GÓRNICTWO. — HUTNICTWO.

KOLEKTORY.

Od roku 1887 zaczęto używać w hutach żelaznych tak zwanych kolektorów (Mischer, mixer, melangeur) — przyrządów, których celem jest ujednostajnienie składu surowca przed wprowadzeniem go do pieców martinowskich albo retort Bessemera. Przyrządy te są to duże zbiorniki budowane po większej części w postaci gruszek Bessemera, do których zlewa się surowiec z wielkich pieców. Ponieważ działanie kolektora polega na mieszaniu się płynnego surowca, pochodzącego z różnych pieców i spustów, objętość jego przeto musi być znaczna. Przeważnie budują kolektory mogące pomieścić 100 do 120 tonn surowca; w Ameryce dochodzą do 600 tonn.

Ilość surowca w kolektorze pozostaje ciągle prawie stałą, ponieważ w miarę przybywania surowca z wielkich pieców, ilość jego ubywa przez odlewanie do pieców stalowych.

Wynalazca amerykanin Jones, zdaje się, nie przewidywał, że kolektor przyniesie korzyść i pod innym względem, a mianowicie pod względem usuwania z surowca szkodliwej domieszki siarki. Jeszcze przed 30 laty zauważono, że surowiec zawierający mangan podczas samego tylko topienia traci dosyć znaczną ilość siarki, która w postaci siarku manganu odchodzi do żuzla, wypływającego na powierzchnię surowca.

W zakładach w Hoerde w Westfalii, gdzie po raz pierwszy zaprowadzono kolektory w Europie (w 1889 r.), stwierdzono, że zapomocą nich można usunąć 60 — 70% siarki zawartej w surowcu. Zapomocą dodatku pewnej ilości manganu, w zakładach tych w 70-tonnowym kolektorze otrzymano następujące rezultaty:

Zawartość siarki w surowcu, wypływającym z wielkiego pieca.	Skład surowca z kolektora				Strata siarki w %
	S	Mn	Ph	Si	
0,216	0,053	1,53	2,82	0,13	75
0,135	0,036	2,97	2,74	0,28	73
0,348	0,051	1,96	2,88	0,21	88
0,481	0,078	1,36	2,87	0,17	84
0,105	0,049	1,39	2,93	0,19	53
0,143	0,073	1,39	2,84	0,30	49
0,100	0,063	1,34	2,62	0,17	37

Do przeróbki surowca zawierającego duże ilości siarki, zastosowanie kolektorów przyniosło ogromne korzyści, i szybkie ich rozpowszechnienie należy głównie temu przypisać.

Ponieważ jedna z większych naszych hut ma zamiar zaprowadzenia kolektorów (co wszakże będzie miało na celu głównie ujednostajnienie składu surowca) i ponieważ przyrządy te znalazły na południu Rosyi bardzo szerokie zastosowanie, sądzę więc, że bliższe szczegóły o urządzeniu i działaniu kolektorów w różnych zakładach będą na czasie.

Ponieważ surowiec pozostaje w kolektorze przez dłuższy przeciąg czasu, naturalną więc była obawa, że tracąc ciepło przez promieniowanie, może zastygnąć. W kolektorze 120-tonnowym, otrzymującym 450 tonn surowca w ciągu

MINING. - METALLURGY.

Collectors (1897 Article)

Technical Review [*Przegląd Techniczny*], 1897, T. 35, nr 46, s. 750-755

Since 1887, so-called collectors (Mischer, mixer, melangeur) began to be used in iron foundries - devices whose purpose is to homogenize the composition of raw materials before introducing them into Martin furnaces or Bessemer retorts. These devices are large tanks, mostly built in the shape of Bessemer pears [*the large tanks used in the Bessemer process were shaped like pears*], into which the raw material from blast furnaces is poured. Since the action of the collector involves the mixing of liquid raw materials coming from different furnaces and outlets, its capacity must be significant. Collectors are usually built to hold 100 to 120 tons of raw materials; in America, they reach up to 600 tons.

The amount of raw material in the collector remains almost constant, as the raw material from the blast furnaces arrives, its quantity decreases by casting into steel furnaces.

The inventor, an American named Jones, did not seem to anticipate that the collector would bring benefits in another aspect, namely in removing harmful sulfur impurities from the raw material. Just over 30 years ago, it was noticed that raw material containing manganese, during the melting process alone, loses a significant amount of sulfur, which in the form of manganese sulfide goes to the slag, floating on the surface of the raw material.

In the Hoerde plants in Westphalia, where collectors were first introduced in Europe (in 1889), it was found that with their help, 60 - 70% of the sulfur contained in the raw material could be removed. By adding a certain amount of manganese, the following results were obtained in these plants with a 70-ton collector:

Sulfur content in the raw material flowing from the blast furnace	Composition of raw material from the collector				Sulfur loss (%)
	S	Mn	Ph	Si	
0.216	0.053	1.5a	2.82	0.13	75
0.135	0.036	2.97	2.74	0.28	73
0.348	0.051	1.96	2.88	0.21	88
0.481	0.078	1.36	2.87	0.17	84
0.105	0.049	1.39	2.93	0.19	53
0.113	0.073	1.39	2.84	0.3	49
0.1	0.063	1.34	2.62	0.17	37

The use of collectors for processing raw materials containing large amounts of sulfur has brought significant benefits, and their rapid dissemination can be mainly attributed to this.

Since one of our larger smelters is planning to introduce collectors (which will primarily serve to standardize the composition of raw materials) and these devices have found widespread use in southern Russia, I believe that more detailed information about the design and operation of collectors in various plants will be timely.

Since the raw material stays in the collector for an extended period, there was a natural concern that it might lose heat through radiation and solidify. In a 120-ton collector, which receives 450 tons of raw material per day from four blast furnaces, the raw material is exchanged 3.75 times, i.e., on average, every 6.4 hours. This duration is significant enough that the concern about solidification was entirely justified. However, in reality, it turned out that the cooling of the raw material is remarkably small. This is because the heat loss through radiation is continuously compensated by the heat generated during the formation of manganese sulfide, the oxidation of sulfur to sulfurous acid, the oxidation of manganese to manganese oxide, and the conversion of the latter to manganese silicate.

Professor J. Thim calculates the heat loss of molten raw material during its stay in a 120-ton collector as follows ("namyj Żurnal" 1897, volume II, p. 193.): The heat loss through the radiation of the collector walls is assumed to be the same as in ordinary steam pipes, namely 1750 heat units per square meter of surface and hour, based on the principle that the collector walls have approximately the same temperature on the surface as steam pipes. Assuming that the temperature of the raw material poured into the collector equals 1200° C, the specific heat of the raw material is 0.13, and the collector's surface area is 82 square meters, we obtain:

Heat contained in 120 tons of raw material at the moment of pouring into the collector:
0.13 x 120,000 x 1,200 = 18,720,000 heat units.

Heat loss through radiation during 6.4 hours: 1,750 x 82 x 6.4 = 936,800 heat units.

Heat remaining in the raw material after this time:
8,720,000 - 936,800 = 17,783,200 heat units.

Temperature of the raw material after 6.4 hours:
17,783,200 / (0.13 x 120,000) = 1,140°C

The decrease in temperature is therefore 60°C. It should be assumed that this loss would be a significant obstacle to the application of collectors if not for the aforementioned reactions taking place in the raw material itself during its stay in the collector (*According to measurements by le Chatelier, the melting point of gray raw material is 1,220°C, and that of white raw material is 1,130°C*.). Nevertheless, the fear of the raw material solidifying with the final volume of the collector cannot be justified, and building giants with a capacity of 600 tons makes no sense. Building overly large collectors is irrational despite high costs, and for this reason, in case of disruption in the normal operation of the steelworks or any unforeseen accident requiring longer repairs, removing a significant amount of raw material from the collector presents great difficulties. It is far more rational to build two collectors, one of which can serve as a backup in case of reduced production.

The action of the collector as a device for removing the harmful admixture of sulfur can be seen in the following table, which contains analyses of 58 samples taken during the operation of the collector in one of the German steelworks over 12 hours (*This table, provided by Masseuez, "Stahl u. Eisen" 1897, p. 388.*)

From this table, it can also be seen that during the transportation of liquid raw material from blast furnaces to the collector, the loss of sulfur is quite significant, averaging 43%. The average sulfur loss in the collector was 36%. In total, 63 ½%.

Blast Furnace #	Time	Weight (kg)	Blast Furnace Sample		Collector Sample		Converter Sample	
			Mn %	S %	Mn %	S %	Mn %	S %
	March 29th, 1897							
II	2:45 AM	31850	1.03	0.19	0.85	0.1		
III	2:46 AM	33050	1.07	0.17	0.92	0.09		
VI	3:30 AM	32350	1.97	0.08	1.42	0.06		
X	4:30 AM	10400	1.13	0.2	0.86	0.1		
	6:03 AM						0.9	0.04
VII	5:30 AM	44700	1.08	0.19	0.89	0.14		
	5:32 AM						0.9	0.06
	6:54 AM						0.89	0.04
	6:18 AM						0.84	0.04
	6:37 AM						0.89	0.05
III	6:45 AM	22800	1.65	0.12	1.08	0.09		
	6:50 AM						0.84	0.04
II	7:00 AM	21700	1.22	0.17	0.97	0.11		
	7:10 AM						0.84	0.05
	7:30 AM						0.84	0.05
	7:43 AM						0.84	0.05
VIII	7:45 AM	25850	1.03	0.25	0.7	0.14	0.75	0.07
	8:10 AM							
VI	8:15 AM	32450	1.22	0.11	0.85	0.06		
	8:30 AM						0.8	0.06
	8:49 AM						0.8	0.06
VII	9:00 AM	32050	1.13	0.22	0.8	0.07		
	9:08 AM						0.84	0.06
	9:34 AM						0.8	0.06
	9:50 AM						0.8	0.06
III	10:00 AM	23000	1.03	0.18	0.75	0.12		
	10:15 AM						0.8	0.07
II	10:30 AM	29050	1.18	0.19	0.89	0.09		
	10:33 AM						0.71	0.06
	10:56 AM						0.75	0.07
VI	11:00 AM	23750	1.03	0.19	0.67	0.14		
	11:10 AM						0.75	0.08
	11:29 AM						0.75	0.08
	11:41 AM						0.75	0.08
VIII	12:00 PM	28300	0.75	0.23	0.51	0.15		
	12:16 PM						0.67	0.09
VII	12:45 PM	34300	0.94	0.18	0.74	0.1		
	12:59 PM						0.61	0.1
	1:21 PM						0.71	0.08
II	1:30 PM	21450	1.31	0.2	1.17	0.08		
	1:46 PM						0.7	0.08
	2:08 PM						0.71	0.08
	Average		0.175			0.1		0.064

Original Table:

Nr. wielkiego pieca	Czas	Waga spustu *kg*	Próba wzięta przy wielkim piecu		Próba wzięta przy wlewaniu do kolektora		Próba wzięta przy wlewaniu do konwertora Bessemera	
			Mn %	S %	Mn %	S %	Mn %	S %
	29 marca 1897 r.							
II	godz. 2	31350	1,03	0,19	0,85	0,10		
III	2—45	33050	1,17	0,17	0,92	0,09		
VI	3—30	32350	1,97	0,08	1,42	0,06		
X	4—30	10400	1,13	0,20	0,86	0,10		
	5—03						0,90	0,04
VII	5—30	44700	1,08	0,19	0,89	0,14		
	5—32						0,90	0,06
	5—54						0,89	0,04
	6—18						0,84	0,04
	6—37						0,89	0,05
III	6—45	22800	1,55	0,12	1,08	0,09		
	6—50						0,84	0,04
II	7—00	21700	1,22	0,17	0,97	0,11		
	7—10						0,84	0,05
	7—30						0,84	0,05
	7—43						0,84	0,05
VIII	7—45	25850	1,03	0,25	0,70	0,14	0,75	0,07
	8—10							
VI	8—15	32450	1,22	0,11	0,85	0,06		
	8—30						0,80	0,06
	8—49						0,80	0,06
VII	9—00	32050	1,13	0,22	0,80	0,07		
	9—08						0,84	0,06
	9—34						0,80	0,06
	9—50						0,80	0,06
III	10—00	23000	1,03	0,18	0,75	0,12		
	10—15						0,80	0,07
II	10—30	29050	1,13	0,19	0,89	0,09		
	10—33						0,71	0,06
	10—56						0,75	0,07
VI	11—00	23750	1,03	0,19	0,67	0,14		
	11—10						0,75	0,08
	11—29						0,75	0,08
	11—48						0,75	0,08
VIII	12—00	28300	0,75	0,23	0,51	0,15		
	12—16						0,67	0,09
VII	12—45	34300	0,94	0,18	0,74	0,10		
	12—59						0,61	0,10
	1—21						0,71	0,08
II	1—30	21450	1,31	0,20	1,17	0,08		
	1—45						0,71	0,08
	2—08						0,71	0,08
	Średnio			0,175		0,10		0,064

The walls of the collector are made of refractory materials, enclosed in an iron shell, similar to Bessemer retorts. The thickness of the walls is 400 - 450 mm. Inside, the lining was initially made of acidic materials (quartz sandstone), but such a mortar turned out to be very unstable, due to the formation of manganese oxide, which at the level where slag accumulates, strongly affects the walls of acidic materials, causing them to be quickly destroyed. For example,

engineer Knaff reports ("Steel and Iron", year 1896, p. 100) that in the Hoerde plant, the collector walls with a thickness of 425 mm (with an inner layer of quartz stone 75 mm thick) were so eroded after three weeks at the slag collection level that only 170 mm remained. (In slags, 24 to 30% S and 0.2 were found).

In 1893, a part of the mortar was made of magnesite in one place as a test; after some time, it was noticed that while the acidic mortar underwent severe damage, the magnesite mortar remained almost intact.

Soon after such a successful test result, the collector walls, at the slag collection level, began to be lined with a 600 mm wide strip of magnesite; however, since the walls below this strip, like before, quickly deteriorated at the low level of raw material, it was decided to line the entire interior of the collector, except for the vault, with magnesite. Figure 1 of Table XVII shows the cross-section of the current collector in the Hoerde plant. Magnesite stones should be as large as possible and very accurately cut because the mortar for joining the stones is quickly eroded, so there should be as little of it as possible. Figure 2 shows the dimensions of the stones used in Hoerde. Magnesite walls used in these plants last for over 8 months, with only minor repairs. The cost of lining the walls with magnesite, together with all labor, is reported by Knaff to be 1800 marks.

From the following table, it is clear that the benefits achieved through the use of magnesite walls are not only in labor, but also in the reduction of downtime for repairs:

Year	Wall Material Type	Raw Material Passed Through the Collector	Labor Cost for Repairs in Marks
1891	Walls made of acidic materials	96,711 tons	1,605.50 marks
1892	Walls made of acidic materials	111,103 tons	1,786.00 marks
1893	Walls made of acidic materials	145,131 tons	1,638.20 marks
1894	Walls made of basic materials	155,964 tons	831.00 marks

Some inconveniences arise from the exposure of magnesite to air, cracking during cooling, and disintegration into pieces during cooling of ignited stones with steam. For this reason, when there is a need to stop the collector, it is necessary to avoid this method of cooling and instead cool it very slowly. Despite this, cracks with a width of up to 25 mm always form. These gaps are filled with a resin-magnesite mortar.

When laying the magnesite layer, slightly heated stones should be joined with the same mortar. External joints should be sealed with a thin layer of clay to prevent molten material leakage during collector heating. It is a good idea to cool the collector after the first heating, repair the cracks, and then heat it again. After a longer break, the walls should always be thoroughly inspected.

The heating of the collector should be carried out very carefully using blast furnace gases or coke. When filling with raw material, the outlet should be sealed to prevent cooling. It is

essential to remove solidified slag after each pouring of raw material; it not only absorbs a lot of heat but also makes the oxidation of manganese and sulfur more difficult. Artificial draft for the removal of sulfuric acid through a chimney works too cooling and, for this reason, should not be used.

English engineer, J.M. While, proposes in his patent (British patent M 563/1893) the use of refractory material blowers, installed through holes in the collector ceiling and submerged in molten metal. The device aims to achieve more vigorous combustion of manganese, silicon, and carbon to obtain the necessary heat.

The first collectors, built by Captain Jones at the Carnegie Iron Works (one of the largest metallurgical plants in the United States), had the form presented in Fig. 3. Two collectors with a capacity of 80 tons each were built; both were in simultaneous operation, and for better mixing, the raw material was drained into the ladle (poche, Pfanne), half from each collector.

Currently, many metallurgical plants in Europe have collectors, mainly in the form of large Bessemer retorts. Movement is mainly carried out using hydraulic devices.

In the Friedenshütte plants in Upper Silesia, collectors were built, seemingly very rational, in the form of cylinders resting on rollers (Fig. 4). The hydraulic device for rotating is remarkably simple and small.

In Russia, collectors were first applied in 1892 at the Alexandrovsky plant of the Bryansk Society in Yekaterinburg. South Russian raw materials, smelted on local coke, contain a considerable amount of sulfur (which comes from coke), so the use of collectors should be considered one of the more significant improvements in the production of South Russian steelworks. It is expected that, in a few years, thanks to the introduction of collectors, the iron of these steelworks will lose its reputation for being brittle when hot, and our plants will face a competitor armed with an equally good grade of iron, like ours.

Fig. 5 shows the collector device of the Alexandrovsky plant; it is a device very similar to that in the Cockerill plant in Seraing. The collector's capacity is 100 tons, wall thickness is 300 mm. Raw materials from blast furnaces are transported in a ladle by a locomotive, then the ladle is lifted using a hydraulic winch b to the level of the spout c, through which the raw material is poured into the collector while rotating the ladle on pivots. From time to time, the device is rotated using a hydraulic winch cl for pouring the ladle c, in which the raw material is then transported to the Bessemer steelworks or to Martin's furnaces. Within 24 hours, the collector produces 450 tons of raw material. Thorough repairs are required for the walls every three months. The entire device cost about 25,000 rubles.

The results obtained in terms of sulfur removal can be seen in the following table:

# of Attempts	Raw material from blast furnaces			Raw material from the collector			Sulfer Loss in %
	Si	Mn	S	Si	Mn	S	
Avg of 6	1.66	1.57	0.039	1.61	1.52	0.006	87
Avg of 3	2.55	2.44	0.044	2.86	1.62	0.008	82
Avg of 9	1.87	1.53	0.066	1.82	1.36	0.0094	86
Avg of 11	2.21	2.12	0.049	2.21	1.88	0.008	84

In the plants of the Noworosyjsk Society in Tuzov, two collectors of 120 tons each were built (Fig. 6). One collector is always in operation, while the other serves as a backup. Railway 'a' is used to transport liquid raw material from blast furnaces, and railway 'b' is used to transport it to the steelworks. The rotation of the collector 'c' is performed with the help of hydraulic cylinders 'd', operating at a pressure of 40 atmospheres. The external diameter of the collector is 3550 mm, length 6050 mm, outer plate thickness 25½ mm, and wall thickness 400 mm. Every two months, the walls require thorough repairs. Four workers operate the collector during its operation:

1. Two workers at the collectors;
2. One boy at the hydraulic cranes;
3. One machinist at the pump and accumulator.

According to the data provided by the plant management, sulfur loss ranges from 75-90%.

Collectors have also been introduced in the south of Russia at the plants in Kamienskoje (two at 130 tons each), which started operation last year. In the construction of the Russian-Belgian Society plants in Volyn, two collectors are planned for four blast furnaces.

As for the production costs when passing raw material through the collectors, they are very small: taking into account labor, wall repairs, pump and accumulator maintenance, mechanism repairs, and transport of raw material - in short, the total production costs amount to a maximum of 10 kopecks per 1 ton of raw material, i.e., 0.165 kopecks per 1 pud. [*1 pood ≈ 16.38 kg]*.

Engineer Kintzle states that production costs range from 8-15 pfennigs per 1 tonne (Stahl and Eisen, 1897, p. 387).

It is also worth mentioning the latest experiments of Mr. de Vathaire on the purification of raw material from sulfur. He proposes the use of barium ferrocyanide $FeCy_6Ba_2 + 3H_2O$ or barium and potassium ferrocyanide $FeCy_6K_2Ba + 3H_2O$ for this purpose. These salts are obtained by mixing concentrated solutions of yellow potassium ferrocyanide and barium chloride; if the latter is in excess, the first salt is obtained, and if both solutions are in amounts corresponding to the equivalents, the second salt is obtained. Both salts, when added to the liquid raw material, decompose into C, Ba, and K - the latter metals combine with sulfur, forming barium sulfide and potassium sulfide. Since these metals have a very strong affinity for sulfur, the removal of the latter is very efficient.