CHAPTER -4

METAL, CHEMICAL AND ALLIED CRAFTS:
TECHNIQUES, PRODUCTION AND TRADE
DURING 18TH CENTURY
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(I) METALLURGY AND METAL WORK

Among the goods which India traditionally exported with success were metals and its allied objects. Metal items played an important role especially great demand these goods were in the countries of the near East, Middle East and Transcaucasia.¹

In this regard Geniza documents as cited by Goitein referred to iron, steel bronze and copper items (household utensils, arms, etc.) as exported from India to the Arab countries in great quantities. A part from thus Geniza merchants bought back to India old or broken metal were for the Indian craftsmen were famous for not only making but mending and restoring metal wares.²

In the Later periods the reputation of the Indian metal was still very high. In 1664 the officers of east India company informed that Indian iron was winning the competition with the British one.³ Tavernier explained that the barrels of their muskets are stronger then our’s and the iron is better and purer: this makes them not liable to burst.⁴ Abul Fazl in the Ain-i-Akbari provides then the prevelants theories of metal ‘chemical nature lists the same metals as the Sukranti: but adds quick silver.⁵ Before we descents metallurgy and metal working techniques it has to be noted that only metal work was among the urban crafts, while mining and metallurgy were mainly carried on in the country side.⁶

Mining Techniques

Medieval Indian mining technique was perhaps as primitive as the European during 13th to 17th centuries, and even later on. In Europe
there existed mines which were very much like the Indian ones. But by
the end of Middle Ages some important innovation were introduced,
especially in water lifting techniques. The 17th century European was
surprised to see that in the Golkonda diamonds mines no device but
human conveyor was used for removing water. It has to be specially
stressed that in most cases ore extraction was not a professional
occupation in India. It was a seasonal work, performed by the villagers
in the period when no work was done in the fields. There is no
reference in the sources about any special caste or group professionally
engaged in mining, perhaps this work was done by the rural poor of
lower castes. At the same the evidence of some deeper mines
presupposes the existence of some other forms of labour organization.
Perhaps by the state such were the crown owned diamond mines the
south India or lead mines in Kashmir as described respectively by
Tavernier and Hard Wick. Now to metallurgy proper, the hitherto
available source material makes it possible to suppose that in the 16th-
18th centuries the Indian iron smelting technique logged behind the
European of the same epoch. The archaic forges of furnaces prevailed:
the construction was similar Stuckofen type used in Europe in the
eleventh-thirteen centuries. This furnace had form of a double truncated
cone upto 3 m high: or and Charcoal was loaded at the top and iron was
obtained from the bottom part. The crude bloom was worked on the
anvil many times to remove the scale and give it a bar form. The
process was going on differently regions and perhaps never reached its
logical end. It was noteworthy that, unlike many other craft, the
professional name for the smelters in the northern Indian languages is
description and not connected with respective caste name (compare
dhuniya the Carder, Lohar (the iron smith), kumbhar (the potter) etc.
Nevertheless medieval India metallurgists have to their credit the
empirical discovery of a specific method of manufacturing highest quality steel (wootz). This method was much more effective than medieval European on according to which steel was obtained by heating an iron bloom was broken into pieces; each piece heated a new and so on. This process was time and labour consuming indeed. In India to make steel they used crudest bloom of most impure iron. This technology attracted the attention of the great British naturalist Robert Hook, another scholar, Hellenns Scott, who in the 18th century explored the techniques of some Indian crafts noted that this crucible made steel was used for weapons borers, files etc. It is an established fact that Indian steel was exported to the Roman empire, but it is not known weather it was manufacture according to the above described technology. Later on the producers of the celebrated Damascus and Toledo sword used high quality Indian steel.

Among the innovation of medieval India we may also note the celebrated Bidri alloy of copper, lead and zinc. The manufacture of Bidri ornaments sword and dagger milts and scabbards, smoking utensils, vases and inkstand, etc emerged in the seventeenth century, Bidar and later on spread in Lucknow, Purnea, Hydrabad and Mrushidabad in later place at the end of eighteenth century. On Bidri master by name Mir Illahi Baksh was himself great repute by introducing some innovation in the manufacturing process. Usually four men were engaged in the Bidri manufacturing: one made the alloy and cast the item, another formed it, and the third made the inlay, the fourth blackened and polished.

II. IRON

The sources reveal that during the Mughal era several iron mines were being worked in the region. These were located in Kalinjer,
Gwalior\textsuperscript{17} Kumaon\textsuperscript{18} Subah Mandi\textsuperscript{19}, Been Mahl and other districts in the Subah Ajmer\textsuperscript{20}. The earliest account of the mode of processing iron is found in Ibratnamah which was compiled in 1826\textsuperscript{c}. The author narrates that the Suket Mandi mine had an abundant deposit of a superior variety of iron ore. The blocks of ore extracted by the employees of blacksmiths were mixed with earth. Therefore in order to separate the two blocks were first placed in a furnace which had live coals both above and below it. Twenty men worked the bellows so that the fire w\as stirred into flames.

Thus softened, the block of the ore was then beaten to powder with a mallet. The operation rendered the iron content solid, like stone, so that the earth remains could be discarded. The ore was taken out of the furnace and again subjected to intense heat at the blacksmith’s workshop. From there it was brought back in small quantities, put on the anvil and beaten hard. Thousands of maunds of iron were manufactured in this way.\textsuperscript{21}

During the Mughal days iron wares constituted an indispensable part of human needs. The cheapness of the metal as well as its intrinsic properties, as its sharpness, hardness and heaviness, rendered it very popular which is reflected for example in the existence of iron mongers within the precinct of each village habitation. The \textit{parganas},\textsuperscript{22} and towns,\textsuperscript{23} naturally have their own blacksmiths as may inferred from allusions to them in our authorities indeed, two or three marts of blacksmiths are mentioned at Agra,\textsuperscript{24} and a lane there Loha Galy-- also came to be known after them. Similarly it is possible that in other cities most of them were concentrated within a world or in streets. The demand for their wares led iron mongers’ to set up their small furnaces where ore and fuel were available.\textsuperscript{25} But Moreland further inference that
they abandoned them when either of them failed,\textsuperscript{26} is not borne out by facts.

No such dissertation of their workshop is mentioned by any of our authorities. Though Abul Fazal does not mention it in 1793 the blacksmiths in the camp of De Boigne, a colonel in Sindhia’s army were being paid rupees six per month.\textsuperscript{27} Agriculture implements required by the bulk of the population were either wholly or partly made of iron. Iron tools had to be furnished also to those following non agriculture profession, to blacksmith, carpenters, masons, artisans, sculpture's, tailors, shopkeepers, confectionaries, sugar makers, oil pressers, dyers, washer man, butcher, gardeners, barbers, cobbler and so on, in order to enable them ply their respective trades.

The use of iron nails, hooks, bars, escrows, ring fences,\textsuperscript{28} was also required building industry. The domestic kitchen too had to be equipped with iron ware.\textsuperscript{29} Some ideas of use of canons may be obtained by four thousand four hundred and fourteen piece furnished by a relatively, reduced army of prince of Bahadur Shah in 1707.\textsuperscript{30} This also reflects an expansion and advance in the industry so greatly encouraged earlier by emperor Akbar which is corroborated by Dastural Amal’s evidence seen above is for the confirmed by a report of 1806, where the English are advised to cast their guns an oriental models as these were, besides being effective, much lighter in weight and therefore, more convenient for transportation.\textsuperscript{31} Todd mention Mewar,\textsuperscript{32} and Bikaner as centers for manufactures of match locks.\textsuperscript{33} It is obvious from the Ain-i-Akbari that Shahi Karkhanas produced ordnance which in excellence and effectiveness, was rated as second to that of Turkey alone.\textsuperscript{34} Presumably later, in the eighteenth century the provincial rulers had established their own manufacturing foundries in their own capitals as was the case with the Nawab of Oudh.\textsuperscript{35} One of the principal manufactured of the Punjab
is said to have been match lock during the Sikh regime and considering that each Sikh was armed with a spear, matchlock, scimitar. The number of these weapons required must have been considerable indeed. This implies that the production of relatively heavier armament had multiplied with the progress time. Sirohi swords made on the Damascus model were held in high esteem. Terry, the English traveler, was quite disappointed with the tempering of the Indian Sharp blades for unlike the English swords they could not be bent without breaking. As matter of fact he offered this as the reason for the demand for English Swords. But this does not seem to have lasted long as Majmmuatus-Sanai describes the method for the making of sword describes the method for the making of sword on the model of European (firangi) swords which could be bent like paper without breaking. The provision of equipment for imperial armies up to 1707. In addition to the supply of private requirements, was no mean achievement. But the disintegration of the Empire, the rise of the petty principalities, adventures and free booters, and the consequently greater urgency for private individuals to service themselves against the ruling anarchy are combined to greatly stimulate the industry. No only did the production multiply manifold but improvements is the existing models were also affected. This is perhaps the only industry which flourished and thrived amidst the political changes particularly that of the 18th century.

III. COOPER

Copper mines of great antiquity were to be found in upper India. In the Singhbhum district of Bihar these was a copper bearing belt extending to about eighteen miles in length and delineated by many ancient working. However, we do not have any knowledge of copper working during the sixteenth to eighteenth century period. Evidence
regarding copper mines in the Subah of Lahore are generally vague, with the exception of the suket mandi mines\textsuperscript{42} which poor quality did not pay\textsuperscript{43} since Abul Fazl does not make a similar comment is possible that this deterioration in its quality was a subsequent development some cooper could be obtained in this province by washing the soul.\textsuperscript{44}

There were mines in the mountainous region\textsuperscript{45}, as well as in its other parts.\textsuperscript{46} The processing of ore, or the details of the method employed in converting copper sheets into articles of use. However, we learn from the \textit{Ain-i-Akbari} that besides pure copper its alloys were compounded. Thus bronze was obtained by compounding four seers of cooper one seer of tin.\textsuperscript{47} In brass the proportion of copper and \textit{ruh-i-tutiya} was \(2\frac{1}{2}:1\) varying proportion yielding varieties of brass. In ruyi the composition was four seers of copper and one and a half seers of lead and so on.\textsuperscript{48} Except in the striking of coins, generally these alloys were used for the purpose as the copper itself since tin, \textit{tutiyah} and lead were cheaper than copper, these compound alloys must have gained greater popularity.

Several articles were manufactured from this metal.\textsuperscript{49} Copper vessels had been in used in India since ancient time, but their use seems to have been greatly extended since the advent of Muslims who had been ordinarily using it elsewhere in the Middle East.\textsuperscript{50} In brief Muslims generally used copper vessels for their domestic purposes.\textsuperscript{51} There were Muslim dealers at all events in Lucknow, who let out cooking vessels for festival assemblies in Moharam, marriages or for alms giving.\textsuperscript{52} There are however, some noteworthy names as principal centers for their production. Banaras manufactured both copper and brass wares but more especially the later.\textsuperscript{53} While Lucknow\textsuperscript{54} and Delhi were famous for their copper ares.\textsuperscript{55} It is indeed strange that W.H. Moreland who himself translated and edited Pelsaert original text, should have over
looked his and Abul Fazl's evidence and categorically stated that he found no mention of the use of copper or brass utensils except in Goa, where Linschoten tell us that he had found copper cans commonly employed for the travelers disposes of W.H. Moreland's inference that copper was for too expensive for the common man (at any rate at Goa, where the prices could not have been very much lower than in upper India).

Occasionally, Copper plates were employed as materials for decor in splendid edifices. For instance, a place in Gwalior had plates of this metal in its fine domes, The eastern front of the Agra fort was covered on top with plates of copper gilt. Like wise all the cupolas of the suit of Rang Mahal at Delhi were formerly covered with copper.

Some quantity of this metal was also used as a means of personal decoration. Obviously copper jewellery must have been confined to the poor people. Copper and its alloys were, again used for casting idols of all shapes and size by the Hindus. But a much more substantial quantity of this metal as well as of its alloys was used for making guns and canons.

According to Mirat-i-Aftabnuma Aurangzeb used to copper brick of Akbar in the Agra fort for making seven large guns. But by far the most important and stable function of this metal was coinage, copper coins under various names had been current in our region by long before our times, as may be gathered from, among other sources. The numismatic catalogues of the extant coins. Their importance grows rapidly from the binning of our period. The revenue assessment payable in cash as introduced by Emperor Akbar had led to a greater monetization of the economy and copper coins in conjunction with the silver rupee were the medium for affecting the process. In fact the frequency of use of the copper dam (one fortieth part of rupee) and its
fractions was for greater than that of silver rupee or gold mohor. It is indeed a pity that he does not like wise mention the number of dams issued at any mint or in any year. Such information would have enabled us to establish the volume of copper thus required.

Later, in the seventeenth century, some of the local mines having failed the price of copper rose sharply, a situation that was aggravated by the inadequate imports of the article. The import position, however, improved in the course of the next century when large quantities were brought in by the east India companies of Dutch, and the English from Japan. Thus during the middle of the 18th century when an extreme scarcity of silver in reported from Patna, the copper position seem to have remained satisfactory. In the price list of Banaras fixed in 1781, four varieties of copper are noted whose prices were rupees fifty five, fifty Nine, Sixty five a maund respectively.

IV. SALT

Salt occurred mainly at two places in northern India at Sambhar in the Subah of Ajmer and Shamsabad in the Subah of Lahore. While at the former the salt was obtained by evaporating the water of lakes, relatively simple process. The latter was the rock variety requiring more or less the skilled Labour of minor to extract it.

It is believed that the Sambhar Lake has been worked for salt for fourteen hundred years. Todd however tells us that the process of natural evaporation was expedited by means of sirkindah grass. Which lessens the superficial agitation, after collecting the salt into immense the superficial agitation. After collecting the salt into immense masses a variety of an alkaline plant was burnt at its summit to render it impervious to weather. That salt was red white or blue. We learn that in 1900, “The salt industry of Rajputana produces about two hundred thousand tons a year and meets the requirement of fifty mine million
people. By piecing together the relevant evidence we get some idea of the method of the working of these mines at the foot of hill and operator was dug which was reached with a flight of stairs to the depth of twelve yards below. Hadiqatul Aqalim makes the depth to be three hundred yards. The steps measured two to three yards in width so that two or three labourers might be able to move up and down breast. Further in order to prevent the roof of the mine from falling in pillars were erected at intervals of about three yards. The miners using mattock (Zaghnole in the original) extracted block of salt weighing from one to three maud each. According to Khlasatul Tawarikh and Hadiqatul Aqahim, each of the miner also carried a torch in his hand and emerged from the mine loaded with a thick block of salt weighing from one to three maund each. According to khulasat-ul-Twarikland and Hadiqatul Aqalim, each of the miners also carried a torch in his hand and emerged from the mine loaded with a thick block of salt on his shoulder. Khairuddin Lahor, however states that they used to tie the slabs of salt out. Perhaps this easier mode of carrying it out was development subsequent to the writing of Khulasal-ut-Tawarikh and Hadiqat-ul-Aqalim. The change—however, is too miner to be regarded as an advance. Even as late as 1830 blasting of these rocks with gun powder was considered to be too risky to be attempted.

V. CHEMICAL INDUSTRIES

In this chapter we will discuss urban crafts like manufacture of dye stuffs, gunpowder ink, paper, soap and glass. Gunpowder manufacturing became an important field of urban industries even prior to the adoption of fire arms, i.e., in the late thirteenth Century. Firstly it was used for fireworks, which for many centuries remain significant part of the Indian festivals. Moreover from China through the Mongols
the technique of undermining fortress wall was borrowed: gunpowder was also used in hand "rockets" or bana, the latter were known as early as in the fourteenth fifteenth centuries. But the real growth of demand for gunpowder was connected, of course, with the spread of firearms. Medieval chemical treatises and the sukranti have a detailed recipe of making gunpowder out of saltpeter (5 parts), sulphur (1 part), charcoal (1 part), ground together with the Juices of some herbs and garlic, dried and powdered.

Soap maker (sabungar) were frequently mentioned by our sources as a significant group of urban population. Soap manufacture began in India in the eleventh-twelfth centuries, perhaps slightly earlier than in Europe. Soap was made such. Ingredients as tallow, linseed or sesame oil, soda, lime and aromatic herbs. This mixture was boiled in huge metal cauldron, built masonry kiln. Usually a sabungar had two or three helpers, his family members or hired waremen. apart from soap various kinds of cosmetics and scents were produced in the cities. This was facilitated by the fact that distillation, known to early medieval chemists, became by the fourteenth century a widely spread practice. Scents which became to be known in Europe only during the crusades, had been manufactured and widely used as early as in the middle of the first millennium: chemical treatises and the Ain-i-Akbari describe dozens of recipes for manufacturing scents, fragrance and other aromatic essences, which had a great demand both in India and abroad.

Ink was known to early medieval Indians, which is testified by the eleventh century Kashmiri chronicle Rajtarangini. Its recipe was included into the Rasaratnakara, a thirteenth century treatise. The Lekhapaddhati had it in the following way: sot and lotus petals were ground together in a copper vessel, then resin, gum and water were added drop by drop. Ink makers (Siyahi) were a distinct urban
professional group.\textsuperscript{97} According to S.A. Ghori and A. Rahman, paper was brought to India during the Arab invasion of Sindh in the eight century.\textsuperscript{98} P.C. Ray, however, was of opinion that paper and the technology of its manufacture were brought to India in the tenth-early 11\textsuperscript{th} centuries through Nepal, frequented by the Chinese pilgrims.\textsuperscript{99} Whatever it might have been in the 14\textsuperscript{th} century making was so widely spread in the north of India, that the Delhi sweet sellers used it as packing material.\textsuperscript{100}

In the 15\textsuperscript{th} -16\textsuperscript{th} century paper making emerged as one of the most popular fields of urban industries. It was especially well developed in Kashmir, where in the fifteenth century craftsmen from Samarkand worked; also in Sialkot, Zaferabad, Agra, Oudh, Murshidabad, Hugli Pattan, Zafarbad, a small town near Jaunpur, even got the nickname of Kaghzishahr or paper town. In many Indian cities the Kaghzi mohallas or quarters were paper makers (Kaghzi) lived, still exist.\textsuperscript{101} Raw material for paper consisted on flax and hemp, both reduced to a stage of pulp. The pulp was soaked for a certain time, washed, pounded by feet worked wooden pestles: then the stuff was washed, dried and soaked several times more in a mixture of water \textit{Sajjz} (Soda subcarbonate, and slashed lime, cleansed by passing it through running water, sorted in a vat and spread upon bamboo frames. The frames were gently moved to and the water was allowed to escape, the mass was equally spread upon the frame. After that the frame was turned down, wet sheets pressed, dried and polished by oiled cloth and agate; a skilled polisher was able to polish up to 100-120 sheet a day.\textsuperscript{102}

The manufacturing process required 6-10 workmen; raw material was usually purchased from the market. The organization of labour was different: it might be a big family with several grown up men (pounding required much physical strength) a cooperation of partners or, in other
cases, well-to-do- kaghzis, who had several pestles and vats hired workman. The paper technology as used in medieval and even nineteenth century India was different from its European counterpart only in one aspect. In Europe pounding was performed by water wheels. Perhaps in India, given its great cultural achievements and traditional aspects for learning, paper making experienced no stimulus equal to the one which in the west was connected with the adoption of printing press.

Glass making was known in India since ancient times, as archaeological excavations testify and was mention by early medieval Literature and dictionaries. In the list of goods exported from Coromandel coast in 1225 a Chinese traveler mentioned transparent and opaque glass. Another rural industry was the manufacture of glass ornaments, such as bangles and beads. The quality of glass might have been rough and coarse. In Bihar various glass ornaments such as bracelets, bangles and rings etc. were produced by the peasant as an indication of their knowledge of this craft. The different kinds of village industries, owned by the peasants help us conclude that the village industries of northern India in the second of the 17th century were not only self sufficient but sometimes, were rich enough to supply industrial goods (though in rough, crude and coarse form) to the town other sources also refer to various glass vessels and utensil (glassware was, however much less used than in Europe) and European traveler praised its good quality.

Most widely spread among glass items were, no doubt, ornaments like bangles and beads. Another important and well developed sphere of glasswork was manufacture artificial precious and semi-previous stones: this craft required significant knowledge of ingredients for colouring glass and was looked upon as respectable one, provided the craftsmen did not try to pass artificial stones off as real ones. We may therefore
suggest that the emergence of glassmakers as a professional group was a slow process due to the limited demand for glass items. As can be judged from the available description the tools and techniques of medieval Indian glass makers were similar to those of their European counterparts.¹¹⁰

Nevertheless glass making experienced more foreign influence than any other craft referred to in this paragraph. This was especially relevant for the manufacture of looking glasses, spectacles, cut-glass mirrors and telescopes. In the sixteenth eighteenth centuries these things gradually penetrated into the households of the nobles, the city rich and then more wider strata of city dwellers.¹¹¹ Some more information is needed of course, to substantiate such a reading but other sources, like the Mughal miniature painting of the seventeenth century, leave no room for doubt that spectacles were well-known to the late medieval elite or perhaps even more wide articles of urban society.¹¹² In the dictionaries of the seventeenth and eighteenth centuries things like spectacles and spy-glasses are referred to by well-established terms; for examples, Bahar-i-Ajam explains one of these term, i.e., spy glass, through another one, “spyglass (durbin) is something like spectacles (ainak) to see the thing situated for away. It helps ship captains to watch sea and (the military) to reconnoiter the enemy’s camp.”¹¹³ Thus in late medieval and early modern times the Indian glass making adopted a number of technological innovations from Europe. But due to the fact that in India glass items, with the exception of bangles, were not among the goods of mass demand the progress in this sphere of industry had no serious impact upon economic and technological development as a whole. The crafts discussed in this paragraph were, however, important parts of the urban crafts structure, different as they were; they had some common features as well. Most of them belonged to the invention of the
middle ages, not antiquity, in the northern and central India professional groups and castes involved in these crafts were more often than not known by Arabic Persian and Turkish names (*Kaghzis*, paper makers, siscars, glass makers: *sabungars* soap makers; *siyahis*, ink maker and soon) many of them professed Islam. This means that even if a respective craft existed in early medieval times, the group or community which practiced it emerged as a distinct and professional one much later, when Persian, Arabic and Turkish words widely entered the Northern Indian languages it was likewise natural that these occupations defiling according to the standards of orthodox Hinduism (especially soap and paper making) were carried on by low castes and untouchables who were among the first to accept the new faith, i.e., Islam. But for our study more important is the fact that all these crafts were predominantly urban. Last but not least, their development had a significant impact upon the development of chemical science, which owed most of its achievements of the period to analyzing and generalizing the experience gained from industrial activity.
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