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Moscow, USSR, 19 September – 9 October 1968

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MODERN DESIGNS OF BLAST FURNACES 1/

by

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SUMMARY

MODERN DESIGNS OF BLAST FURNACES 1/

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In 1967 75 million tons of iron was produced in the USSR. The coke rate per 1 ton of pig iron amounted to 561 kgs.

The highest maximum output of blast furnaces has been achieved in the USSR. In 1967 a blast furnace of 2000 m^3 volume achieved an output of 4300-4400 n. tns/day and during a trial melt with the use of 28 % oxygen-enriched blast a daily output of 4850 tns/day was achieved.

In 1967 126 million tons of sinter was produced in the USSR, which fact accounted for 90 % - content of sinter in the blast furnace charge.

Industrial production of pellets has been started in the USSR.

Blast furnace operation at an elevated top gas pressure is used extensively in the USSR. More than half of all the blast furnaces operate at top gas pressure being higher than 1.0 atm gage including part of the furnaces with the pressure ranging from 1.5 to 1.9 atm. gage. Blast furnaces of 2000 and 2700 m^3 volumes are designed to operate at top gas pressure up to 2.5 atm. gage.

For the first time in the world practice a blast furnace operation with blowing natural gas into the hearth has been developed and mastered in the USSR. The consumption of natural gas in 1967 averaged 87.7 m^3/tn of pig iron.

Oxygen is also widely used in the Soviet blast furnace practice. Blast furnace operation practice in the USSR shows that with natural gas blowing accompanied by simultaneous oxygen enrichment of the blast the output of blast furnaces is increased by [illegible] % per each per cent of additional increase of oxygen content in the blast.

In 1967 the actual average blast temperature was 963° and at a number of blast furnaces it reached 1150-1180°.

A considerable success has been achieved in the field of mechanization and automation of blast-furnace processes.

Raising the volume of operating blast furnaces during the scheduled overhauls is a wide practice in the USSR.

I. Characteristics of Soviet blast furnaces

Standard blast furnaces in the USSR have the following ~~main~~ dimensions:

Dimension	Volume of blast furnaces, m^3				
	1033	1386	1719	2000	2700
Useful height, m	26.0	27.3	28.5	29.4	31.20
Diameter, m:					
hearth	7.2	8.2	9.1	9.75	11.0
bosh	8.2	9.3	10.2	10.9	12.3
furnace top	5.8	6.5	6.9	7.3	8.1

The increase of the blast furnace volume is accompanied by the extension of transverse dimensions, the height increase being insignificant. The improvement of the outline is characterized by a lower ratio of the furnace height to the bosh diameter.

Blast furnaces are designed to operate at a completely prepared burden, with the blowing-in of natural gas, to use a blast with constant humidity, heated up to 1200° and oxygen-enriched up to 30 %. Top gas pressure amounts to 1.5-2.5 atm. gage. The hot-blast stoves are designed to heat the blast up to 1200° with the temperature of products of combustion under the furnace top being 1350°.

Blast furnaces are provided with a blast by turbo-compressors with a steam drive.

II. Characteristics of main designs and equipment of lately commissioned blast furnaces

1. Blast furnace

The all-welded shell of a blast furnace is made of low-alloy plate steel. The top structures consisting of the headframe, mounting beam and platforms are supported through a mantle by the stack columns, which are the continuation of the hearth columns.

The lining of the bottom is a combination, of which the centre is made of large alumina-silicate bricks 550 x 200 x 150 mm with carbon blocks about the periphery. The lower bottom section is laid of graphitized or carbon blocks up to a height of 1600 mm. The walls of the hearth up to the level of the cinder notches are lined with carbon blocks and above the cinder notches - with fireclay bricks.

The bosh, body and the stack are lined with alumina-silicate refractory bricks.

The furnace top is protected with protecting steel plates of "set of shelves" type.

The top part of the furnace is protected with cast-iron non-cooled plates and cast - in bricks.

The furnace refractory lining is cooled by vertical cooling plates. For the bottom and the hearth, smooth cooling plates are used, in the tuyere zone and bosh, ribbed ones with cast-in bricks, in the stack, plates with projections are used.

The furnace cooling is either water or evaporative. From below the bottom is cooled by air.

Blast furnaces of 2000 m^3 volume and bigger have two iron and two cinder notches.

The iron notch is opened with the help of pneumo-electrical machine, which is also used for cleaning and ramming the casing. The closing of the iron notch is done with the help of electrical gun.

For closing, opening and spearing the cinder notch the cinder stopper is used. The charging complex of a furnace consists of the bell-and-hopper, charge distributor and bell rockers. On the furnace top a mounting trolley is placed, which is used for the erection of the bell-and-hopper and charge distributor during repairs.

2. The casting yard and bottom house

Blast furnaces of a large volume are designed to have two casting yards.

Melting products are removed: iron - into iron ladle cars with a carrying capacity up to 140 tns, slag - into slag cars with a capacity up to 16.5 m^3.

Molten iron and slag are run into the ladles with the help of turning runners. To haul trains of iron ladle cars and slag cars during running molten iron and slag, pushers are used.

Casting yards are equipped with magnet cranes with grab. To improve working conditions, showers at working places are provided in the casting yard and bottom house as well as exhaust ventilation.

3. Hot-blast stoves

The hot-blast stove shell is welded and made of low-alloy plate steel.

The walls of the hot-blast stove, the dome and checker in the high-temperature zone, the internal lining of the fire chamber over the whole height and the external lining in the high--temperature zone are made of high-alumina bricks. For medium-temperature and low-temperature zones fireclay bricks are used. The gap between the shell and the walls ie filled with heat--insulating bricks and filling. The checker is single-stage with cells 45 x 45 made of bricks 40 mm thick.

The working platform of the hot-blast stoves is situated at the same level ae the furnace working platform.

The hot-blast stoves can operate in sequential and couple-parallel regime.

4. Dust catcher

Primary gas cleaning is done in the dust catcher. The steel shell of the dust catcher, the diameter of its cylindrical part being 11 m, is lined inside with refractory brick. Release and moistening of dust is done by two screw conveyors.

5. Charging of the blast furnace

Blast furnaces are skip charged. Lifting of skips and manoeuvring the bells are done with the help of winches.

Raw materials are carried to the skips by apron conveyors through weighing hoppers.

Coke is charged into skips directly from the bunker through weighing hoppers. The skip pit and under-bunker house have facilities for protection of equipment and aspiration of dust-formation places, as well as for cleaning of the released air.

Skip charging with materials is done automatically according to a preset program.

The system of conveyor supply of materials to the skips together with the main hoisting system makes blast furnace charging fully automatic.

6. Automatic checking and control

Control is effected of the following parameters: heating of hot-blast stoves, the temperature of the hot blast, top gas pressure, moisture content of the blast, feeding of natural gas into the furnace.

The blast furnace is equipped with a system of centralized checking and control of the blast furnace process, including the use of computers.

Conclusions

1. The main technical directions of development of the blast-furnace practice in the USSR are the following: construction of big mechanized blast furnaces, improvement of burden preparation, utilization of the latest achievements in advancement of the technology of blast-furnace process, reconstruction of blast furnaces with the purpose of increasing their volume and advancing their technical level.

2. The designs of modern blast furnaces are improved on the basis of long operational experience and ensure long life of blast furnaces.

3. The installed equipment ensures intensive operation of blast furnaces and their auxiliary facilities with the high temperature of the blast and increased top gas pressure.

4. A wide introduction of mechanization and automation of production and technological processes alongside with sanitary engineering arrangements, makes for improvement of the working conditions.

MODERN DESIGNS OF BLAST FURNACES

Introduction

In the USSR production of iron steadily grows up due to erection of new blast furnaces, modernisation of the existing furnaces with their volume enlargement, improvement of burden preparation, development of blast furnace process, constructions and equipment.

The production of iron in the USSR was approximately 75 million tons, 1967. Coke rate per one ton of open-hearth iron was 561 kg.

Two blast furnaces having useful volume of 1513 cu. m. each, seven blast furnaces having useful volume of 1719 cu, m, each, twelve blast furnaces having useful volume of 2000 cu, m, each and one blast furnace having useful volume of 2700 cu. m. were erected after 1958.

In the USSR, average useful volume of a blast furnace amounted to 1090 cu. m. and maximum useful volume of the furnace amounted to 2700 cu.m. as of January 1, 1968.

One blast furnace of 2000 cu. m. useful volume produced in 1967 approximately 1.6 million tons of iron.

Considered as efficient are enlargement of useful volume of blast furnaces and improvement of their performances through reconstructions during overhauls.

In the USSR 126 million tons of sinter were produced in 1967 which ensured a 90-per cent content of sinter in the blast furnace burden. Pellets are produced as well. A number of new pelletising plants are being built.

More than half of all existing blast furnaces operate at a top gas pressure exceeding 1.0 atm. gauge, while many others at a pressure ranging from 1.5 up to 1.9 atm gauge. The blast furnaces having a useful volume of 2000 and 2700 cu, m, are designed to operate at a top gas pressure of up to 2.5 atm. gauge.

The USSR was the first in the world to adopt the blast furnace operation with natural gas injected into the hearth. In 1967, average consumption of natural gas was 87.7 N cu.m. per ton of iron.

Oxygen is widely used. With the natural gas injecting the output of the blast furnaces increases by 2 pct per each percent of increasing the oxygen content in the blast.

In the USSR since 1959 the stoves for heating the blast up to a temperature of 1200°C are being constructed. The capacity of the stoves and blast mains is increased to rise a temperature of the blast up to 1000 - 1200°C at the existing blast furnaces having useful volume above 900 cu. m.

In 1967 the actual average temperature of the blast was 965°C, while at a number of blast furnaces it was 1150 - 1180°C.

Delivering and charging of raw materials at the most of the blast furnaces are mechamised. New and reconstructed blast furnaces are completely mechanized.

In 1967 the blast furnace having useful volume of 2000 cu. m. was put into operation whereat projected is the highest mechanisation of operations involving disposal of molten products by means of constructing two casting yards and mounting cranes with big spans.

Automated in the blast furnace shops are: control of a skip hoist and burden charging into the blast furnace, weighing and charging coke (and on some furnaces, sinter) into the skips, control of blast temperature and some other operations.

The Scientific Research and Designing Institutes carry out investigations to develop a system of automatic control of blast furnace operation.

1. Characteristics of Blast Furnaces in the USSR

In the USSR the standard blast furnaces are characterized by the following basic dimensions.

Table 1

Dimensions	Volume, cu. m.				
	1033	1386	1719	2000	2700
Height, m					
Useful one /from iron notch axis up to the bottom of lowered large bell/	26.0	27.3	28.5	29.4	31.20
Diameter, m					
hearth	7.2	8.2	9.1	9.75	11.0
bosh	8.2	9.3	10.2	10.9	12.3
furnace top	5.8	6.5	6.9	7.3	8.1
Ratio					
Useful height to bosh diameter	3.17	2.94	2.79	2.70	2.54
Furnace top diameter to bosh diameter	0.707	0.698	0.675	0.670	0.657

The increase of the blast furnace volume is accompanied with enlargement of cross-section dimensions and a miserable increase of height, thereat blast furnace height-to-bosh diameter ratio goes down.

Slow increase of top diameter as compared with increase of hearth and bosh diameters depends on top gas pressure rise which brings down volume, velocity and back-pressure at the furnace top. In the lower sections of the blast furnace the volume and velocity go down in lesser relative rates. Therefore, with the gas dynamic characteristics preserved gas pressure rise provides for decreasing the upper part of the blast furnace.

2. Rated Operating Conditions

The new blast furnaces are designed to operate on completely prepared raw materials with blowing-in of natural gas heated up to 1200°C and enriched by oxygen up to 30 per cent and at a top gas pressure equalling 2.5 atm. gauge.

3. Blast Furnace Stoves

The blast furnace stoves are designed to heat the blast up to 1200°C.

Characteristics of Blast Furnace Stoves

Table 2

Characteristics	Unit of measurement	Blast furnace volume, cu. m.				
		1033	1386	1719	2000	2700
Diameter	m.	8.5	8.5	9.0	9.0	9.5
Height	m.	38.6	46.7	38.0	46.6	50.0
Dimensions of checkers	mm.	45x45	45x45	45x45	45x45	45x45
Heating surface of one stove	sq.m.	21500	29000	27000	31500	42500
Number of apparatus	pcs	3	3	4	4	4

Total heating surface per I cu.m. of the blast furnace volume is 63 sq.m.

4. Charging Equipment

The blast furnaces are provided with the following charging equipment.

Table 3

Description	Unit of measurement	Volume of furnace, cu. m.				
		1033	1386	1719	2000	2700
Skip, volume	cu. m.	8.1	10.0	10.0	13.5	20.0
Skip winch, lifting capacity	tons	15.0	22.5	22.5	22.5	39.0
Bell-and-hopper volume	cu. m.	33.5	45.0	45.0	45.0	70.0

5. Air Blowing Facilities

The blast furnaces are provided with the blast from blast turboblower with steam-powered drive having the following characteristics:

Table 4

Characteristics	Volume of furnace, cu.m.				
	1033	1386	1719	2000	2700
Rated capacity, cu.m./min	2500	2800	3900	4130	4130-5000
Pressure, abs. atm.	4.5	4.5	5.0	5.3	5.0-5.3

II. Designs and Equipment of Blast Furnaces Constructed during Recent Years

1. Blast Furnace (Fig. 1)

The all-welded shell of the blast furnace is made of low-alloy steel.

Furnace top steel structures comprising a hopper, outrigger and platforms rest through an annular girder against the shaft columns which are continuation of hearth columns. Arrang. around the blast furnaces are circular and radial platforms interconnected by means of staircases.

The botton of the blast furnaces (Fig.3) is lined with a combination of carbon and alu-

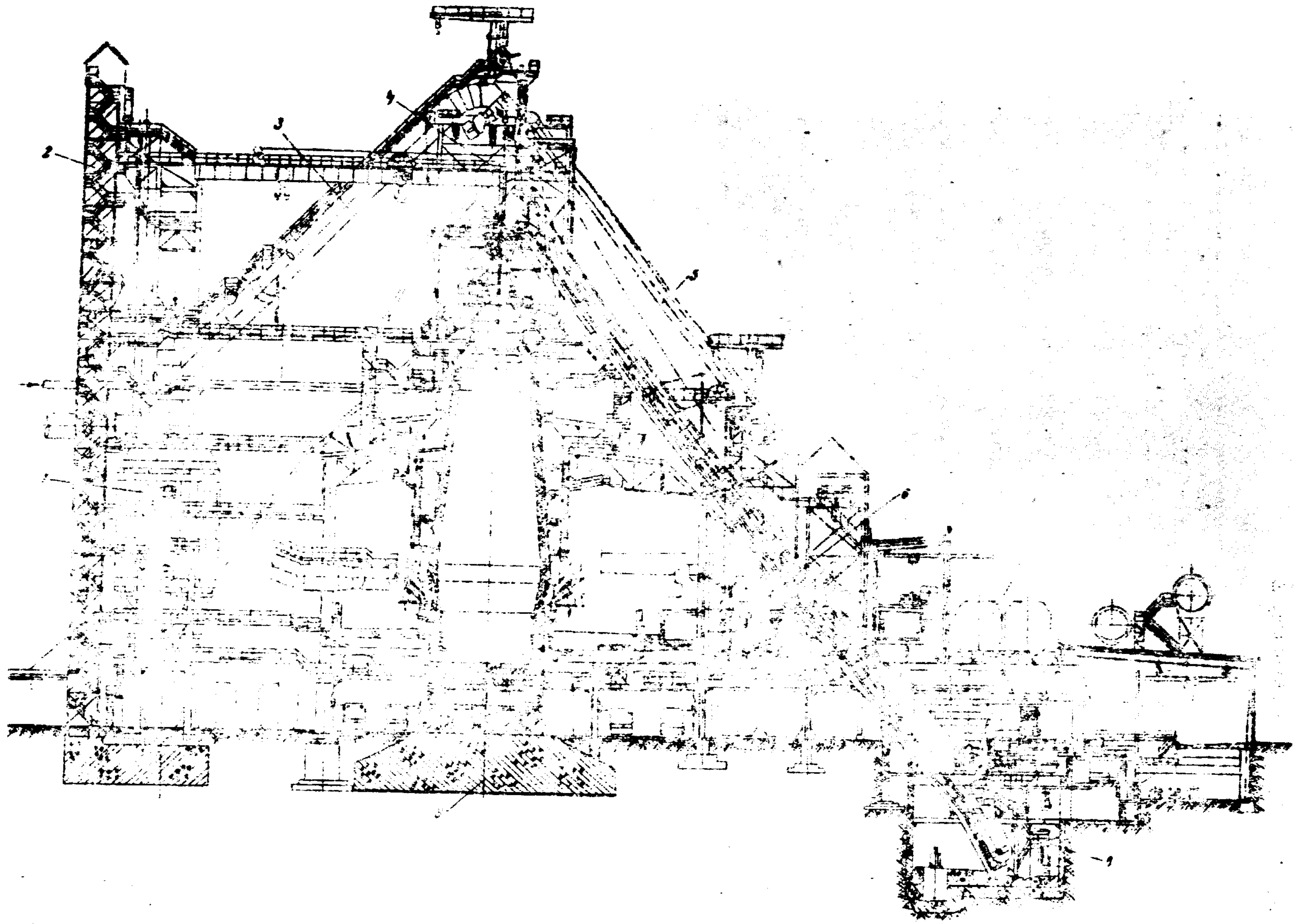

Fig.1. Blast furnace plant cross-section

1 - Dust catcher; 2 - Lift; 3 - Raw gas main; 4 - Top construction; 5 - Skip bridge; 6 - Hoist house; 7 - High line; 8 - Skip pit; 9 - X blast furnace.

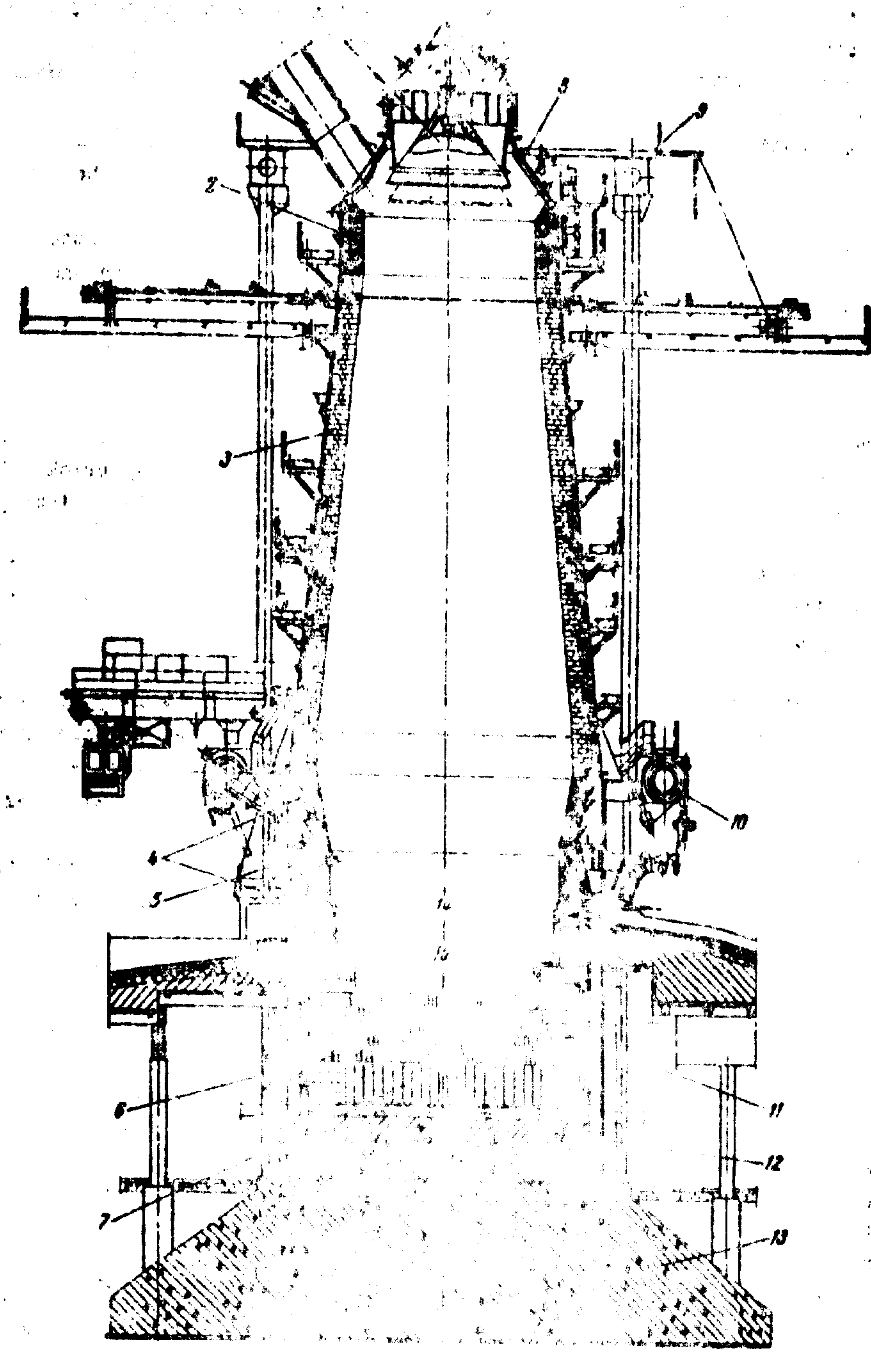

Fig. 3. Blast furnace cross-section

1 – **Bell and** hopper; 2 – Top wearing plates; 3 – **High-density aluminosilicate** blocks; 4 – Fireclay brick; 5 – **Tuyere stock; 6** – **Large-size** high-alumina **bricks**; 7 – Graphitized **blocks; 8** – **Wearing** plates of dome; 9 – **Top platform**; 10 – **Hot blast main**; 11 – Carbon blocks; 12 – **Fire** concrete; 13 – **Furnace foundation**; 14 – $\mathscr{J}$ **cinder notches**; 15 – $\mathscr{J}$ **iron notches.**

mosilicate materials.

The centre of the lower section of the bottom is laid of a single course of square carbon or graphitised blocks, of a 400 x 400 mm up to 1600 mm height, placed onto the butt and four courses of trapezoidal blocks, 400 mm thick by circumference.

The centre of the bottom is laid of five courses of big-size bricks, 550x200x150 mm containing at least 62 per cent of alumina.

The circumferential portion of the bottom arranged above the lower section is constructed of key carbon blocks of different length forming the bond between the carbon and high-alumina brickwork.

To compensate for heat expansion left between the brickwork of the bottom and the cooling plates is 100-150-mm ring space, while between the circumferential carbon and central high-alumina brickwork, 40-mm ring space.

The spaces are filled in with carbon paste.

The new construction of the bottom in combination with the intensive cooling made it possible to reduce the bottom height to 4350 mm.

The hearth walls up to the cinder notches are lined with carbon blocks of trapezoidal shape, while those arranged above the cinder notches, with fireclay bricks. The brickwork of the hearth in the zone of iron and cinder notches is laid of fireclay bricks placed close to the stoves.

At the level of the iron notch line the thickness of the hearth walls is 1030 mm.

Lining of a 345-mm bosh is made of fireclay bricks. The design of the stack lining is developed through improvement of alumino-silicate brick quality with decrease of brickwork thickness.

The bosh and the stack of the new blast furnaces are lined with large-size high-density alumino-silicate firebrick. The thickness of the lining of the cooled portion of the brickwork is: from 575 up to 805 mm in the bosh, from 575 up to 790 mm in the stack and 345 mm at the lugs of the plate coolers. In the uncooled portion of the shaft the thickness of the lining is 920 mm.

The height of the cooled portion constitutes two-thirds of its total height.

A 150-250 mm space between the brickwork and the coolers and a 50 mm horizontal space between the brickwork and the lower surface of the lug are filled in with fireclay paste.

The space between the brickwork and the shell in the uncooled portion of the shaft is filled in with cinder-and-asbestos filling. Every 1.5 m the brickwork is constructed close to the shell.

To protect the lining against the shocks during fall of charge from the large bell installed on the furnace top are steel cast plates "set of shelves" which are secured to the shell by means of suspensions thus making provision for vertical displacement of plates during the growth of the brickwork.

The plates are lined with fireclay brick. The blast furnace dome is protected by means of iron non-cooled plates with filled bricks.

The refractory lining of the modern blast furnaces is cooled with the aid of iron cooling plates with filled coils made of pipes, 45 mm in dia. wherethrough circulated is water. The coolers are installed between the brickwork and the shell and are bolted to the latter. Use is made of internal coolers placed into the lining. The cooling plates of the bottom and the hearth are of 160 mm thick.

Placed in the bosh and the tuyere zone are finned cooling plates with filled bricks. The said cooling staves display better resistance against abrasive effect of the charge.

A 20 - 40 mm space between the shell and the staves is filled in with fireclay - cement mortar. The space between the staves is filled in with iron cement.

To cool down the bosh and the lower part of the stack use is made of iron vertical cooling plates provided with lugs. The plates safeguard the shell against excess overheating and deformation, while the lugs support the lining.

The lugs of the staves are one brick short of the working surface of the brickwork. Used may be a combined cooling system of the stack composed of vertical cooling plates and horizontal staves.

The blast-furnace staves are connected in sequence into the groups except for the staves arranged in the zone of iron and cinder notches which are cooled independently. Water consumption per a group of staves depends on the temperature drop of the water delivered and issued which should not exceed 10°. The pressure of cooling water should be above the gas pressure in the blast furnace. Water consumption is from 1.1 up to 1.4 cu.m. per one cu.m. of useful volume of the blast furnace for one hour.

For some time past introduced is an evaporative cooling system of the blast furnaces. All blast-furnace staves are converted for operation with evaporative cooling except for tuyere and cinder stocks and the coolers in the zone of iron notches.

The bottom is cooled from below by air passed through the cooling plates.

180-mm air-cooled iron cooling plates with filled steel pipes, 114 mm in dia. are placed onto the concrete surface of the blast furnace foundation. The space between the plates is filled in with iron cement.

To protect the carbon blocks against oxidation, in case of leakage of the air delivered over the pipes the air-cooled plates are provided with a metal bottom cover, 10 mm thick welded to the blast furnace shell. The space between the bottom cover and the plates is filled in with carbon-concrete mixture.

As a result of development of the lining and the cooling system of the hearth and the bottom in combination with airtightness of the shell, service life of the blast furnaces has reached 12 years, some cases are known when the service life of the blast furnace has reached 16 years.

The blast furnaces having volume of 2000 cu.m. and above are equipped with two notches for tapping iron and with two notches for removing cinder. The blast furnaces of lower volume are provided with one iron notch.

To open the iron notch use is made of a pneumo-electrically-operated machine which is intended as well for cleaning and ramming the case. The machine comprises a swivel device and a drill feeding and driving mechanism.

Plugging the iron notch is effected through an electric gun. The electric gun consists of a cylinder having useful volume of 0.5 cu.m. with a piston, a clamping device and a turning mechanism.

To close the cinder notch after removal of cinder, to open the cinder notch before cinder removal and facilitate cinder removal provision is made for a cinder-notch stopper. The stopper is rope controlled. The cinder stock consists of tuyere, a tuyere cooler, a tub and a barrel inserted one into the other and taper secured in position.

The charging device of the blast-furnace comprises a bell-and-hopper, a charge distributor and rocker arms of the bells.

Installed on the blast furnace top is an assembly trolley designed for mounting the bell-and-hopper and the charge distributor during overhauls.

2. <u>Casting Yard and Bottom House</u>

High volume blast furnaces are provided with two casting houses (Fig. 2).

Two through railways tracks are laid out in the casting yard to move hot-metal ladles, while from the opposite side laid out are two through railways tracks to move slag cars. There exists a special railway track to supply service goods.

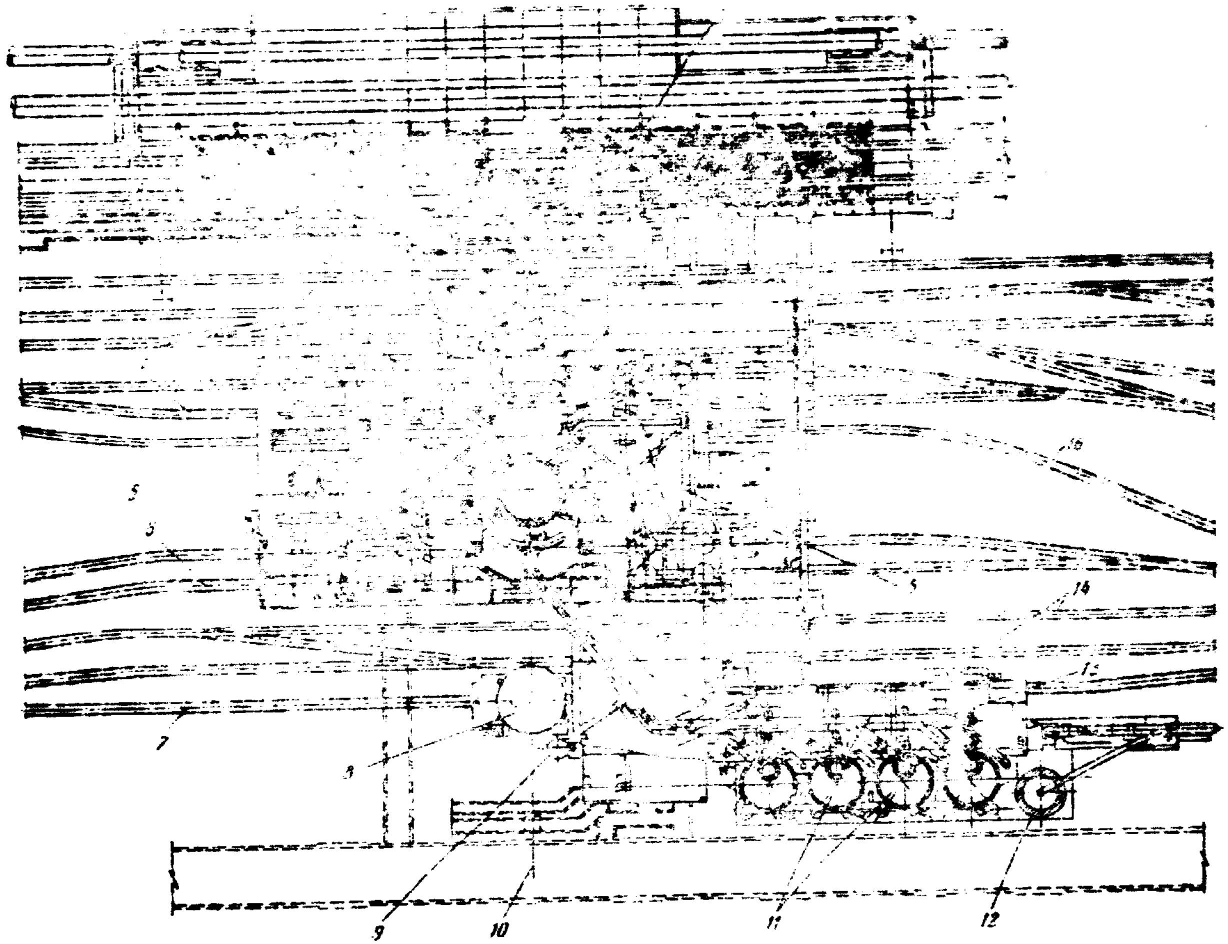

Fig.2. Plan of blast furnace area

1 - High line; 2 - Hoist house; 3 - Blast furnace; 4 - Cinder track; 5 - blast furnace plant and iron notches; 6 - Hot metal track; 7 - Dust disposal track; 8 - Dust catcher; 9 - Lift; 10 - blast furnace; 11 - Stoves; 12 - Chimney; 13 - Hot blast main; 14 - track; 15 - Casting yard; 16 - Service track; 17 - Instrumentation control.

Molten products are removed: iron into hot-metal ladles having lifting capacity of up to 140 tons, cinder - into slag ladles having capacity of up to 16.5 cu.m.

To facilitate working conditions provisions are made for showering of workplaces at the casting yard and the bottom house.

Before discharge into the atmosphere the exhausted air is cleaned.

Iron and slag are run into ladles by means of swing chutes.

The swing chute consists of a lined through resting with its one end against the stationary axle, while with the other - against the roller track. The roller track is intended to provide displacement of the chute during its swing.

The chute swing is carried out by an electric-operated drive.

To move hot-metal and slag ladle trains during running iron and slag use is made of a trolley-type pushers having pulling force equalling 15 tons.

The casting yards are equipped with cranes having lifting capacity 30/5 tons with an electromagnet and a grab.

3. Blast-Furnace Stoves

New blast furnaces are equipped with four stoves having heating surface of 63 sq.m. per cu.m. of the blast furnace useful volume designed for heating the blast up to a temperature of 1200°C.

All-welded shells of the blast-furnace stoves are manufactured of low-alloy sheet steel.

When brickwork of the blast-furnace stoves is performed three temperature zones should be taken into consideration, they are as follows: a high temperature zone for operating temperatures ranging from 1100 up to 1350°C, a medium temperature zone for operating temperature ranging from 900 up to 1100°C and a low-temperature zone for operating temperatures ranging from 150 up to 900°C. The ranges of the temperature zones are determined by calculation.

The walls of the stove, its dome and checker in the high temperature zone, internal layer of the combustion chamber throughout the entire height and external layer in the high temperature zone are laid out of high alumina brick containing 62 pct of Al_2O_3.

The wall thickness is 450 mm.

Space between the wall brickwork and the shell is filled in with heat-insulating materials: fireclay light brick of 113 mm thickness placed close to high - alumina brick and one course of tripoline brick of 65 mm thickness placed close to the shell in the high-temperature zone. Space between the fireclay light brick and the tripoline brick is filled in with tripolina crumb.

In the medium and low temperature zones heat insulation of two courses of tripoline brick having total thickness of 188 mm is placed close to the shell. Space between the heat insulation and the brickwork is filled in with tripoline crumb.

Brickwork of the dome is laid out of one course of high-alumina brick 450 mm thick, placed above is one course of fireclay light brick 113 mm thick, and one course of tripoline brick 123 mm thick.

The space between the brickwork of the dome and the spherical shell is laid down to compensate for the growth of the brickwork of the stove.

The checkerwork of the stove rests on the under-checkerwork structure comprising columns and plates provided with openings corresponding to the shape and dimensions of the checkerwork.

The courses of the checkerwork are laid dry with binding of brick in each course.

A 10-15 mm space is laid down between the checkerwork and the walls.

The hot blast main is lined with four layers. Two external layers are made of fireclay brick, while the internal layers, of high-alumina brick. Placed between the brickwork and the shell of the hot blast main is a course of asbestos cardboard, 40 mm thick.

The stoves are equipped with gas burners, type "pipe-in-pipe".

Air is delivered through the internal pipe by means of a fan. Gas is supplied through the external pipe. Air consumption is controlled by means of an electric-driven throttle valve which consists of a cast iron case fitted onto the shaft, cast iron crank, a gear reduction unit and an electric motor.

Developed and put into practice is a centralized system of blast air delivery at which the air is pumped into a manifold by means of two fans one of which is a spare one. The air is distributed from the manifold into the burners by means of pipelines provided with throttle valves which are intended for controlling the air delivery.

To separate the gas burner from the stove as the latter operates for the blast, provision is made for a shutoff slide valve furnished with a forced opening and shutting system actuated with the aid of a hydraulic drive.

The valve case is made of a steel casting, while the slide valve case, of copper. When closed the slide valve is installed between two cast copper rings.

The cooling system of the slide valve and the rings is of an evaporative type. The valve case is cooled by means of industrial water.

The hot blast valve having similar design with the shutoff valve serves for separating the hot-blast main from the stoves during its heating.

The cold blast valve of a horizontal slide valve type provided with an electric drive serves for separating the stove from the cold blast main during heating period.

Air relief from the stove as it is converted from the blast to heating conditions is effected by means of an angle-type bypass valve. The valve is provided with an electric drive built therein comprising an electric motor and worm reducing gear.

The smoke disk valve is actuated by the electric drive installed on a special platform above the valve. The electric drive is coupled with the valve rocker arm by means of a steel rope. The valve disk is fitted onto the common shaft whereon mounted are the rocker arm and the balancing counterweight.

The shutoff slide valve is designed for separating the mixing main from the hot blast main. The valve is furnished with a built-in drive comprising an electric motor and a worm reducing gear.

Throttle valves are installed to control the blast temperature: one on the mixing main and one on each blast main to the stoves.

The air relief valve designed for delivering the air into the chimney is installed on the cold blast main between the blower and the assembly of stoves. The valve is provided with an electric drive having a worm reducing gear. The valve is equipped as well with an emergency hand-operated drive actuated from the handle through the cylinder reducing gear.

The working platform of the stoves is located on the same level with the working platform the blast furnace. The house is equipped with 10-ton lifting capacity crane.

The blast furnace stoves are designed to operate one after another and pair-parallel cycle.

To heat the stoves use is made of the blast furnace gas as well as a mixture of the blast furnace and the high-calorific value gases.

The blast furnace stoves are automatically converted from the heating to the blast operating conditions and vise versa.

4. Dust Catcher

The gas is primarily cleaned in the dry dust catcher. The steel welded housing of the dust catcher, the ring portion of which has 11 m in dia is lined from inside with firebricks.

Discharging and wetting dust are performed by means of two screw conveyers. A shutoff valve 15 installed over the dust catcher to disconnect the blast furnace from the blast mains during pauses.

5. Blast-Furnace Charging

The blast furnaces are equipped with skip hoists and two bell-and-hoppers with rotary charge distributors. The skip cars are hoisted along the inclined bridge with the aid of the skip winch, the bell-and-hoppers are manipulated by means of a bell-and-hopper winch. The winches are installed in the skip hoist building. Charging is effected automatically, by the cycles of feeds consisting of coke and sinter skip cars.

The blast furnaces having volume over than 1719 cu.m. are equipped with a conveyer-type system of feeding burden into the skips. The bin trestle provides for 6-12 hour storage of charge materials. Installed over the skip pit on either side of the inclined bridge axis are coke and additives bins.

The coke is batched from each bin by means of two electric-operated feeding screens into a respective weighing hopper.

As the coke weight reaches its preset value the screens are automatically disconnected and feeding of coke from the bin into the weighing hopper stops.

The skip is charged with coke in compliance with the operation program of the skip hoist as the skip car approaches the extreme lower position.

The gate of the coke weighing hopper is opened automatically. Feeding of a new portion of coke into the weighing hopper begins provided no coke is present therein after the gate has been closed and the screens have been automatically connected. With the next portion of coke fed into the weighing hopper the vibration screens get disconnected. Sinter and additives are delivered with the aid of two self-contained groups of mechanisms arranged on either side of the skip pit. Each group of mechanisms comprises: vibrating feeding screens for additives and sinter, additives weighing hoppers and a sinter weighing hopper.

Sinter and additives are delivered from the weighing hopper into the skips automatically according to the preset program. Coming the skip into the extreme lower position is considered as an impulse for opening the gate. With the sinter unloaded, the gate of the weighing hopper gets closed and an impulse for engaging a plate-type conveyer is transmitted.

The sinter fines screened out by the electric-operated screens are directed into the bins by means of belt conveyers. From the bins located in special pits the fines are delivered into the overhead bins by means of skip hoists placed over the railway and are loaded into the cars.

Coke breeze screened out through the grate of the screens falls down into the underneath bins wherefrom it is directed by the skips into the overhead hoppers for loading into the railway cars.

In the skip pit and the under-bins room provisions are made for sheltering the equipment and for aspiration of the dust formation places and cleaning of discharged air.

The blast-furnace charging mechanisms are automatically controlled. The burden materials are delivered into the skips and the blast furnace is charged in accordance with the preset program.

The programmer provides for selecting some different charging programs with portions of sinter, coke and additives alternated in the preset sequency.

The program-information devices of the charging system are located in the control board of the blast furnace and in the room of the charging control stations located in the skip hoist house.

6. Automatic Control

The equipment intended for automatic control and signalization is located in the blast-furnace control board house.

The blast-furnace control station accommodates control panels with instruments intended for recording the operation cycle and conditions of the blast furnace, for the operation of the stoves and charging system.

Controlled are: heating of the stoves, hot blast temperature, top gas pressure, blast humidity, natural gas injection into the blast furnace.

Conclusions

1. The basic trends of further technical development of blast-furnace process in the USSR are as follows: erecting new mechanized blast furnaces, improving burden preparation, applying new achievements for improvement of the blast-furnace operation process, reconstruction of blast furnaces with enlargement of their volume and further development of the technical level.

2. The constructions of the modern blast furnaces are modified on the basis of the experience obtained during many years of maintenance and provide for long-term service life of the blast furnaces.

3. The equipment installed provides for intense operation of blast furnaces and their auxiliaries at higher heating of the blast and at raised top gas pressure.

4. Wide implantation of mechanization and automation of manufacturing and technological processes along with sanitary engineering measures facilitates further improvement of working conditions.

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