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USSR Report

MATERIALS SCIENCE AND METALLURGY

(FOUO 2/82)

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FERROUS METALLURGY

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IMPROVING IRON AND STEEL SCRAP PROCESSING

Moscow STAL' in Russian No 11, Nov 81 pp 6-8

[Article by G. S. Khomskiy, Soyuzvtorchermet All-Union Production Association: "State and Prospects of Development of Scrap Metal Processing"]

[Text] The importance of steel and iron scrap and waste in steelmaking is well known. In 1980 64.8 million tons of scrap and waste were consumed in producing 148 million tons of steel, that is, approximately 44 percent of total steel was obtained by remelting scrap. Forecasts indicate that this figure will steadily rise; in electric furnace steelmaking 95 percent of the entire charge consists of steel and iron scrap and waste.

Further increase in steel production and improvement in quality of steel depend to a significant degree on the quality of preparation of scrap metal for remelting. Efficient preparation of scrap metal shortens by as much as 25 percent open-hearth furnace cold charging time; the output of open-hearth furnaces increases by 4-5 percent; a number of other indices also improve.

In the "Principal Directions of Economic and Social Development of the USSR for 1981-1985 and the Period up to 1990" adopted at the 26th CPSU Congress, the country's metallurgical workers were assigned the task of ensuring fuller utilization and high-quality preparation of iron and steel scrap. A program was drawn up for accomplishment of this task, specifying further improvement of organization of procurement (delivery) and processing of iron and steel scrap and waste, implementation of which will make it possible substantially to improve provision of metallurgical enterprises with high-quality metal charge.

To ensure fuller utilization of existing scrap metal resources in the nation's economy, plans call for substantially expanding by 1985 the network of shops and sections of the Vtorchermet system, equipping them with modern scrap processing equipment, and increasing processing volume to 35 million tons for the system as a whole.

This means increasing by 30 percent receiving and processing of scrap metal at Vtorchermet enterprises in the 11th Five-Year Plan; an increase of only 10 percent was achieved in the preceding five-year plan (at metallurgical plants volume of scrap and waste processing increased by 8.4 percent, but by only 6.2 percent at metalworking plants).

The relatively small increase in volume of processing at metalworking enterprises is due to a number of objective and subjective factors, in particular the absence of centralized planning, insufficient material incentive for enterprises to process scrap, as well as the difficulty of obtaining high-efficiency scrap processing equipment.

Assignment of a target to ministries and agencies pertaining to increasing the processing of metal scrap, communication to subordinate enterprises and organizations of steel and iron scrap and waste processing targets simultaneously with delivery targets, construction, renovation and retooling of scrap processing shops and sections should in coming years promote a sharp increase in the quantity of scrap metal delivered in processed (proper size) form.

An important role in this should be played by including all scrap supplier enterprises in the plan and report pertaining to commodity output and volume of sales, at full value of scrap prepared for remelting, in conformity with the requirements of GOST 2787-75, "Metals, Ferrous, Secondary."

The necessity of further increasing the volume of scrap processing directly at the locations where it is generated is also connected with the fact that this reduces overall labor expenditures on scrap processing, and metallurgical workers receive higher-quality scrap, since there is an appreciable reduction in mixing in scrap differing in its physical and chemical parameters. In addition, considerable savings in hauling costs are achieved, since hauling processed scrap metal costs from 33 to 50 percent as much.

Metallurgical plants process both their own scrap metal and commercial scrap supplied by the Vtorchermet system. The percentage share of commercial scrap comprises approximately 53 percent of total processing at the present time; one notes a trend toward its gradual decline.

As a rule, metallurgical enterprises install hydraulic baling presses of 10 MN or more, and 10 MN hydraulic shears. Many plants have set up their own powerful scrap-breaking facilities, which make it possible even at peak delivery times to accept all scrap and to increase processing volume from year to year.

Here we should mention first of all the Magnitogorsk Metallurgical Combine, the Cherepovets and Makeyevka Metallugical plants: a great deal of work on uninterrupted supply of high-quality charge material for steelmaking is being done at the Novolipetskiy Metallurgical Plant, where they are building crane facilities for unloading iron and steel scrap and waste received from elsewhere and bringing new scrap processing facilities on-stream: practically the entire stockpile of scrap metal is stored only in processed form.

All metallurgical plants should adopt the experience of these enterprises, and particularly NLMZ [Novolipetskiy Metallurgical Plant].

Total volume of scrap processing at metallurgical enterprises should increase to 32 million tons in the current five-year plan. Metallurgical workers have been assigned the task not only of increasing processing volumes on carbon steel scrap but also of organizing the dismantling of retired cast iron molds, with the aim of eliminating, beginning in 1983, the hauling of scrap cast iron unprepared for remelting, as well as eliminating return and inefficient hauls.

The Dnepropetrovsk Press Forging Equipment Plant makes hydraulic presses for processing cast iron ingot molds and bottom plates, which are high-output units and are operating reliably at the Dnepropetrovsk Association and at the Konstantinovka Vtorchermet Plant. Good results are obtained by employing equipment for chopping cast iron ingot molds, which includes a hydraulic press manufactured by the Odessa Press Forging Equipment Plant imeni 16th Party Congress, and a manipulator designed at VNIPIvtorchermet [All-Union Scientific Research and Design Institute for Scrap Iron and Steel].

Many years of experience in operating this equipment indicates that its employment, especially in conditions of metallurgical production, enables one fully to eliminate the construction of tower and trestle-type scrap breakers, to reduce the cost of processing, and substantially to improve working conditions.

The Vtorchermet system is faced with large and responsible tasks. In order to increase scrap procurement and processing volumes it is necessary not only to expand the system's network of shops and sections but also to achieve a fundamental change in view on the question of where it is more advantageous to process scrap metal -- only in large shops and at Vtorchermet plants, or whether it is possible to utilize for this a larger number of rayon shops and sections, providing them with the requisite scrap processing equipment.

The experience of recent years, when particular importance has begun to be attached to maximum utilization of the carrying capacity of each Ministry of Railways freight car and reducing time spent on loading and unloading operations, has shown the expediency of the latter variant.

For example, to increase the output capacities of the main shops just of such large associations as the Dnepropetrovskaya, Sverdlovskaya, Gor'kovskaya, and especially the Chelyabinskaya, tens of thousands of Ministry of Railways cars are now required to provide for hauling in oversize scrap metal, and their load capacity is utilized at only 25-50 percent on such hauls.

In connection with this the Soyuzvtorchermet All-Union Production Association is equipping not only main shops but also all other shops and sections within the Vtorchermet system with 3.15-6.3 MN equipment for baling or cutting scrap.

Very important for ensuring high-quality scrap is the method of processing it. The most effective are separation methods of processing retired scrap, which make it possible to remove nonferrous metals and nonmetallic impurities: shearing, breaking, etc. In connection with this it is necessary to change the structure of scrap processing which has become established in this country, substantially increasing the percentage share of cutting by shears.

Special requirements are imposed on scrap processing equipment for mid-size and small shops: it should have the capability not only of baling metal scrap but also of cutting it, with the simplest possible installation mounting arrangement for speeding up and simplifying installations, and should be delivered as ready as possible for installation and startup.

Of considerable interest in connection with this are 4 MN combined press-shears, manufacture of which should begin in the 11th Five-Year Plan. These units can both bale and cut scrap metal in relation to its characteristics; they are sufficiently powerful for processing all agricultural and domestic scrap, which opens up extensive possibilities for utilization of such equipment in the numerous shops and sections of the Vtorcherment system with a small annual volume of procured scrap, 15-25 thousand tons.

Of the new equipment which in coming years will be installed in the shops and sections of the Vtorchermet system, we might also mention 6.3 MN hydraulic combined press-shears manufactured by the Novosibirsk Tyazhstankogidropress Plant imeni Yefremov and hydraulic presses for processing scrap machine cast iron, manufactured by the Odessa Press Forging Equipment Plant imeni 16th Party Congress; this same plant has been assigned development of the first Soviet mobile baling press.

There will be expanded output of 3.15 MN hydraulic shears and alligator shears which are already being produced by industry.

Expansion of processing of metal scrap on presses of not more than 6.3 MN and rapid growth of cutting scrap with shears will enable the Vtorchermet system to provide growing electric furnace steel production with high-quality charge.

A further increase in demands on quality of supplied metal scrap is compelling experts in scrap processing to look for new technological solutions alongside improvement of existing processing methods (baling and cutting). Breaking lightweight scrap in special crushers and hot baling seem to be the most promising methods.

As is indicated by foreign practices and experience in operating the Lindeman breaker installed in the main shop at the Gor'kiy Vtorchermet Association, this method produces the greatest effectiveness when it is necessary to process mixed scrap consisting of ferrous and nonferrous metals and nonmetallic materials in various mass ratios.

The breaking process consists essentially in processing lightweight scrap metal in a hammer-type rotary crusher (disintegrator), with subsequent sorting and magnetic separation of the broken material. This method can reduce content of nonferrous metals in the final product to 0.25 percent and can remove nonmetallic impurities.

The importance of this processing method is increasing in connection with steady growth in the quantity of automobiles, household appliances, and various electrical equipment going into scrap. Recovery of nonferrous metals from broken scrap makes it possible to return nonferrous metal scrap to nonferrous metallurgical enterprises as raw material and to improve the quality of the produced steel, reducing its contamination with harmful impurities. The latter factor is particularly important if one considers that in the last 10-15 years copper content in carbon steels has increased on the average from 0.10-0.12 to 0.25-0.27 percent, or more than double.

Even higher results can be achieved with low-temperature processing of scrap metal. The so-called cryogenic method is based on a peculiarity of carbon steel -- its toughness decreases 4-15-fold when cooled to -100-120°C, while the toughness of

alloy steel and nonferrous metals remains practically unchanged with such cooling. Thanks to this peculiarity, carbon steel can be broken up into smaller pieces than alloy steel or nonferrous metals, and subsequently they can be separated with greater precision.

Since cooled steel has lower strength than at normal temperatures, it is possible to increase the output of a conventional breaker unit by 3 to 4-fold, depending on specific conditions, or it can be made lighter, reducing physical size and drive mechanism power.

Scrap produced by the cryogenic method possesses significant advantages over other types of scrap -- it is cleaner and smaller. Its employment in electric-furnace steelmaking makes it possible to solve the problem of continuous furnace charging, reduces consumption of electrodes and electric power, and helps extend refractory lining life and increase furnace output.

Cryogenic scrap can be successfully utilized to cool metal in the ladle during continuous steel casting and to increase bulk density in loading scoops and charging boxes.

The cryogenic processing method is being intensively developed abroad.

In most cases liquid nitrogen or refrigerated air is employed as coolant.

In the USSR a method of cryogenic processing of scrap metal employing cold produced by air turbine refrigerating units (gas-expansion machines of Soviet invention) has been developed by a number of organizations jointly with the Cherepovets Metallurgical Plant.

Employment of refrigerated air in place of liquid nitrogen makes it possible to cut cooling costs 2-4-fold and to develop a highly-efficient scrap metal processing arrangement.

An experimental commercial unit for cryogenic scrap processing is to be constructed at the Cherepovets Metallurgical Plant.

Hot baling is a second promising method of processing scrap metal. It is especially efficient for processing chips and other types of scrap which are little suited to cutting -- steel wire rope, high-strength wire, various tubular structures, etc.

The Konstantinovka Vtorchermet Plant is operating a facility for hot-baling difficult-to-process scrap, consisting of a two-chamber heating furnace fired by natural gas and a 10 MN hydraulic baling press. Three years of operating experience has indicated that with hot baling one can significantly reduce the content of nonmetallic impurities in the bale, which burn up during heating and, what is particularly important, one can increase the density of the bales 2-2.5-fold in comparison with that achieved with conventional cold baling.

For example, heat exchangers with the traditional gas cutting method of processing are very labor-intensive and produce scrap of less than 0.5 t/m^3 density. When baled following heating to approximately 1000°C, bales weigh 2.6 tons and have a density of 3.2 t/m^3.

Baling wire heated to 950°C makes it possible to produce bales weighing three tons with a density of 3.6 t/m^3; bales of steel wire rope weigh 3.5 tons with a density of up to 4.2 t/m^3. This highly efficient method of readying scrap for remelting should be extensively adopted at metallurgical enterprises.

Hot baling of steel chips is definitely of interest; the need to find a highly efficient method of preparing chips for remelting is dictated by the steady increase in the volume of chips generated in the economy.

At the present time chips are utilized primarily in making steel and ferroalloys. Small chips obtained by screening out or by breaking spiraled chips are used in producing ferroalloys.

Pellets of chips, charge ingots (obtained by remelting alloy chips), bales with chips added (20-25 percent of the bale by weight), and frequently simply loose chips, in many cases oversize, are utilized in steelmaking. When loose chips are utilized, loss on ignition runs as high as 25-30 percent at some plants.

VNIPIvtorchermet, jointly with the Lipetsk branch of the Stal'proyekt Institute, has designed a combined chip processing shop.

The process provides for screening out fine chips for ferroalloy production, with subsequent degreasing in an inclined rotary furnace. Spiral chips will be batch-loaded into a 12-chamber annular rotary furnace in which, after removal of lubricant-coolant liquids at a temperature of up to 350°C, it will be heated to 650-700°C, which is sufficient for hot baling.

A 4 MN press of Czechoslovak manufacture will be used to bale chips in a heated state. Choice of this press took into account that the bales, 600 x 600 mm in section, are to be suitable for electric-furnace and converter steelmaking.

Calculations indicate the great economic effectiveness of hot chip baling. Construction is in progress on the first combined chip processing shop at the Kolomna Vtorchermet Plant (Moskovskaya Oblast).

The All-Union Scientific Research and Design Institute of Secondary Ferrous Metals (VNIPIvtorchermet, Lipetsk) is called upon to play a leading role in development of new types of equipment and fundamentally new processes of preparing scrap metal for remelting, and efficient location of facilities for processing iron and steel scrap and waste.

High-quality preparation of scrap metals for remelting is an important economic task; it is a matter of honor for all specialists working on this problem, and particularly the Vtorchermet system people, to accomplish it successfully.

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STEELS

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ADVANCED METHODS OF PRODUCING STEEL INGOTS

Kiev PROGRESSIVNYYE SPOSOBY POLUCHENIYA STAL'NYKH SLITKOV in Russian 1980 (signed to press 3 Dec 80) pp 2, 225-228

[Annotation and table of contents from book "Advanced Methods of Producing Steel Ingots", edited by UkSSR Academy of Sciences Academician V. A. Yefimov, UkSSR Academy of Sciences Institute of Problems of Casting, 500 copies, 231 pages]

[Text] This volume contains materials on investigation of modern, advanced methods of producing steel ingots and billets -- continuous casting on horizontal, curved-guidance and radial continuous casting machines, batch electroslag casting, as well as employment of out-of-furnace steel refining and degassing units.

Articles discuss investigation of the nature of formation of external and internal defects in ingots and billets, selection of optimal casting conditions, directed toward increasing equipment productivity and improving quality of the metal.

Articles extensively examine experimental data on physicochemical effect on liquid metal in the process of casting and crystallization, and the design features of equipment employed for these purposes.

This volume is intended for scientists, engineers and technicians working with problems of improving the equipment and technology of metallurgical and machine building production.

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