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MODERNIZATION OF "TREPČA" LEAD SMELTING AND REFINING 1/

by

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MODERNIZATION OF "TREPČA" LEAD SMELTING AND REFINING

1. Intoduction

The first beginnings of lead production in the country, at the place of the present lead smelter in Zvečan, go back to the old times. There are proofs that the lead mining and smelting in this country had been known and developed even in the Roman times. The sovereigns of the first Serbian State developed mining and smelting of lead and silver to a significant level. They brought Saxon miners to Serbia to instruct the people to mine and smelt the ores. This was continued to the distruction of the Serbian State and to the conquest of these countries by the Turks. At the end of the existance of the State "Novo Brdo" was known as the center of lead mining and smelting. In the XIV century this was the first forging of silver money.

The Turks failed to develop mining and smelting in the conquered countries and thus the old finding places were forgotten and the production completely suspended. The previously very developed mining and smelting centres now only showed old pits and slag deposits.

After so a long period we are nowadays in position to smelt in Zvečan smelter 10.000 t/annum of this slag originating from the Roman or Middle Age times. This slag containes a significant amount of lead and silver, which by the old technology could not be extracted.

In the period between the two World Wars the gouvernment of Yugoslavia intrusted the ore exploration to foreign companies. The Selection Trust from London founded on the slopes of Kopaonik an interesting finding place of lead, silver and zinc ore which is characterised by an extraordinar wealth of crystals.

Already in 1929. at the entrance of the Ibar glen, under an old Serbian and later Turk fortress - Zvečan for that time a very modern flotation plant was erected. This flotation plant gave, because of an extraordinar flotability of Stari Trg ore, the concentrates with a very high concentration of lead content i. e. containing from 78 - 80 % Pb. These lead, zinc and pyrite concentrate become well known on the European concentrate market.

Before the II. World War, in 1939. started the erection of the smelter, at first with three and later with six Newnam hearth furnaces. At the same time also started the building of the refinery plant which was able to refine lead, silver, bismuth and zinc chloride. The production started in 1940. The first production was low and did not go over 10-15000 tons of lead. Such production continued to the II. World War. In the course of the War a small blast furnace was built for treatment of "gray slag" which represent a by-product at smelting of lead concentrates in the Newnam hearth furnaces.

Immediately after the War the War the preparations started for enlargement of the existing smelter and refinery of lead with the intention that the concentrates from the whole country should be treated in these plants. The additional six were then built, and the first reconstruction started in 1949. At the same time a new roasting plant of 22 m^2 effective surface with down-drought was erected. The same was with the blast furnace which had 5,6 m^2 in the level of tuyeres and an electrostatic precipitator for the filtration of the blast furnace and roasting plant gases. The four new 300 t. kettles were added to the refinery, and a reverberatory furnace was also built for treatment of copper and antimony drosses.

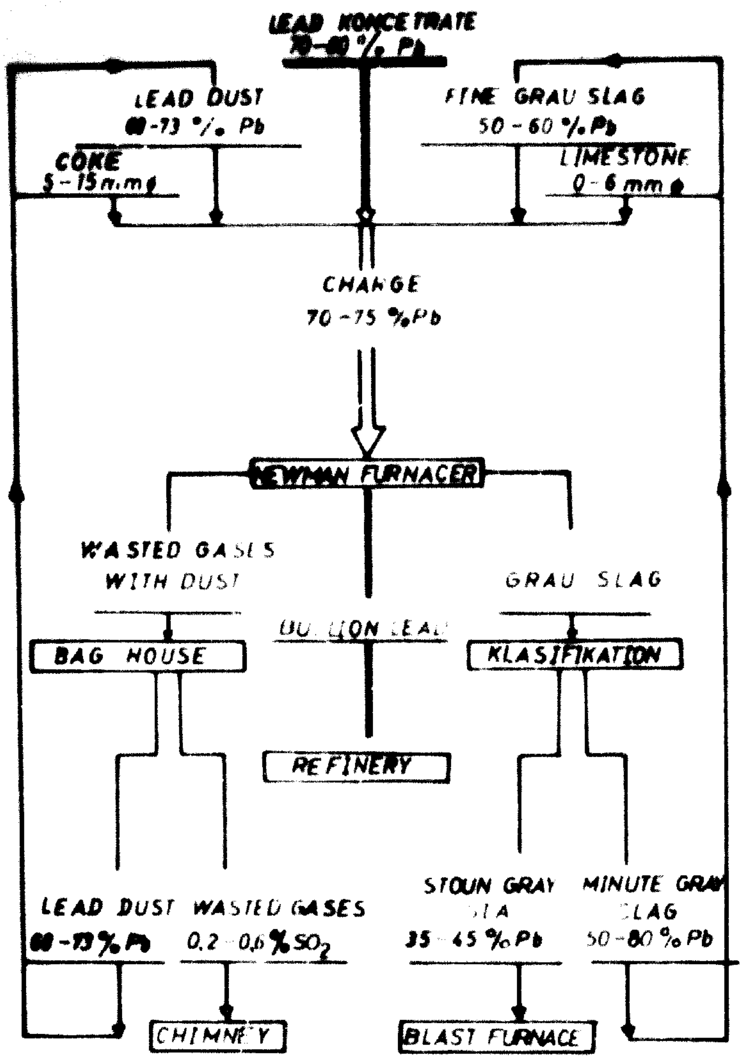
Thus was finished the first enlargement of the lead smelter in "Trepča". The Newnam hearth furnaces produced 70 % of the total lead production and only 30% went to the blast furnaces.

The Newnam furnaces operated in an excellent way with Trepča's concentrate, and in many cases the production was per furnace 20 - 25 t/d of lead bullion.

2. The short description of the early process in the smelter

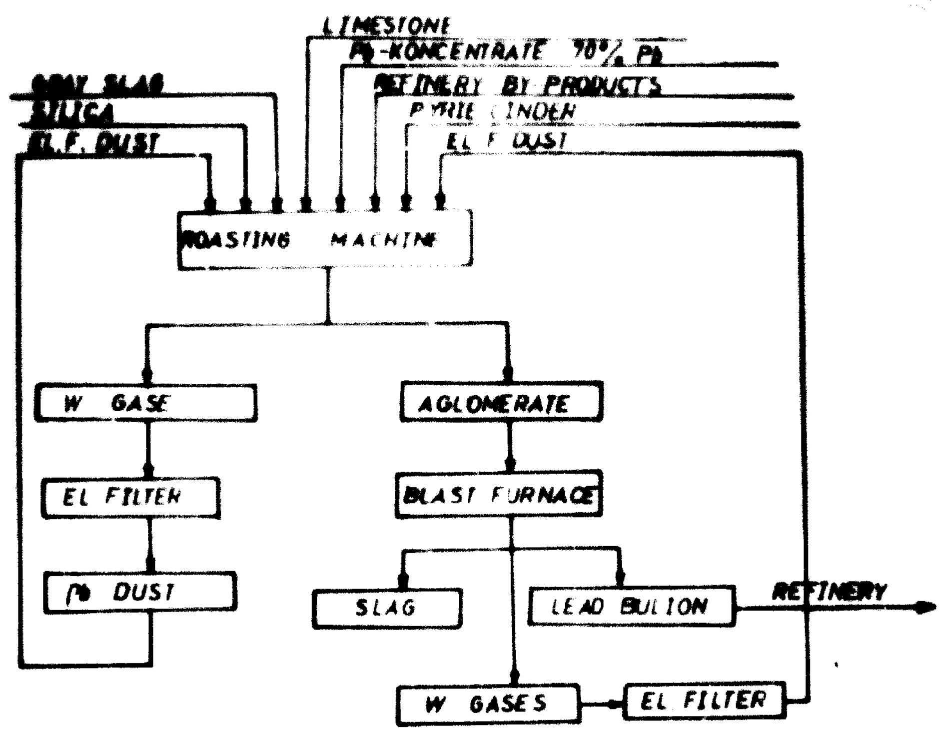
It can be said that the production of the lead bullion, before 1968, went to the two different processes. The first one was the process of the Newnam hearth furnaces, and the second one was a standard process of roasting and reduction of the aglomerate in the blast furnace.

The first process, according to the practice in Trepča, was used for very rich concentrate with a lead content over 70% Pb. and with a low content of Cu and As.

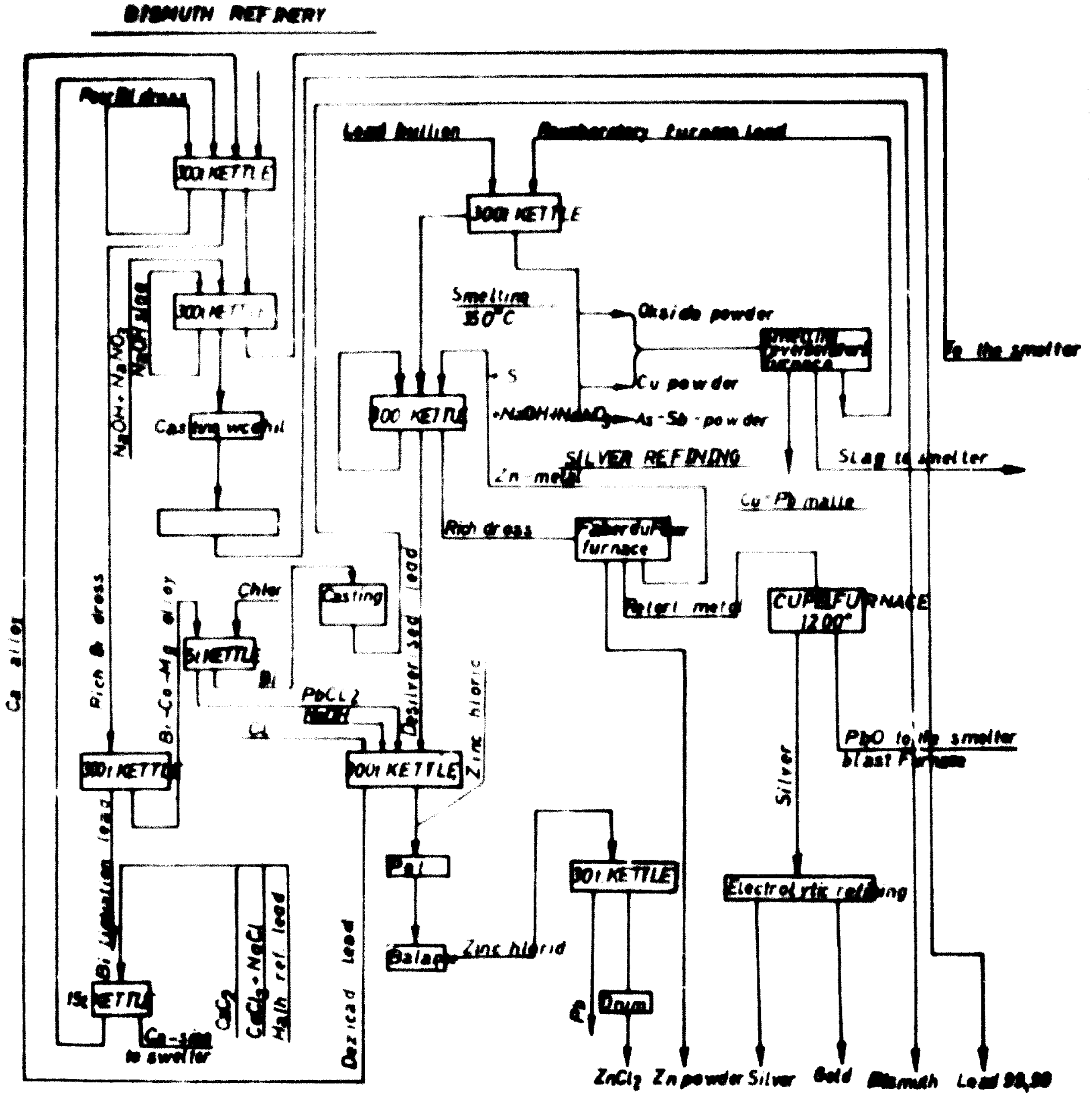


ROASTING AND REAKTIONS FLOW SHEET

FLOW SHEET ROASTING AND REDUCTION



REFINERY FLOW SHEET



The raw material for the second process was lead concentrate with lead content under 70% Pb, and gray slag as a by-product containing 35 - 40% Pb.

The most important caaracteristics of the processes can be seen from the presented flowsheets.

THE PROCESS IN THE REFINERY PLANT

The lead bullion cantainee some other metals and impurities which have to be separated as useful metals like: silver, gold, bismuth, copper and so on. This was chieved by the following process.

ELIMINATION OF COPPER

The lead bullion is smelted in 300 t. kettles. The temperature rises slowly up to 350°C. On the top surface of lead creates a crust after breaking it a mixer is put into the kettle, and the saw dust added. In this way the first oxide dust is obtained, and a large part of copper and arsenic is eliminated. The lead is cooled near the freezing temperature and then the sulphur powder is added. After this the lead in kettles is heated. The sulphur is stirred in lead with a mechanical stirrer. At the end of the chemical reaction sulphur becomes united with copper. The temperature is then raised to about 400 C. until the copper sulphide readily separates as a dross. The saw dust is added. The copper dross is dried and withdrawn.

SMELTING OF COPPER DROSSES

The copper drosses are smelted in the reverberatory furnace which is ignited by heavy oil. The product of smelting is lead copper matte of about 40% Cu and slag of 25 - 35% Pb and 3-4% Cu. Secondary lead containes about 2% Cu.

LEAD SOFTENING

The next step is to add caustic soda and $NaNO_3$ to the metal and to raise the temperature to 500°C, and to thoroughly stir the caustic soda and niter into metal using a mechanical stirrer. As and Sb oxidize and combine with caustic soda and niter. These salts go out to the lead top and are removed when they containe about 15-18% Sb, 1,2% As, 0,015% Bi and 1,4 kg/t Ag.

The mixture of caustic and oxide is then treated in the reverberatory furnace. The product of this process is hard lead.

ELIMINATION OF SILVER

The temperature of lead is raised up to 480°C. The lead is pumped in another 300 t. kettle. A mixer is used to agitate the molten lead when introducing zinc in the Parkes process. At first the blocks (5-6) of silver dross from previous steps are added in the kettle. This dross is mixed. The rich dross is removed. Zn - metal is added, silver is alloyed with zinc and lead, and silver dross comes up. The dross is removed at the temperature of

470 - 500°C and is pressed in Howard Press. The kettle is cooled after that and then the poor dross is removed and put in moulds. The poor silver dross is used in the following process of desilvering.

R E T O R T I N G

The rich dross is then subjected to the distillation process for recovery of zinc, which is returned to the desilvering process. The Faber du Faur type retort furnace is used. Retort furnace is heated by oil. The proper operating, temperature for retorting is about 1260°C. In the condenser a part of zinc metal and a part of Blue Powder is obtained.

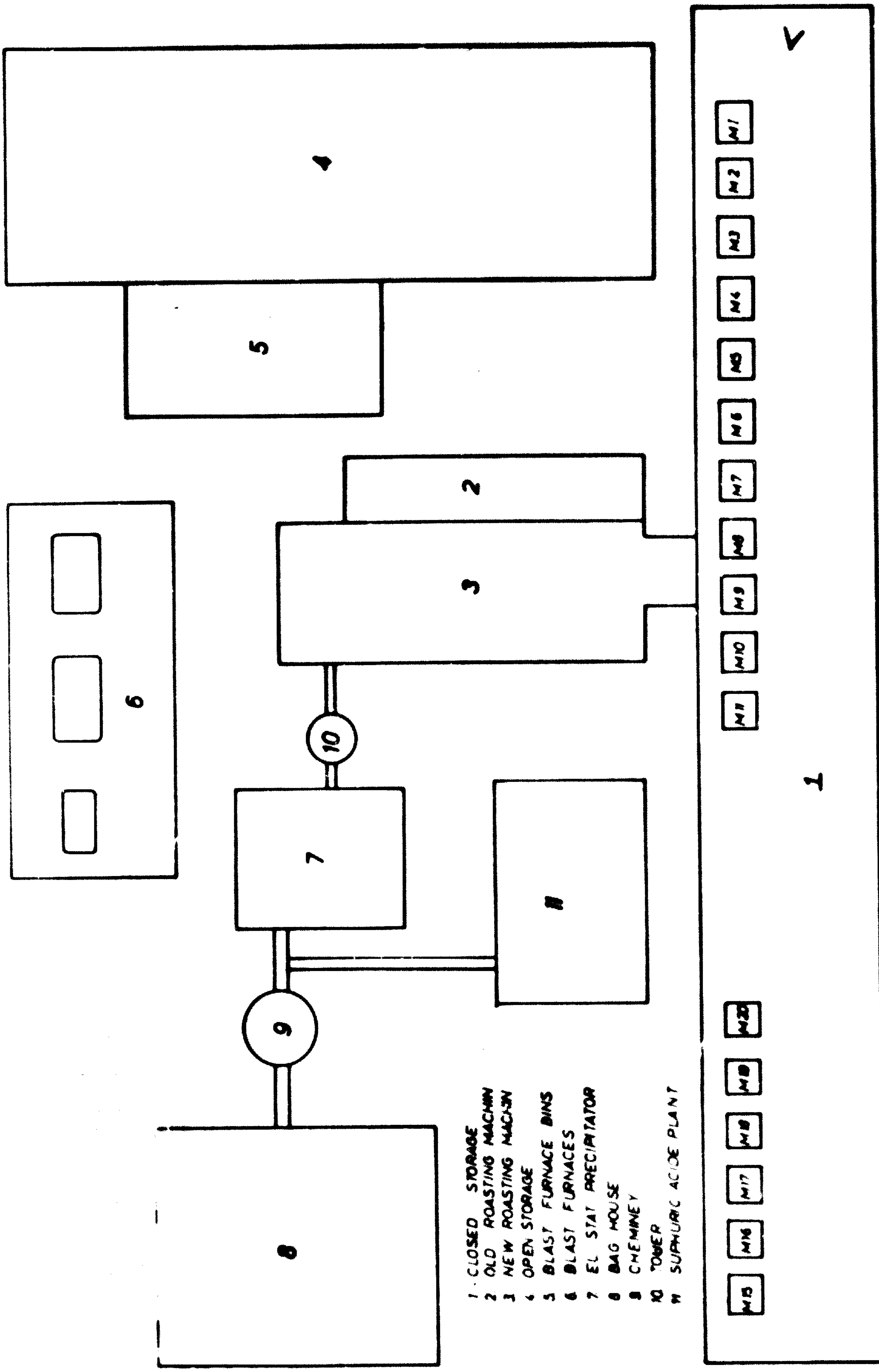
CUPELLATION OF RETORT BULLION

The cupels are heated by oil, the burner is located at the rear of the furnace, directly oposite to the charge door. The cupeles are charged in by adding cold bullion bars. In cupeles lead, zinc, amtimony, copper and bismuth are removed, and in cupeles, at the end of the oxidation process, silver is obtained. The impurities oxidize and go in the litarge, or as a dust to the chimney.

The doré is cast into anodes for the electrolytic separation of gold from silver.

D E Z I N C I N G

The desilverized lead contains about 0,6% Zn. This zinc is removed by chlorine. The process is conducted in a ke-


1 CLOSED STORAGE
2 OLD ROASTING MACHIN
3 NEW ROASTING MACHIN
4 OPEN STORAGE
5 BLAST FURNACE BINS
6 BLAST FURNACES
7 EL STAT PRECIPITATOR
8 BAG HOUSE
9 CHEMINEY
10 TOWER
11 SUPHURIC ACIDE PLANT
M1
M2
M3
M4
M5
M6
M7
M8
M9
M10
M11
M15
M16
M17
M18
M19
M20
V

ttle using the Betterton apparatus. The molten desilverised lead is heated to 400 - 450°C in a kettle and is pumped through a chamber where it is brought into close contact with gaseous chlorine. The zinc contained in lead is converted into zinc chloride, which separates from lead and floats as a molten layer on the surface of the metal. The molten zinc chloride is then removed from the surface, and marketed as a commercial chemical product. The derived lead is treated by sodium hydrate to remove antimony.

REMOVAL OF BISMUTH

The Kroll - Betterton process for bismuth removal by the use of calcium and magnesium is used. These metals form compounds Ca_3Bi_2 and Mg_3Bi_2 which separate on cooling and can be removed as dross, similar to the zinc crust in the Parkes process.

The poor and the middle dross from the previous removal of bismuth are added at about 425°C and thoroughly stirred into lead. On the top the rich dross is formed, which is removed. The dross is cast into moulds and goes to the refinery of bismuth. After that, magnesium is added as metal and calcium is added as 2-3% calcium lead alloy. The calcium - lead alloy is made in a 15 t. kettle from lead, $CaCL_2$ + NaCl and CaC_2.

The second rich dross is removed, and after that, the middle and the poor dross is removed, the kettle is cooled.

The rich Bi dross is smelted in the 30 t. kettle. By liquation, lead is removed. The smelting is done under the cover of calcium and magnesium chlorides. The concentrated Bi - alloy is treated in a small 5 t. kettle with chlorine. At 500°C chlorine is added. Pb is removed as PbC_{12} slag. The obtained bismuth metal is cast into moulds.

REMOVAL OF CALCIUM AND MAGNESIUM

After removal of bismuth lead contains some small quantity of calcium and magnesium which can be eliminated with caustic soda. At the temperature of 340°C NaOH and a small quantity of $NaNO_3$ is added. It is mixed at the temperature of 400°C. CaMg dross is obtained then which, goes to the sintering machine as a return.

The kettles are heated by the generator gas produced from lignite.

The refined lead is cast into moulds on a casting wheel. There are moulds for casting the refined lead in pieces of 900 kgs, each.

3. Reasons for modernization

The first enlargement of the smelter and rafinery capacities, which was finished in 1951. and the way in which it was made, had for that time their justification. The greater part of the lead concentrate was of Trepča Mines origin. These concentrate were suitable for smelting in the Newnam hearth furnaces because the concentration of lead is very high and impurities are low.

In the mean time other mines in the country were developed, and they no more gave the same quality of ore (concentrate) and the production in Newnam furnaces was no more so attractive as it had been before.

This process with 12 small furnaces could not be mechanized. It required a lot of operators per ton of produced lead. They worked under difficult health conditions. It was not possible to use sulphur from concentrates. Such a process could not be used for treatment of the other sorts of concentrate, which according to their qualities did not correspond to the requirements of the blast furnaces. Trepča intended to enlarge the capacity of the smelter plant because large amounts of raw materijal were at its disposal. The next question was how to choose the new technology for the new smelter. After a long study of different possibilities we chose the most modern process which was known, i.e. the roasting of lead concentrate in D.L. machine with up-drought and recirculation of gases to obtaine the concentration of SO_2 of about 5%, which should be treated in the sulphuric acid plant.

The new blast furnaces of Partirie - Lurgi type were installed with the mechanized transportation of the charge.

CHANGES IN THE RECONSTRUCTED SMELTER COMPLETED IN 1968.

The reconstruction of the smelter in Zvečan consists briefly in the following: The capacities of the existing hearth furnaces plant, which mean 65% of the existing smelter, had to be eliminated. The new blast furnaces were built. They have in the level of tuyeres 9,7 m^2 - each. A new modern roasting plant, for lead concentrate roasting with up-drought and recirculation of gases, of 80 m^2 of useful surface, was erected.

The open and closed storage places with transport equipment and bins from the old plant with hearth furnaces and from the old sinter plan also were incorporated in the new technological process. The same is with the bag house, which now is used for the filtration of gases from room - ventilation, and for the filtration of gases from the blast furnaces. Through the reconstruction the parallel work of old blast furnace and 22 m^2 surface sinter machine was possible.

4. General layout

From the south side the smelter surrounded by the old storage places for raw material and fluxes. This closed storage place is of the rectangular chape: 182,9 x 10,8 = 2000 m^2. To this plant several new bins are added.

On the East side the open storage is placed and its dimensions are 100 m x 18,3 m = 1830 m^2. The open storage serves for storage of coke, limestone, granular slag, ready aglomerate for the furnace. The opened and closed storage are connectedby a system of conveyors so that it is possible to transport the material from the open storage to the closed one and to the bins.

In the same direction as the storage goes there are two normal rails for the transportation of fuel, concentrate and fluxes. At the open storage there are 5 low bins with the chutes and feeders, which are used to take and to transport the material, from the open storage to the closed one or to the bins of the blast furnaces, which are also placed parallel to the open storage.

The new roasting plant is located in the North-South direction, parallel to the old sintering plant. This was made to facilitate the parallel work of the old and the new sintering plant. The two new blast furnaces are located towards the East side of the smelter. Such an arrangement was possible after the removal of the lift for the charge from the East to the West side. The upper part of the blast furnace was reconstructed so that it is possible to charge the all blast furnaces by the reversible belt conveyer. From the North side of the furnace building a 50 t. crane was displaced to the South side, and at its place another 50 t. crane was located.

On the north side, in the direction of the rope-way, a pool was built for the granulation of the slag and for its settling down. For further handling with slag 2 cranes were put up. For the storage of granulated slag, two new bins were built. From these bins the slag is dropped in the rope-way baskets.

The new electrostatic precipitator comes at the place of the old ones. The old conditioning tower is shut down, and on its place a new one of larger dimensions was built up. The old electrostatic precipitator of sintering plant was shut down, and only the building was adapted to receive the new filter. The new el. precipitator is suficient for both new and old sintering plant when the latter is modernized for the up-drought sintering. The old el.precipitator had to be used for the part of room ventilation. The existing bag house is used for the filtration of the blast furnace gases and for the room filtration of the blast furnace plant, sintering plant and bins for the blast furnace charge. The 124 m. high chimnex serves to take away all waste gases.

5. The outtake of coke, concentrate, fluxes and by - products

The purchased coke is unloaded from the railway wagons of normal gauge by cranes of 30 m. bridge span each, bu a bucket-1 m^3 and power of 5 t. - to the open storage or into low bins, wherefrom it is transported by the conveyers L-2, L-4 and L-5, to the bin for the coke, By the conveyers L-1 and L-6 the return sinter obtained from sintering of the furnace ready aglomerate, is transported to the closed storage. The belst conveyers L-2, L-4 and L-5, serve periodically to return the ready aglomerate from open storage to the sinter-bins at the preparation of charge for the blast furnaces. The belt width is 650 mm.and its capacity is 100 t/h.

The transport of the lead concentrate from theflotation plant to the closed storage of the smelter is acomplished by the system of belt conveyers. A weighing device a balance is incorporatted in this system.

The lead concentrate can be discharged in the compartments of the closed storage or can be directly sent to the bins for the concentrate by means of the belt conveyers M-50 and M-51. On thebelt conveyer M-51 a trip-machine ismounted which enables the discharging of concentrate to the different bins. Along the open and the closed storage there are rails and in emergency cases it is possible to discharge the lead concentrate in the open as well as in the closed storage by a crane or manually.

If a smaller quatity of lead concentrate arrives (3-6) wagons, it is possible to take it out from the rails in the closed storage by two cranes. Their bridge span is 15,25 m.

For the future, it is foreseen that a part of lead concentrate will come to the smelter by cars. For that reason a part of the closed storage should be opened to receive the cars. It can be said that the discharge of concentrate into the closed storage is not quite convenient one. This problem will be solved after the complete study of the transport in Trepča.

For the discharge and transport of the granulated slag 3 possibilities are foreseen. From the granulation pools, the slag has to be taken out by 2 cranes and sent to the bins from where by the rope-way it goes to the storage.

The other possibility is: to take the granulated slag by cars which are loaded by cranes.

The third one suppose the slag taking away bu the belt conveyers G-1 and G-2 which would transport the slag under cranes on the open storage. The crane transports the granulated slag to the low bin, wherefrom it is possible to bring it by the belt conveyer system to one of the bins for charge preparation for the sintering plant - in the closed storage. The fluxes and the by-products can be taken out at the open and closed storages by cranes or manually.

6. Sampling

We foresee a manual taking of sample. This sampling is convenient because in the fully mechanized process the existing operators have free time to pay to the sample taking. In the course of each shift, an average sample of the charge is taken and content of Pb. S and H_2O is determined. A sample of the return sinter is taken every hour and S is determined. Also in the course of each shift an average sample of ready aglomerate is taken for SiO_2, CaO, FeO, ZnO, Pb. and S to be determined. Two times per shift a sample of granulated slag is taken for determination of FeO, CaO, SiO_2, Al_2O_3 and Pb, Cu and S.

Other samles are taken in the refinery to control the content of Cu, As, Sb, Ag, Zn, Bi, after each operation as described above.

7. The grinding equipment on the open storage

It consists of one Symons 4'Cone Crusher where the limestone is generally grinded and it is necessary for the preparation of the charge for the sintering plant.

8. The preparation of the charge for the sintering plant

The preparation of the charge has at its diposal 19 bins and 29 compartments in the closed storage and according to this there are sufficient possibilities for regular and separate storage and preparation of the components of the charge for the sinter plant.

The charge of the sinter plant consists of:
Lead concentrate;
Return aglomerate;
Return dust;
Grinded limestone;
Roasted pyrite;
Return granulated slag;
and the returned by-products from the refinery.

It is a request that all the components of the charge must not be larger then 2 mm. Only the return aglomerate may have the size up to 6 mm. In our case this request for the material size can not be fulfilled for the limestone. The concentrate and the roasted pyrite form the clods which cause unregularity among the sizes in the charge. The grain size of the bed-layer is 15-27 mm. The moisture content in the charge has to be maintained to approx. 5 - 7% H_2O. The precisely weighed component of the charge is discharged from the bins and via a belt conveyer system the charge is brought to the mixing machine. Water is added to the mixing drum depending on the results of the weighing operation. The function of the mixing drum is to prepare the charge for sintering. It is important that the material is mixed completely and uniformly and that the sinter charge obtains a definite moisture content. In order to attain this the material to be mixed has to remain in the drum approx. 3-4 min. Mixing is improved by adding a paddle wheel to the mixing drum. The r.p.m. of the paddle wheel differs from this for the mixing drum. The drum dimensions are: 2,5 m. dia. x 6 m. length. It is calculated that the charge has about 5,5% S content. The average lead content in the charge is 42-47% Pb.

THE AVERAGE CHEMICAL ANALYSES OF THE LEAD CONCENTRATES IN PERCENTAGE

Pb, Zn, Sb, As, Cu, Ag g/t. Au g/t. Fe, S, Bi: 72,47-2,97 -0,156-0,229-0,367-944-0,76-4,10-16,50-0,062 respectively.

The bins are separated as follows:

4 bins for return aglomerate, 1 for roasted pyrite, 1 for grinded limestone, 1 for quartz, 4 other bins are for other material such as granulated slag, Ca - Mg dust from the refinery. One extra bin is built for the return fume from mechanical filter and electrostatic precipitator.The set of 6 bins is for the hearth furnaces, foreseen to receive the concentrates.

The bins are discharged via feeders and weigh-feeders which are arranged beneath each bin. The se feeders discharge the materials to a system of belt conveyers at an exactly proportional rate. The ratio of the individual materials among each other is adjustable from the control board and maintained constant by the weigh-feeders by aid of a regulating system. The bin M-20 has at its disposal a weighing-feeder. This balance has an arrangement for automatic regulation of determined quality depending on the quantity registred by the balance Om 521 on the belt conveyer M-21.

There are 4 bins to accept the return fine. One of them has a steel feeder and the other 3 are with belt feeders. After the third bin, on the belt conveyer M-13 the balance Om 513 is placed which weighs the quantity of the first 3 bins and regulates the weighing-feeder under the fourth bin for the determined value. The total weight value of the return fines is in this way being held constant. This can be regulated by the remote control, from the central board. The following bin (M-5)is foreseen for wet material such as zinc electrolysis residue or roasted pyrite. This material is difficult to discharge from bins due to a high water content. Such a material is inclined to creating layers but still it must be given to the charge in the determined quantities. Under this bin 2 vibrating parts are mounted. The 2 vibrating grades vibrate periodically by means of a vibration challenger. The material discharge is enabled by an upright slide valve, which can be put in different positions, and another slide valve is there to close the stream of material to the belt conveyer. On the collar of the slide there is a an arrangement to control the hight of the layer of material, which include a vibrating device time relay for the case when the material stream disappears. Under the bins M-6 and M-7 are the normal w. feeders for the lime stone and quartz which do not cause difficulties at the discharge of bins.

The mixed charge is transported by thebelt conveyer M-26 and M-27, which can move in a half circle on rails and can supply with the charge the new and the old sinter-plant.

In the second case the charge comes to the b.c. M-28, and in the first case in the bin M-29 under which there is a table feeder with 2 ploghs. One is used to take away the material for the ignition layer, and the second one to discharge the charge for the pressure layer. The both ploughs discharge the material to the b. conveyers M-30 and M-31. By these conveyers the bins for the ignition layer and for the pressure layer are uniformely filled over the whole length.

9. Sintering plant - LURGIE

This is a modern sintering plant of 80 m^2 of the effective updrought area and the pallet width of 2,5 m. The distance between axes is 41,5 m. There are 89 roasters and 375 pallets.

In the sinter machine the bed-layer of about 2 cm. is put first. It is made from the return sinter of the grain size: 15 - 25 mm. Over this layer an ignition layer of about 2-3 cms. is placed. The feeding for the bed-layer goes through a chute, and the ignition layer is added by means of a cylinder. The latter is ignited under the ignition furnace which is heated by heavy oil. Under it there is a box down - drought, connected to the fan A-23 which forms an under with pressure in the box ranging from 100-150 mm.

After passage of the sinter chain under furnace the pressure layer is added. Its hight is 16-20 cm. From this place the sinter chain passes under 16 wind boxes, through which the air is blown, which is necessary for the roasting and sintering process.

The truck with pallets and charge passes the whole length of the machine. The roasting process goes from below upwards.

At the place where the aglomerate is discharged from the trucks, the sintering process is finished, and the still glowed aglomerate falls on a dicharge grate with pronged beaker A-3, which reduces the sinter discharge from the sinter machine to the size of 150 mm. max. in one dimension.

The fine moist material arriving to the ignition wind boxes tends to caking. In order to avoid this, the ignition wind box has very steep walls. The material falling through the grate of the ignition wind box is discharged via 2 hermetically closed discharge screws R-1 and R-2, which convey the materialto a dust collecting bin.

The discharge from pressure wind box is effected by hand during the shut-downs for cleaning purposes, which are to be done every week. The material thus discharged is led to the dust collecting bin, from where it is further evacuated.

The sinter machine is provided with a central greasing system. From a central pump, installed at the floor level, several pumps near the sinter machine are supplied with grease.

Underneath the sinter machine a dust collecting bin is arranged which receives all the materials resulting from the wind boxes and from the driving and lowering mechanisms. The dust collecting bin is emptied on the belt conveyer R-3.

Above the sinter machine a hood is arranged which is hermetically connected to the sinter machine. The resulting gases are exhausted from it by a fan. In the total, 4 fans are provided to supply the s. machine with the air necessary for sintering. The fan A-23 is arranged to exhaust the ignition wind box. The amount of the gas which is sucked off is led to the circulation fan A-25. The first pressure wind boxes of the sinter machine are supplied with air by a fresh air fan A-24. The last wind boxes are supplied with recirxulation gases by a circulation fan A-25. All the fans excepting the ignition fan are adjustable. The regulation of the air rate is effected by a control system. This ensures the constant air feeding of the sinter machine in all times. The ignition gas fan has a butterfly damper. The gases arising in this way by recirculation have a high content of SO_2 and are transported by the fan A-26 to the electrostatic precipitator.

The produced material is charged via a vibrating feeder, cap: 150 t/h and the temperature 350°C, to a pan-conveyer A-6 which gives it over to a spiked roll crusher which reduces the total sinter to the max. sizes ranging from

40 - 100 mm. In this range the sinter size is adjustable. The crushed sinter falls to the vibrating screen A-10 where the screened aglomerate goes either as a product of 25-40 or as a product of 25-100 mm. The material screened off (from 0-25 mm.) is discharged on the vibrating feeder R-5 - capacity: 90 t/h. In this way the this size comes on the pan-conveyer R-6 and further to the double vibrating screen R-7 screening it to the fraction of 15 - 25 mm. which represent the bed layer and which can, by a slide, be given over to the feeder R-11, which receives the fraction from 0-15 mm. It gives up this fraction to a small roll crusher R-12 - cap: 70 t/h, where it is finally reduced to 6 mm. This last fraction falls to the feeder R-14, cap: 100 t/h, and then to the feeder R-15.

After crushing this material, having temp. of 400 C., must be cooled in order to faciliate its further treatment. For this purpose a cooling drum is povided into which the water is sprayed. Its dimensions are: 2,5 x 6 m. The material stays there for coolin 3 - 4 minutes. The drum is fitted with a paddle wheel which speed the cooling process. The rate of adding water depends on temperature of the material charge and may vary accordingly. The material discharged from the cooling drum is fed to a ribber belt conveyer system R-18 and R-19 and a reversing belt conveyer R-20, wherefrom it is dumpped into the return fines bin or to the compartments in the closed storage place.

The bed layer is given up to the pan conveyer R-27 which is a reversing one and it feeds both bins foe the bed layer from the new and the old sintering plant.

The oversize material of fraction 25 - 40 is the sinter product. This aglomerate is transported by the pan conveyer F-1 to the reversing pan con. F-2, which discharge the ready aglomerate to one of the two 400 t capacity bins for theaglomerate.

To ensure an exact chacking of the water content in returne fine, a moisture probe is arranged after cooling drum for measuring the return fines moisture.

The return fines bin is placed upon lead cells to weigh the bin and its content. The values indications regarding the degree of filling of the return fines bin, are recorded on the illuminated measuring and control panel. By opening or closing the valve underneath the screen, the operator can regulate the return fines quantity in the bin. The Clear-Call system is provided with 15 speaking points which cover the sinter plant, the blast furnaces, acid plant and gas cleaning plant, and enables the intercomunication between the operators 'positions.

THE COMBINED MEASURING AND CONTROL PANEL

This panel is installed in an air conditioned room. It consists of the measuring, recording and signaling instruments for operation and survey, including also all the necessary equipment for signaling a normal operation and break downs of drives, a s well as the process signals, and starting switches for the motors or motor groups, installed in the plant, complete with the mimic diagrams.

10. The Blast furnaces arrangement

The bins and the equipment for the preparation of the charge.

The arrangement of the bins comprises 2 bins for aglomerate of the capacity: 600 - 800 t. 4 x 5 x 6 m. 1 bin for coke, 1 for lump slag, 1 for lime stone, and one as a spare bin / not completely finished /.

Under the bins for the aglomerate, there are 2 vibrating screens S-7 and S-9 which screen of the fine fraction of the aglomerate from 0 - 6 mm. The screen capacity is 40 t/h.

The coke bin is provided with a vibrating feeder of 8 t/h. The foreseen grain size is 0 - 100 mm.

The bin for the lump slag is also provided with a vibrating feeder of 8 t/h. The foreseen size is 0 - 150 mm.

The spare bin and the bin for limestone have no feeder. After each v. screen for the aglomerate there is a balance with a vessel S-8 and S-10, of 2000 kgs. capacity.

The effective volume of the balance is about 1 m^3. As a discharging and transporting device of the aglomerate from the balance a groove feeder is used with a magnetic drive. The width of the groove is 900 mm. the length

1500 mm. The max. capacity of this regulating groove feeder is 180 t/h, so that it is possible to discharge the balance in 40 sec. at max. discharge.

The balance for coke which comes after the vibrating feeder S-3 has 1000 kg. capacity with the maximal feeder capacity of 45 t/h.

The balance for slag S-6, coming after feeder S-5 has 1000 kg. capacity. The max. capacity of the feeder is 90 t/h.

When all these balances are filled with the coresponding materials, they are discharged one after another to the pan conveyer S-11. On this conveyer there are now the exactly weighed quanties of each single material in exactly determined distances. The capacity of this conveyer is 300 t/h. The length is 48 m. and the climbing hight is 14 m. The width of the pan is 600 mm. Fro S-11 the material is discharged of the pan conveyer S-12 - length 53 m. climbing hight 11,5 m. and width of the pan is 800 mm.The pan conveyer S-12 discharges the charge of the blast furnace to a reversing belt conveyer S-13 which can charge the blast furnace according to our choice. The back parts of the conveyer are provided with steel bifurcated chutes with a slide valve which enables uniform chedding of the furnaces.

The material stream from the bins, through the balance with vessels, pan conveyers and reversing belt conveyer is regulate by a control panel. The operator can, according to the run down of the charge in the furnace, request larger or smaller quatities of the material from the bins; and can discharge it on every part of the furnace.

The operator sets up the required quantity of a single material on the panel and the turning potentiometer, and prese the start button. In this way all the balances are filled up to the max. and stay at disposal to invitation.

The groove feeders represent the discharging device of the balance and can be - regarding the capacity, regulated so that the time of discharge of the balance can be empirically adapted to correspond to the moving - time of the filling conveyer above each blast furnace.

The reversing belt conveyer S-13 can be by operator automatically set up to the starting position for the blast furnace which has to be charged. The charging of the furnace itself is made by hand command, so that the operator may vary the speed of the truck and the speed of the conveyer according to the charge falling into furnace.

To change the smaller quantities which are added to the furnace periodically, i.e. litharge, 2 lifts are provided which raise such a material to the platforme where the furnaces are charged. This material is then thrown by hand in the furnace.

11. <u>The blast furnaces</u>

The blast furnaces are of "LURGI" type but they are engineered and built to the experience obtained in the lead smelter Port-Pyrie - Australia. It is in fact a blst furnace which have the water jackets in a shape of a chair with 2 rows of tuyeres. The distance of the tuyeres in the above row is greater than at the lower one.

The furnaces are provided with a separate hood to take out the waste gases. The 2 new furnaces are built. The old one is as a spare furnace. If it is necessary it can be started togather with all 3 furnaces at the same time.

For each furnace there is a turbo-blower. For the upper fow of the tuyeres the separate turbo-blowers are provided.

The bigger turbo-blower has the capacity of 300 N m^3/min. at the temperature of 20 C. The difference in the static pressure is 2000 w.p. This turbo-blower is provided with a damping device which is electrically regulated. The smaller new turbo-blower has a capacity of 150 N m^3/min. at the temp. 20°C. The difference in the static pressure: 2000 w.p. It has no damping arrangement.

The air separation is such that every furnace can obtain the air from the ecisting turbo-blowers.

The commands of the blast furnaces are effected from the central panel. These panels contain the flow-sheet of the blast furnace process with conveyers,balances with shining symbols for every balance, for every drive; further there are the buttons for turning in and off of every driving group.

At this panel there are aparatus which advertise admonitions for the start and appearance of the obstacles. At the board there are the messuring instruments foreseen to control the operation of the blast furnace and the turbo-blower.

12. The room-ventilation

As the lead dust is poisonons, it is indispensable from the health reasons, to erect a ventilatione system which should operate well and protect the operator in the smelter. Unfortunately, it was not possible, at the first step, to foresee all the places which would cause a bad atmosphere, either due to appearance of dust or poisonous gases.

"LURGI" has, on the bases of its long-time experience, foreseen that all the places where the dust arises should be protected. All such places are connected to a central ventilation system. Each individual equipment which creates dust is protected by a sheet-metal envelope. The gases containing dust are connected to an existing Beth-filtration arrangement. In the central ventilation system are included:
oll the discharging points for slag, lead, bins and feeders of aglomerate in the preparation of charge for the blaste furnace.

At the cooling and moistening of return fine aglomerate significants quantity of dust and steam arise. The cooling drum is conected to a Ventury arrengement. The waste from the Ventury are pumped into the cooling drum. The cleaned gas goes to the chaminay.

13. The filtration of furnace gases

Electrostatic precipitator servs for this purpose nad partly bag-hous.

Electrostatic precipitator is bildt for the folowing corition: gas volume; 72.000 Nm^3/h; temperature 250°C; SO_2 content in the gas: 5%; water dew point: 55°C. In front of the electrostatic preicipitator a cooling tower is instolled. The tower and dubble electrostatic precipitator are with acid resistent bricks overlayed in the internal side, and outside wa is ovelayed with normal bricks. Between this two walls is an air space which servs as an isolation and prevent the condensate which eventualy arise, to come in the concat withe the normall bricks. The lower part of the filter is made as an even plate. The dust precipitated here is discharged with 2 reddlers which are driven by an el.motor. When the dust is emptied, it is transported by a cross-reddler to the equipment where it is moistened. In fact this is a double screw built in a vessel of stainless steel. The reddler is emptied by 2 rotary dust valves.

As the electrostatic precipitator is built as a double filter, in emergency cases, one of its half can be stopped.

The filter is supplied with the required high voltage direct current by 2 Si-rectifiers which have an electronic command.

There is an automatic voltage regulation. The dedusting grade in the filters goes from 10 gr/Nm^3 to 0,250 mgr./Nm^3 in the cleaned gas. The voltage of the filter is: 78 KV.

The electro-filter contains a sygnaling equipment which shows the visual and acoustical signals for dropping out of high voltage.

THE BAG-HOUSE

The gases from the blast furnace are filtered in the filters with woolen bags. From each furnace the gases are taken away by the 2 gas lines which are placed on the narrower side of the furnace and go to the common pipe line which brings both the furnace and the room ventilation gases to the bag house. These gases come first to the collecting pipe and then to the filter. The bag house consists of 14 chambers. In each chamber there are 340 bags each having 1,6 m^2 of the effective filtration surface. The gases released from dust come in the collecting pipe. Hence they go over 4 fans of 1500 m^3/min cap. at 45°C. static difference in pressure is 220 mm. w.p. - to the chimney.

The precipitated dust is discharged from the chambers by means of a moving scraper and drops down to a belt conveyer M-41 which brings it to a bucket elevator M-40 which lifts the dust to a vessel M-40 a with two screws where the dust is moistened. This dust from the bag hous and electrostatic precipitator arrives via belt conveyers M-41 and 42 in a dust bin. From here the dust is discharged by an eccentric feeder to the conveyer M-49.

At the chute 67 the return dust joins the charge for the roasting plant.

14. <u>Contact sulphuric acid plant
Cleaning and cooling plant</u>

After a preliminary treatment in the horizontal electrostatic precipitator, the gas is subjected to scrubbing in a Venturi - scrubber and cooled at the same time by the evaporation of liquid.

The gas is then cooled in the four horizontal type indirect gas coolers. With a view to the removal of sulphuric acid mists from the gases the following two groups of electrostatic wet treaters and the parallelly arranged vertical type indirect gas coolers cool the gas down to 35°C. When leaving the second group of electrostatic wet treaters, the gas is completely free from mist and this permits the further processing in the contact plant.

15. <u>Sulphuric acid contact plant</u>

In order to ensure a perfect SO_3 absorbtion after the conversion from SO_2 to SO_3, the water content in the gases must be reduced as much as possible. A drying tower is provided for this purpose. It is designed as an irrigation tower where the acid of approx: 96% H_2SO_4 is circulated. A special device, at pressure tower head, ensures the uniform wetting of china clay filling bodies provided in the tower.

The gases leaving the drying tower are periodically free from water and are conveyed by SO_2 fan to a convertor via the heat exchangers. The necessary vanadiferrous catalist is inside the converter in 4 horizontal layers. Since by conversion from SO_2 to SO_3 heat is produced, but temperature max. has to be limitted because of the conversion balance, heat exchangers are arranged between the catalist layers. In the converter at least 98% of SO_2 is converted, and SO_3 contained in leaving gases must be absorbed by a thorough in the absorption tower. The acid production is drawn off from the absorbtion tower. It is diluted with water in a mixing vessel to the required concentration and cooled in the irrigation cooler. The pump delivers it to the storage tanks.

The contact sulphuric acid plant is now under erection in lead smelter and it will be ready to start up to the end of this year.

The third stage in the modernization of the lead smelter should be the erection of a fuming plant to treate the zinc electrolysis residues and the slag from the blast furnaces. This stage has not been started yet.

16. R e f i n i n g

In the refining we have foreseen only the change of some processes. For the lead softening the complete Harris - process should be introduced. The lead dezincing after desilveration should be made by vacuum process of zinc elimination. The treatment of zinc-silver-lead crust should be done by an el.process. The two short rotary furnaces should be added for treatment of rafinery by-prodicts. To the reverberatory furnaces and to the cupels the bag filters should be added.

17. The supply

In the frame of the sintering plant a "Trafo"-station of 3,3/0,4 KV is built, with two transformers - each of 1600 KVA power. This station is equiped with high voltage distribution consisting of 11 cells. 2 cells-for bringing from the main T.S. and for between connection with the existing T.S. of the smelter.

- 2 transformers cells;
- 6 outcomers for high-tention motors (AG-28,A-25);
- S-21, S-23 two receivers;
- measuring cell;

On the low-voltage side there are separate systems of gathering bars for each transformer with a connecting field in it. The power factor fi. is compensated through the condenser-batteries with an auto-matic regulator. All the outcomers on the low voltage side are provided with fuses and separators. The transformer power is sellected so that one of them, in emergency cases, can supply the whole arrangement, but at normal work both transformers are separated with a connecting field.

THE HIGH AND LOW-VOLTAGE DISTRIBUTION FOR MOTORS

All the brakers for high tention motors, which are supplied from T.S. of the sintering plant, are in T.S. and can be remotely switched in from the control panel or by the buttons placed beside the motors. The brakes, for the motors supplied from the smelter T.S., are in the immediate vicinity of motors and have their command at site.

The distribution cables are placed along the cable channels. The lowvoltage el. motors distribution is located in separate room and is connected to each single equipment.

All the protecting brakers at the el.motors distribution have a remote command and protecting relays for automatic switching off of the motors in the cases of damage. These are the closed type motors (protection P-33) adapted for operation in dusty plants and at active evaporation. The motors of higher power have a termical protection in the motor casing.

ELECTRICAL LIGHTING OF THE PLANT

The lighting adapted to the conditions and needs of each individual part of the plant is used. In most cases mercury steam lights are applied.

EARTHING AND LIGHTNING-ARRESTER

In the whole plant there is a zero-system applied. All the cables for low voltage motors are 4-core cables, where the fourth core is connected to the mass of the motor and el.motors distribution, and respectively at transformer, onto the zero bar. The earthing is accomplished through pipe earthing along the river "Ibar".

The lightning arrest is performed by two radioactive insulators on the sinter plant building and on the blast furnace building, and in this way the whole plant is covered.

THE WATER SUPPLY

A. Industrial water

The water supply for smelter and refinery is solved by installing a system of pipes to the line Zvečan - Chemical Industry at K.Mitrovica, which is a part of the main system Chemical Industry - Prelez, where the water is taken directly from the river Ibar, about 12 km. from K.Mitrovica. The pipes of the system Zvečan-Ch.Industry are made of steel and have the diam. 900 mm. and the capacity of 600 l/sec. It is a gravitation system and the pressure at smelter is 3,8 atm.

The internal system is arranged in circle. The steel pipes have a special isolation from corrosion and aggressive ambient. There is a sufficient number of valves which enables the shutting down of some damaged parts without disturbing the other consumers.

The drinking water: the new part of the system is included in the existing system.

The fire water system: a separate system is built for this purpose with a pressure of 7 atm. This water is supplied through a separate pump at the pump station near Ibar. By pumping an accumulation pool onthe hill Zvečan is filled first, wherefrom this water, by its gravity fall, supplies the fire water system.

THE STEAM, COMPRESSED AIR AND HEAVY OIL SUPPLY

Steam - The water steam is generally used for heating rooms and water for baths. In the process it is used to warm the heavy oil for heating the furnace of the sinter machine. The steam is obtained through a separate pipe lines connected to the main steam pipe from the power station. This is a saturated steam with the pressure of 0,5-2 atm.

Compressed air: It is obtained from the central station at the flotation plant. The air pressure is 7 atm. In the cases when this supply is interrupted there are local compressors to ensure air for the sinter plant.

- Heavy oil: This oil is foreseen to ignite the furnace charge at the sinter plant. Its quality is "bunker C". There is a tank for heavy oil storage with the cap.: 20 m^3, which is located on the ground floor of the sinter plant building. It is provided with an arrangement for heating by steam and el.power. The heavy oil supply of this tank is accomplished by a h. oil pipe line from the main station at the refinery to the sinter plant.

18. The start up of the smelter
The sinter plant

Several months had to elapse to examine the process and the equipment, and to obtain the guaranteed production results. The first difficulty appeared with heavy oil which could not achieve the corresponding viscosity. We were obliged to change the oil and to turn to a light oil.

A lot of difficulties were caused also by the old cranes at the open and closed storage. The fan A-23 was often out of work due to vibrations and wear.

After several months, at the end of the checking period, it was possible to achieve the following results at the sinter plant: -

Production: 1180 t/24 h.;
Desulphuration: < 1,3 m^2/24 h.;
SO_2 concentration 5% (calculated);
%Pb in aglom.: about 45% ;
%S in aglom.: > 2% ;

THE BLAST FURNACES

At the beginning there were some difficulties due to the lack of experience with this kind of furnaces. After this period the furnace "A" was started first which had to be shut down due to a low capacity recovery. The furnace had to be devided in two parts. The middle part was cooled first and then one half of it. All the time the upper fire could be observed. The charging of the furnace was difficult. Then the second furnace in the factory was started and the guaranteed examinations were made. After the period of several days we achieved the production of 250 t/day/furnace. The Pb. content in the slag at that time was under 1,5% Pb.

THE ELECTROSTATIC PRECIPITATOR

The measuring of dust content in gases after el.precipitator shows that this precipitator gives the guaranteed results, i.e. that dust content was under 0,2 gr./m^3.

THE SUMMARY

In the south part of Yugoslavia, where in old times lead mining and smelting had been developed, before the II. World War a smelter and refinery were built with the process of the Newnam hearth furnaces. For that time this process was a very modern one. These plants were enlarged in 1951. so that 65% of the total production belonged to the blast furnace and other 35% to the standard roasting and reduction process. The two parallel processes existed in Trepča. These processes have been shortly described as well as the refining consisting of: decopperation, copper dross smelting, lead softening, desilveration, retorting, cupelation of return bullion, dezincing, and removal of calcium and bismuth.

The new modernization started with the reconstruction of lead smelter. During the period of the first "Trepča" smelter development, the major part of the smelted concentrate was from "Trepča" s Mines. It was very convenient for smelting in the Newnam hearth furnaces because of its high concentration of lead and lack of impurities.

In the meantime the other mines in the country were developed, which no more gave the same quality of concentrate and the production in Newnam hearth furnaces was no more so attractive.

The process with 12 small furnaces could not be modernized and mechanized. It was impossible to use sulphur from concentrates. "Trepča" wanted to enlarge its capacities of the smelter because onough raw material was at disposal. After a long study of different possibilities the standard and the newest known process has been chooseen, i.e. roasting of lead concentrate on the D.L. machine with an updrought and recirculation of gases to obtain the concentration of SO_2 of about 5% which should be treated in the sulphuric acid plant which is also now under erection. The blast furnace of Portpirie-"Lurgi" type, with a mechanized transport of the charge, and with the room ventilation and filtration of gases in the bag-house was erected.

The gases from the sinter machine are filtred in the electrostatic precipitator.

The two new blast furnaces have 9,7 m^2. in the level of tuyeres each. A new modern roasting plant with up-drought and gases recirculation with 80 m^2 of useful surface with all other accessories was also erected. The sulphuric acid contact plant is now being erected. For the modernization of the refinery we foresee a complete Harris process, vacuum dezincing. The bag-house should be introduced in different points of the plant.

The description of plant supplying with el.power, water, steam, heavy and light oil is given in this paper, as well as the results at starting up of the smelter.

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