DECCAN HERALD
Science & Technology
Tuesday, August 7, 2007

Zinc metallurgy in ancient India

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Ancient mine workings and distillation furnaces indicate that ancient India had acquired the technical knowledge much before the industrial revolution.

The heritage of zinc metal is unique to India. In a way, it is a tribute to the technical excellence of our ancient people who pioneered the zinc extraction for the first time anywhere in the world. The chief evidences are : the existence of ancient mine workings, smelting (metallurgical) sites and artefacts – especially the zinc-based alloys, notably brass recovered from the archaeological sites.

The state of Rajasthan, in the northwestern part of the country, exhibits a number of ancient zinc-lead mines viz, at Zawar, Rajpura-Dariba and Rampura-Agucha which are approximately 2300- 3000 years old (radio -carbon dates).

Zawar, 45kms south of Udaipur city, was the major producer where an advanced, zinc mining and smelting activity flourished in the past. It is no wonder that even at present Rajasthan is the principal producer of zinc and lead in the country. Extraction of zinc metal from its ores had posed problems during the earliest times in other countries in the world and metallic zinc was rarely reported in antiquity. The main reason being it required extreme reducing conditions for its extraction, as it would form only as a vapour in furnace.

A breakthrough was achieved a long time ago as recorded in our ancient literature (Sanskrit) : Rasarnavam Rasatantram (500 BC), Rasaratnakara (2 century AD) and most notably in Rasaratnasamuchchaya (late 13 century AD) where a detailed description of the process of high temperature distillation that was developed and applied in this country for extraction and purification of the zinc metal from the ores is mentioned.

Smelting: After breaking the zinc ores by iron hammers or pestles (as made out by the remains found at the mines), they were crushed by larger pestles in a series of large mortars carved into the hard rock exposed outside. The ore would have been thoroughly roasted (to reduce the level of sulphur) and a high proportion of calcined dolomite (flux) was mixed.

Further, 1.5 percent of common salt was included to assist or augment the distillation process as soda vapour would help to sinter calcium and magnesium oxides, thus helping the zinc vapour to flow out of freely and probably to increase the yield of zinc.

Finally, this charge was placed into brinjal (aubergine)-shaped clay retorts of two sizes : about 200 mm in length by 80 mm diameter and about 350 mm length by

120 mm diameter with 1 cm thick clay wall.(Photo)

Intact ancient zinc distillation furnaces (known as koshthi) containing their full spent charge of 36 retorts (6x6 arrangement) are well preserved at Zawar.

Each furnace (charcoal-fired) 60 cm in height, in the form of a truncated pyramid, was divided into two parts – a lower condensing chamber (65x65x20 cm) and upper, the main furnace chamber separated by a parallel terracotta plate.

It has been estimated based on studies using a scanning electron microscope to determine the degree of fusion of clay and other minerals, that the temperature reached in the Zawar zinc distillation furnace was of the order of 1150 to 1200 degrees C and this temperature was maintained for over 6 hours – according to the findings of a team of archaeology experts from the British Museum, and M S University Baroda, in collaboration with the Hindustan Zinc Limited in the 80s.

Based on the huge amount of smelting debris accumulated, roughly estimated to be around 400,000 tonnes the daily production was supposed to be around 150 tonnes, which represented a production of approximately 60,000 tonnes of zinc metal spread over a period of 400 years. The smelting activity was at its peak between 1300 and 1600 AD.

The technology of production of zinc metal was unknown in Europe and other countries in the western world, until W Champion produced zinc from its ore at Bristol, England in 1736. There are unconfirmed reports that Champion's process of distillation was exactly the same same as that existed in India, suggesting that the technology reached England from Zawar.

The main incentive for continuous production of zinc metal was probably to prepare high quality brass (an alloy of zinc and copper) not only for making vessels for domestic use, but also for casting images of gods and goddesses.

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