained has been termed as pure (Bis Biswa) useful for coin making. The impure silver is also purified with the help of lead used in various proportions. On heating this in crucibles, or cupels, pure silver is obtained and impurities are either absorbed by the material of the crucible or volatalised. The pure silver could be converted into rods, ingots or foils. Different qualities of silver could be prepared and named by mixing it with a mixture of copper and brass in various proportions. The material absorbed by the crucible could be desilverised, if any, by mixing it with borax, sajjī and fusing it strongly.

(*b*) *Extraction of gold* :—Gold is normally found in sands of the rivers and mountains or mines. The ore is mixed with a mixture of white chalk (calcium carbonate), salt (sodium chloride) and kallar (sajji mitti, mixture of sodium carbonate and sulfate) and heated strongly 3-21 times to get pure gold. There is always loss of weight in the original ore by this treatment. The gold ore may also be treated with the above mixture and kommans powder (containing perhaps lead, copper and tin) to obtain gold containing a small amount of copper in it. Like silver, the quality of gold could be determined by the amount of gold contained in it, the nongold material being a mixture of silver, copper and brass in various proportions. In a farmula, he gives that a fused mixture of 23 parts of copper with 77 parts of gold serves a good material to prepare various qualities of gold. The method of calculating the cost of a particular quality of gold has also been presented in the book. The gold extracted today is also based on the same basic principles but with a better quantitative accuracy.

(*c*) *Extraction of copper* :—The copper ore obtained from mines is ground and mixed with cowdung and dried. It is then heated strongly in a furnace with strong blasts until the slag forms. After the removal of slag, the copper so obtained is again heated by blasting to get it purified. The pure copper is then converted into either sheets or ingots.

According to the current practices, the ore is mixed with coke rather then cowdung which serves to produce carbon particles or carbon monoxide while burnlng to supply necessary reducing agents. However, no flux seems to have been added in the olden times.

(*d*) *Extraction of lead* :—The lead ore is ground and mixed with iron in the ratio of 2:3 and heated strongly in crucibles and furnaces. The iron might have served the purpose of removing sulfur from the sulfurous ores and reducing

the oxidised ores. It has also been pointed out that the slag from any extraction has half the value of the metal.

(*e*) *Extraction of mercury* :—The mercury ore is kept in a closed furnace and covered with dried cowdung cakes. On heating the furnaces with slow blasts, mercury comes out as sublimate and collected on the top of the furnace.

2. Preparation of some common alloys

(*a*) *Brass* :—It is prepared by fusing one part of copper with a fusion mixture containing four parts of Dhavadia and two parts of jaggery (here dhavadia must contain zinc compounds which are reduced to zinc metal by the reducing property of the jaggery) in a furnace. The brass so obtained is ideal brass. Other qualities of brasses may also be obtained by increasing the quantity of copper during fusion. It is now known that brass is a mixture of copper and zinc in varying proportions and a variety of brasses are possible.

(b) *Bronze* :—The bronze is a mixture of copper and tin in various proportions. In Pheru's days, it was made by boiling one part of tin obtained from the treatment of solder metal with four parts of copper.

(c) *Solder* :—It seems that this alloy was prepared directly from some ore, heating it with kommans powder. The process gave a hot flowing liquid metal called Cambia which was used for making bronze as above.

3. Preparation of some Compounds

(a) *Hingul* :—This is called cinnabar today. It is prepared by heating sulfur and mercury in the ratio of 1:4. On current knowledge, the ratio should be 32:200. There is mention of preparing the compound by heating the powder of realgar and orpiment together for three days continuously. It seems these compounds arsenic must be containing mercury in some form which forms hingul after complete elimination of arsenic during long heating.

(b) *Sindūra or red lead* :—This is prepared in two stages. In the first stage the lead metal is fused with 5% ashes of bamboos making the metal perchance in soluble form. The mass is then dissolved in water and filtered hot. The filtrate is allowed to settle and after decantation, it is ground and heated strongly in a furnace upto three days when its color changes to deep red, If heated too strongly, it is again converted to lead metal.

4. Some other useful description

Besides the coinage metals and some of their compounds, there are descriptions about the units of weights used for these metals as below :

16 yavas = 1 masha = 1 vanni
4 māśās = 1 tanka
3 ṭāṅkas = 1 tola = 11.55 gms.

which gives the least unit of yava as equivalent to 0.057 gm.

There is description of various types of coins in use in various parts of the country at that time. This includes their composition and values. Some classes of coins are given in Table 11.

Table 11. Classes of coins in use during 13-14th century as per Pheru

	Class	Number of types
1.	Coins of silver	11
2.	Coins of gold	15
3.	Coins of three metals (Cu, Ag, Au)	22
4.	Coins of two metals (Cu, Ag)	10
5.	Special coins. gurjar, chanderi etc.	8
6.	Coins of Delhi	48
7.	Qutubuddin coins	63

There is description of some other materials which were in use in those times. These include shankh, rudraksha, shaligram, chandan (sandalwood), Kastūrī, kuṁkuma, dhūpa, camphor and aguru. This description includes only the natural source of these materials and their general physical properties.

Conclusion

Though the Dravyaparīkṣā and Dhātūtpattiḥ of Pheru is small in size, but it gives sufficient information about the metallurgical practices of his time. This helps us to learn about the chemical knowledge of this period where Chemistry in India was supposed to be passing through an age of recession. It is hoped that reference to this book will be included by the history writers of sciences in India in future.

References

1. Satyaprakāśa : Vaijñānika Vikāsa kī Bhāratīya Paramparā, Rashtrabhasha Parishad, Patna. 1954; (b) Rasayan Vikas ki Bharatiya Parampara, Uttar Pradesh Hindi Akadami, Lucknow, 1960.

1. (b) Ray, P.C. History of Hindu Chemistry, Chemical Society, Calcutta, 1902.

लेखसार

ठक्कुर फेरू के समय (1290-1318 ई०) में धातुयें और मिश्रधातुयें

एन. एल. जैन, रसायन विभाग, गर्ल्स कालेज, रीवा म. प्र.

यद्यपि अनेक लेखकों ने भारतीय रसायन के इतिहास में चरक, सुश्रुत आदि के योगदान की चर्चा की है, पर किसी ने भी आठवीं सदी के उग्रादित्याचार्य (कल्याण कारक) और चौदहवीं सदी के ठक्कुर फेरू (द्रव्य परीक्षा) की चर्चा नहीं की है। ठक्कुर फेरू वर्तमान महेन्द्रगढ़ (दिल्ली के पास) के रहने वाले थे औरउन्होंने 1290-1318 के बीच सात पुस्तकें लिखी हैं। उस समय इन्होंने अलाउद्दीन और कुत्तुबुद्दीन के कोषागार अधिकारी के रूप में काम किया। इन पुस्तकों की साठ पृष्ठ की एक प्रति जैन ज्ञान भंडार कलकत्ता में 1946 में मिली थी। ये ठक्कुर फेरूने अपने पुत्र के लिये लिखी थीं। यहां केवल द्रव्य परीक्षा की चर्चा की गई है।

द्रव्यपरिक्षा में 149 गाथायें हैं जिनमें तत्कालीन धातुओं, मिश्रधातुओं, सिक्कों एवं खनिजों के संबंध में विवरण मिलता है। यहां उस समय प्रयुक्त अनेक पारिभाषिक शब्द भी मिलते हैं। इस पुस्तक में चांदी, सोना, तांबा, सीसा तथा पारद धातुओं के निष्कर्षण की विधियां दी गई हैं। उनके शोधन की विधि भी दो गई है। इसमें पीतल, कांसा तथा रांगा बनाने की विधि भी है। इसके अतिरिक्त, हिंगुल और सिन्दूर भी इसमें दिये गये हैं। उस समय यव, माशा, टंक और तोला की तौल प्रसिद्ध थी। आज के अनुसार, यव का मान 0.057 ग्राम आता है। इसमें 177 प्रकार के विभिन्न सिक्कों का भी वर्णन है।