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RECLAMATION OF COPPER BASE SCRAP AND RESIDUES(*)

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The Railways' holdings of non-ferrous metals are estimated to exceed Rs. 21 crores and a substantial portion of this amount is accounted for by the copper and copper-base alloys. The annual outturn of the railway non-ferrous foundries amounts to about 23 thousand tonnes and accumulation of non-ferrous scrap at the end of March 1967 were reported as 11,400 tonnes. The value was estimated as Rs. 2.62 crores. The Railways reclaim most of their non-ferrous scrap arisings in their foundries; during the year 1966-67, 19,604 tonnes of non-ferrous scrap, mostly copper base, was utilised by the Railways for their own use and 1469 tonnes was disposed of to the trade.

The quality of the secondary alloys and the ecomomics of their production largely depend on the effectiveness of sorting of the charge. For worn components and lump scraps of phosphor bronze, leaded bronze, gun metals, brass, plated scrap, claddings etc., simple sorting by shapes, colour, filing, sawing etc. with implements such as magnifying glass, file, hack saw, magnet, small portable drill can be applied with considerable success. Drill sorting may be resorted to after colour sorting in case of scrap having marked difference in machinability or to facilitate colour sorting in case of tarnished, plated or coated scrap. In doubtful case, simple spot tests with nitric acid, ammonia etc. may help. For mixed up finely divided scrap, complete melting of sample charges has to be undertaken to ascertain the average analysis.

Pre-treatment is necessary for improving quality and to facilitate handling, storage, and charging of the scrap. Iron and steel attachments are removed, white metal lining melted down and separated and large pieces broken down into small ones to suit the melting units. Insulations are either stripped or burnt and the wires compressed or bundled to

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facilitate charging. Grease and oil present are removed by alkali bath treatment and moisture by pre-drying. Where bronze swarf is not mixed with white metal, briquetting after separation of ferrous contaminants is advantageous as substantial quantity of water and oil also gets removed in the process. For swarf, containing 5% or more of oxides, flux may be incorporated in the briquettes to enable better fluxing action.

Skimmings, slag, dross etc. are first broken down and then seived by which they can be separated into two groups viz., (i) fines containing about 10% metallics, & (ii) coarse particles containing about 90% of the metallics. Screening of moulding sands, discarded crucibles, worn out refractories from ladles may lead to fruitful sources of scrap, and should be examined and procedures formulated for reclamation where profitable.

For lumps, turnings and swarf, sorted into distinct grades, commercially free from ferrous or whitemetal contaminants, straightforward melting is adopted in crucible rotary or reverberatory furnaces under cover of suitable flux. Reverberatory melting is not favoured for fines as flue losses are high. Swarf or turnings are charged in concentrated form. The crucibles or hearth are preheated to 700°C-800°C before charging and partly filled with molten metal. This helps quicker heating and prevents undue oxidation. The molten metal also protects the lining of the hearth from reacting with the flux.

The differential process in which the separation is achieved by differential melting of the high & low melting constitutents in the mixed scrap, is under operation on the N.E.Railway. Briefly, the process operates on the following steps: (i) Bronze swarf mixtures, mixed with ferrous and white metal ingredients but free from contamination, are first passed through magnetic separators which remove the ferrous ingredients. (ii) The bronze swarf mixed with white metal is then fed into a cylindrical 12 mesh sieve in which the charge is moved forward by a screw arrangement fitted to the shaft. During forward movement of the charge, the sieve retains almost all the white metal and the coarser particles of bronze swarf. The finer bronze swarf passing through is collected separately. (iii) The coarse mixture of bronze and white metal swarf is then fed into a second cylindrical 16 mesh sieve rotating at a speed of 14 RPM. The sieve is kept at a temperature of about 350°C. The forward movement of the charge is also achieved by a similar screw arrangement as in the first drum. During the forward movement of the charge, the white metal portion of the swarf melts and gets collected.

Bronze swarf, practically free from white metal is discharged through the end of the second sieve. (iv) The bronze borings collected from the first and second sieve are melted in a rotary furnace.

It has been observed that the mixed bronze swarf contain about 4-5% antimony. The analyses of the bronze borings after the separation of white metal averages - tin 7-8%, lead 9-10%, antimony .05-.07%, others generally below 0.5%, and copper remainder.

Salient features of the process of reclamation adopted for bronze residues on the Eastern Railway are (i) Milling of the residues in Surki mills, (ii) milled residues are fed on to vibrating Wilflay-Tables in which the fines i.e. non-metallics, mostly sand is washed away with water and the coarse particles containing metallics are carried forward and collected, (iii) Concentrates containing metallics are air-dried by spreading on floor and fed to magnetic separators, (iv) the concentrate is sieved. Fines passing through contains about 2% metallics and the coarse particles retained are melted in a reverberatory furnace with a flux. 22 tonnes of washed concentrate yield about 10-15 tonnes of ingots per month. Chemical composition of the reclaimed ingot averages Sn 5-7%, Pb. 8.5-9.5%, Fe. 0.3% max., Zn - trace and Cu- balance.

In published literature, details of various refining methods for copper base scrap containing lead tin and zinc as alloying elements have been described. Some of these can be successfully applied for reclamation of mixed bronze scrap containing brass or mixed brass scrap.

W.S. Nelmes et al have reported on the experimental work on top jetting oxygen process in replacing the conventional conversion process of black copper in plain converters. The experimental work and trials indicated satisfactory results.

The process patented by Lissauer et la involves selective oxidation of the alloys by blowing reducing gasses through the melt while maintaining a reducing atmosphere above the melt in the first stage when zinc was burnt to oxide and collected. The rich oxide fumes were collected when oxidising atmosphere was brought about above the melt.

In a process described by Kohlmeyer, brass scrap was melted in an oil-fired rotary furnace and then heated to drive off zinc preferentially which burnt to oxide and was collected through an electrostatic precipitator.

The unique feature of the Poland process described for treatment of brass scrap was that zinc of about 98% purity could be distilled out directly from brass melt. 85% - 92% of the zinc and about 95% of the copper present in the scrap could be recovered in the Process and the **z**inc content in the residual melt was about 2%.

Work on conversion of copper base scrap containing high proportion of zinc has been recently undertaken in R.D.S.O. Mixed scrap arisings procured from the Railways analysed Sn 0.23%, Pb 1.80%, Zn 26.17%, Cu 66.20% (1st lot) and Sn 3.3%, Pb 1.48%, Zn 9.7%, Cu82.78%, (2nd lot). Scrap was melted in oil fired crucible furnace of 50Kg.capacity. The molten metal was tapped in a preheated fire clay lined handout ladle of 50 Kg. capacity in which oxygen lancing was carried out. The lancer used was made up of 12 mm dia copper tube having 3 mm wall thickness. About 450 mm length from the tip of the lancer was protected with asbestos rope and coated with magnesite powder and slay. The lancing was carried out intermittently and samples were taken at intervals.

In order to assess the possibility of application of the oxygen lancing process in ladles for reclamation of mixed bronze brass scrap further experimental trials are considered necessary. The limited experiments carried out, however, indicate that by regulating the oxygen lancing rate, it may be possible to minimise volatilization losses of zinc by retaining most of it in the slag. Slower rate of oxygen lancing is also expected to reduce process metal losses. It is also considered that in presence of sufficient proportion of zinc in the melt, the losses of tin and lead during oxygen lancing may be negligible.

Reclamation of mixed copper base scrap containing high proportion of zinc is expected to produce considerable amount of zinc oxide mixed with other oxides e.g. tin, lead, iron, antimony, aluminium, manganese etc. in varying amount . Zinc oxide with small amounts of lead upto 0.05% can be used for manufacture of zinc oxide pigments. Lead compounds upto 15% can be tolerated in leaded zinc oxide paints. A number of processes have been patented for treatment of mixed oxides working on the principle of differential volatilization and extraction by leaching.

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