

Evaluation of world and Iranian sponge iron production in 2020

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Abstract

Sponge iron is one of the rechargeable materials of electric arc furnaces. The share of these materials in the world and Iranian steel production is 5 and 85.9%, respectively. According to development plans, Iran is expected to be one of the world's top producers this year. India, Iran, Russia, Mexico and Saudi Arabia are the world's largest producers of sponge iron. Sponge iron is loaded as cold, hot briquette and hot charge in an electric arc furnace. Last year, the world's sponge iron production was 104.4 million tons. 11.38 million tons of hot sponge iron (HDRI) are charged in arc furnaces. The production of hot briquettes (HBI) in the world last year was more than 9 million tons. Mobarakeh Steel Company (Isfahan-Iran) is the world's largest producer of sponge iron with a production of 7.25 million tons. The process of producing Iranian sponge iron (PERED) is expanding more and more.

Keywords: Sponge iron, Steel, Bricks, Iron ore, Electric arc furnaces, EAF.

1. Introduction

In 2020, the world production of sponge iron products with a 3.4 percent decrease in production reached 104.4 million tons. Figure (1) shows the types of sponge iron products, including hot briquettes, sponge iron produced from pellets and lump iron ore. This production has been achieved while the total production capacity of sponge iron in the world has been over 125 million tons. In 2020, the highest growth of sponge iron production in Iran and Algeria was observed at 1.69 and 0.69 million tons, respectively. Compared to 2019, the production of sponge iron in the Islamic Republic of Iran has increased by 1.69 million tons. In Qatar, compared to the previous year, production was reduced (0.78 million tons). In Qa-

tar, compared to the previous year, production was reduced (0.78 million tons). In Saudi Arabia, decreasing the production of sponge iron has been reported to be 800,000 tons. The MENA region, with the production of 50.04 million tons of sponge iron, has obtained 47.93% of the world's sponge iron. Last year, Russia produced 7.93 million tons of sponge iron. In two key points of the world, in other words, in India and Iran, there is a large increase in production. India's production of sponge iron has increased to 32.98 million tons, but in 2010, the country's sponge iron production was 23.4 million tons. 50% of India's sponge iron production is consumed in induction furnaces. Table (1) shows the production trend of sponge iron in India. In Venezuela, the amount of sponge iron production has decreased by 55,000 tons compared to 2019. Table (2) shows the trend of world sponge iron production during the years 2005-2020. 46.95 percent, equivalent to 49.02 million tons of sponge iron in the world, is produced by Islamic countries. In Algeria, a 2.5 million tons' unit was successfully launched by Algerian Qatari Steel Co. on 13/2/2021. The first hot charge

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of the company’s sponge iron took place in the electric arc furnace on 8/18/2021. A backup module for the production of sponge iron by the energiron method with a capacity of 0.25 million tons in Bolivia and a module of 2.5 million tons in Russia are currently being installed. In China, a sponge iron unit with a capacity of 300,000 tons per year is being built by the PERED method based on coke gas. In fact, in the next few years, the world’s sponge iron production capacity will increase by more than 11.4 million tons. The cumulative production of sponge iron by the Midrex method in 2020 exceeded the

limit of 1215.63 million tons. For the 38th consecutive year, the Midrex DRI process, with a production of 62.63 million tons (60% of total world production), topped the world’s main sponge iron production processes. During the previous year, the share of sponge iron production processes based on gas and coal was 75.6% and 24.4%, respectively. The cumulative production of sponge iron by various methods from 1970 to 2020 is estimated to be more than 1882.4 million tons. It is predicted that by 2030, the world’s sponge iron production capacity will exceed 200 million tons per year.



Fig. 1. Types of sponge iron products.

Table 1. Indian sponge iron production trend.

Year	MMT	Year	MMT	Year	MMT
2006	14.74	2013	17.77	2016	18.47
2007	19.06	2014	17.31	2017	22.34
2008	21.2	2015	17.68	2018	28.11
2009	22.03	2011	21.97	2019	36.8
2010	23.43	2012	20.05	2020	32.98

Table 2. World sponge iron production trend (million tons).

Year	Production	Year	Production
2005	56.87	2013	74.92
2006	59.7	2014	74.55
2007	67.12	2015	72.57
2008	67.95	2016	72.76
2009	64.33	2017	87.1
2010	70.28	2018	100.73
2011	73.21	2019	108.1
2012	73.14	2020	104.4

At present, the production growth of the Midrex process has been very high and another 70 million tonnes of sponge iron are expected to be produced this year. Last year, out of 89 Modrex installed modules, 79 modules with a capacity of 79.95 million tons were in operation. Currently, 13 Midrex sponge iron modules are under construction in Iran (12 million tons) and Algeria (2.5 million tons) with a total capacity of 12.5 million tons. Table (3) shows the sponge iron production units of Iran under construction. Figure (2) also shows the trend of increasing the production capacity of Midrex modules. Following the Midrex process, the coal-based rotary kiln process is in second place with a production of more than 25.47 million tons (24.4% of total world production). Production of the HYL ENERGIRON process is reported to be 12.95 million tons (12.4% of world total production). Last year, Iran's innovative process of producing sponge iron called PERED produced more than 3.55 million tons (2.9% of the world total production). In Iran, sponge iron units of Miyaneh, Baft, Shadegan and Neyriz companies produce sponge iron by the PERED method. The capacity of each of these modules is 800,000 tons per year. In the year before, 23 sponge iron modules were installed by HYL ENERGIRON, 18 modules with a capacity of 20.2 million tons, it is also in operation and the remaining 6 modules (4.36 million tons' capacity) have been stopped. Currently, 6 Midrex modules, 2 HYL modules and a PERED module are under construction worldwide. Figure (3) shows the share of different processes in the production of sponge iron in the world in 2020. Also, Figure (4) shows the contribution of different methods in the gas based sponge iron process of the world in 2020. Midrex share in the world's gas based

sponge iron process is 79.6%. Iran is the world's largest producer of gas-based sponge iron, producing 30.21 million tons. Iran's sponge iron production capacity last year was estimated at 36.375 million tons. In fact, the utilization rate of sponge iron production in Iran last year was 85.74%. Since the beginning of operation of Midrex units, the amount of production of sponge iron by Midrex method has been reported up to 1165 million tons. The production of sponge iron of Mobarakeh Steel Company is 7.249 million tons per year. The amount of sponge iron production of these companies in Hormozgan and Saba in 2020 has been reported 1.51 and 1.382 million tons, respectively. In fact, Mobarakeh Group Steel Company is the largest producer of sponge iron in the world with a production of 10 million tons. Mobarakeh Group's sponge iron production capacity is more than 11 million tons. The production of sponge iron of the Khuzestan Steel Company last year was 3.9 million tons. It is worth mentioning that the production of pellets of this company was recorded in the previous year to 5.761 million tons. Chadormelo Company has produced 1.602 million tons of sponge iron in 2020. Table (4) shows the companies producing Iranian sponge iron in 2020. Among the companies producing sponge iron in Iran, the highest production growth has been made with 108% of the Saba Steel Company at the rate of 799461 tons of hot briquettes. The production of Iranian sponge iron by PERED method in the previous year was recorded at 2.939 million tons. Table (5) shows the producers of Iranian sponge iron by the PERED method. The production capacity of sponge iron in Arab countries is 25 million tons. Last year, the production of sponge iron in Arab countries was 19.83 million.

Table 3. Iranian sponge iron production units under construction.

#	Company	Capacity (million tons)
1	Bootibaye Iranian	1.8
2	Torbat Heydariyeh Steel Complex	1.8
3	Bafgh Kasra Steel	1.7
4	Makran Steel Phase 1	1.6
5	Ghaenat Steel	0.8
6	Bafgh Mineral Iron & Steel Complex	0.8
7	Bafgh Steel Phase 2	0.8
8	Kordestan- Bijar Steel	0.8
9	Iran Ghatak	0.7
10	Kavand Nahan Zamin	0.5
11	Behnavar Kavir Steel Complex	0.5
12	Biseton Steel	0.2
Total		

The sponge iron production unit of Algerian-Qatar Steel Company dated 13 February 2021 has been put into

operation. Figure (5) shows the sponge iron production unit of Algerian-Qatar Steel Company.

Table 4. Iranian sponge iron producing companies in 2020.

#	Company	million tons	#	Company	million tons
1	Mobarakeh Steel	7.25	11	Neyriz Steel	0.784
2	Khouzestan Steel	4.88	12	Arafa	0.837
3	Keven Jonoub	1.713	13	Saba Steel	0.8
4	Chadermalou	1.6	14	Baft	0.79
5	Gol Gohar (Kowsar)	1.538	15	Sefid Dasht	0.744
6	Hormozgan Steel	1.52	16	Midco	0.743
7	Gol Gohar (Gohar)	1.48	17	Sabzevar	0.743
8	Saba Steel	1.38	18	Ghadir Iron & Steel	0.731
9	Khorasan Steel	1.16	19	Miyaneh Steel	0.72
10	Jahan Steel Sirjan	0.98	20	Shadegan	0.555

Table 5. Production of sponge iron by PERED method in Iran in 2020.

Company Name	Production (thousand tons)
Miyane	720
Baft	790
Neyriz	874
Shadegan	555

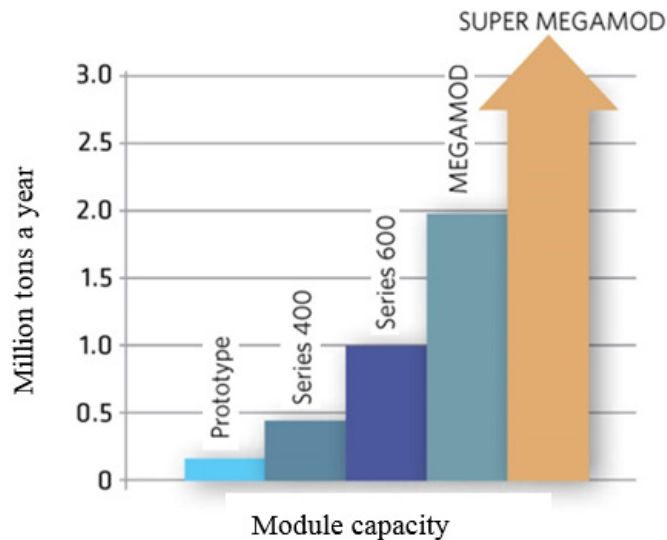


Fig. 2. The trend of increasing the production capacity of Midrex sponge iron modules.

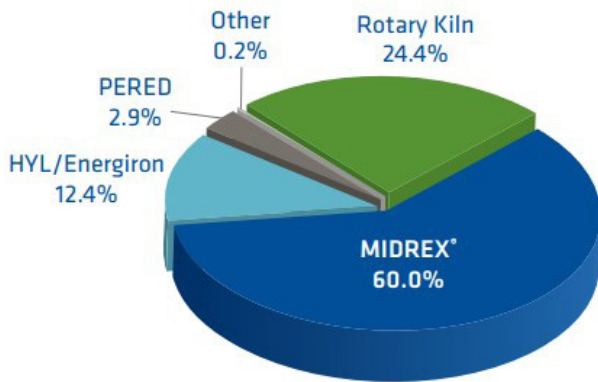


Fig. 3. The share of different processes in world sponge iron production in 2020.

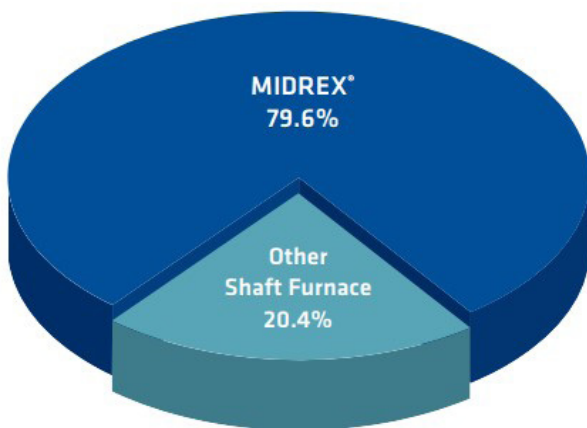


Fig. 4. The contribution of different methods in the world sponge iron base gas process in 2020.



Fig. 5. View of the sponge iron production unit of Algerian-Qatar Steel Company.

India is the world's largest producer of sponge iron with a production of 32.98 million tons. In 2020, India exported more than 550,000 tons of sponge iron. It is noteworthy that about 76.8% of the country's sponge iron is obtained from coal-based rotary kilns. Production of sponge iron coal-based rotary kilns in India has

declined due to iron ore shortages. In India, the production capacity of coal-based sponge iron in 2010 was 18.1 million tons. AM / NS (formerly ESSAR) India's sponge iron production last year was 4.54 million tonnes. Last year, the hot charge sponge iron of AM / NS (Arcelor-Mittal / Nippon Steel) in EAF's was 2.48 million tons. India's Tata Steel Co. sponge iron production last year was 797,000 tons. The company's sales of sponge iron last year were reported at 626,000 tons. Iran, with 30.21 million tons (2020, 31.19 million tons), has become the second largest producer of sponge iron in the world. Among them, the production of iron ore concentrates and pellets in Iran is estimated at 49.7 and 46 million tons, respectively. In Iran, from the beginning until now, a total of 284.5 million tons of sponge iron has been produced. In 2020, Iran exported 843 thousand tons of sponge iron. The consumption of Iranian sponge iron in the previous year was 30.346 million tons. Turkey imported 458,000 tons of sponge iron worth \$ 123 million last year. Venezuela's production of sponge iron was 0.46 million, making it the 19th largest producer of sponge iron in the world. The country's sponge iron production in 2005 was about 8.9 million tons. The production of sponge iron of the Russian OEMK company is close to 3.155 million tons. Russia's Metalloinvest sponge iron production is reported at 7.8 million tons. Figure (6) shows the production process of Metalloinvest sponge iron. Russia's Metalloinvest's sponge iron sales last year were reported at 4.428 million tonnes. The production of sponge iron of the Venezuelan company Sidor is also announced as 0.46 million tons. The company's Module No. 2C has been discontinued for the past two years. Argentina's production of Acindar sponge iron is reported to be more than 0.5 million tons. The company's cumulative production of sponge iron in the last 42 years is estimated at 32 million tons. The production of sponge iron modules 1 and 2 of DRIC Saudi Arabia was 1.09 million tons. Last year, the input charge percentage of Venezuela direct regeneration furnaces was made of lump iron ore. Last year, 68 percent of South Africa Saldanha's direct-charge furnace input came from lump iron ore. The production of sponge iron of the Egyptian company EZDK last year was reported to be about 649 thousand tons. Last year, the company loaded 25 percent of its lump iron ore due to a shortage of pellets. Bahrain-based SULB produced 1.38 million tonnes of sponge iron last year, of which 1 million tonnes were charged as HDRI in furnaces. The company has produced more than 10 million tons of sponge iron since 2013. Russia, Saudi Arabia and Mexico are ranked third to fifth in the world with 7.93, 5.19 and 5.17 million tons of sponge iron, respectively. In the European Union, Germany and Sweden produced 0.53 and 0.1 million tonnes of sponge iron, respectively. Table (6) shows the production of sponge iron in different countries of the world in 2020. Iran ranks first among Islamic countries and the Middle East and North Africa (MENA) in

the production of sponge iron. The five leading countries (India, Iran, Russia, Saudi Arabia and Mexico) produce 70.46% of the world's total sponge iron. In 2020, ArcelorMittal produced 5.3 million tonnes of sponge iron. ArcelorMittal has 12 sponge iron production units worldwide with a production capacity of 8.6 million tons. The United States imported 1.3 million tonnes of sponge iron from Trinidad and Tobago last year.

According to the plan, in the near future, Iran's sponge iron production capacity will increase by 6.15 million tons. The production of sponge iron in the UAE in 2020 was about 2.96 million tons. Oman is ranked in the world for the sixth consecutive year with the production of 1.73 million tons of sponge iron. According to reports, Oman-produced hot sponge iron is transported to neighboring companies through insulated bunkers on

trucks and charged in arc furnaces. Oman Shadid's EAF was completed at the end of 2013. Bahrain sponge iron production is estimated at 1.38 million tons. Qatar sponge iron production has been recorded at about 0.78 million tons. It is worth mentioning that all sponge iron in Qatar is produced by Qatar Steel Company. Qatar Steel Module No. 1 has produced more than 27.5 million tons of sponge iron since 1978.

More than 315 charcoal-based rotary kilns with a production capacity of more than 30 million tonnes of sponge iron are currently in operation in India. Conventional rotary kilns (coal) typically have a production capacity of 25,000 to 50,000 tons of sponge iron per year. Most sponge iron produced in India is used in induction furnaces. The production process of sponge iron in South Africa is also based on coal. Figure (6) shows the

Table 6. The amount of sponge iron production in different countries in the world in 2020.

Rank	Country	(MMT)	Rank	Country	(MMT)
1	India	32.98	12	Trinidad Tobago	1.5
2	Iran ★	30.21	13	Canada	1.2
3	Russia	7.93	14	Qatar	0.8
4	S. Arabia	5.19	15	Libya	0.8
5	Mexico	5.17	16	Malaysia	0.6
6	Egypt	4.8	17	Germany	0.5
7	US	3.5	18	Argentina	0.5
8	UAE	3	19	Venezuela	0.46
9	Algeria	2.2	20	S. Africa	0.2
10	Oman	1.8	21	Sweden	0.1
11	Bahrain	1.5		Total	104.4

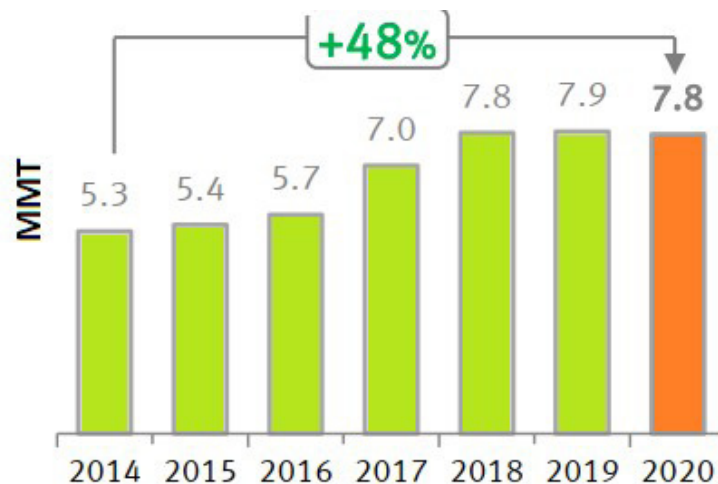


Fig. 6. Production process of sponge iron and hot briquettes of the Russian company Metalloinvest.

production of cold, hot and briquette sponge iron in the world separately. Last year, 11.38 million tons of hot sponge iron were charged in the world's arc furnaces. In other words, 10.9% of the sponge iron produced in the world is hot-charged in electric arc furnaces. In the near future in Iran, Pasargad and Chadormelo companies will start hot charging of sponge iron in electric arc furnaces. In 2020, the production of sponge iron and hot briquettes in the world has been recorded as 83.95 and 9.07 million tons, respectively (Figure 7). In 2020, 12.39 and 8.67 million tons of sponge iron and hot briquettes were exported to other parts of the world (21.06 million tons, respectively). World sponge iron exports by water and land were 14.2 and 6.86 million tons, respectively. The largest export of hot briquette sponge iron (HBI) was made by Russia (mostly by LGOK) at 3.8 million tons.

Trinidad and Tobago has exported 1.3 million tonnes of hot briquette sponge iron (HBI) to the United States. Exports of US hot briquette sponge iron (HBI) are also recorded at 1 million tons (50% of which to China). Figure (8) shows the trade flow (export) of sponge iron worldwide. As shown in the map, the origin of sponge iron products is exported to the United States, Russia and Venezuela to European countries, China and the United States. It should be noted that the total installed capacity of HBI worldwide is more than 30 million tons. In the Islamic Republic of Iran, Saba Persian Gulf Steel Company offers its sponge iron products in the form of hot briquettes. In the previous year, the three main importers of DRI / HBI in the world were 3.24, 1.4 and 0.9 million tons of China, USA and Italy, respectively.

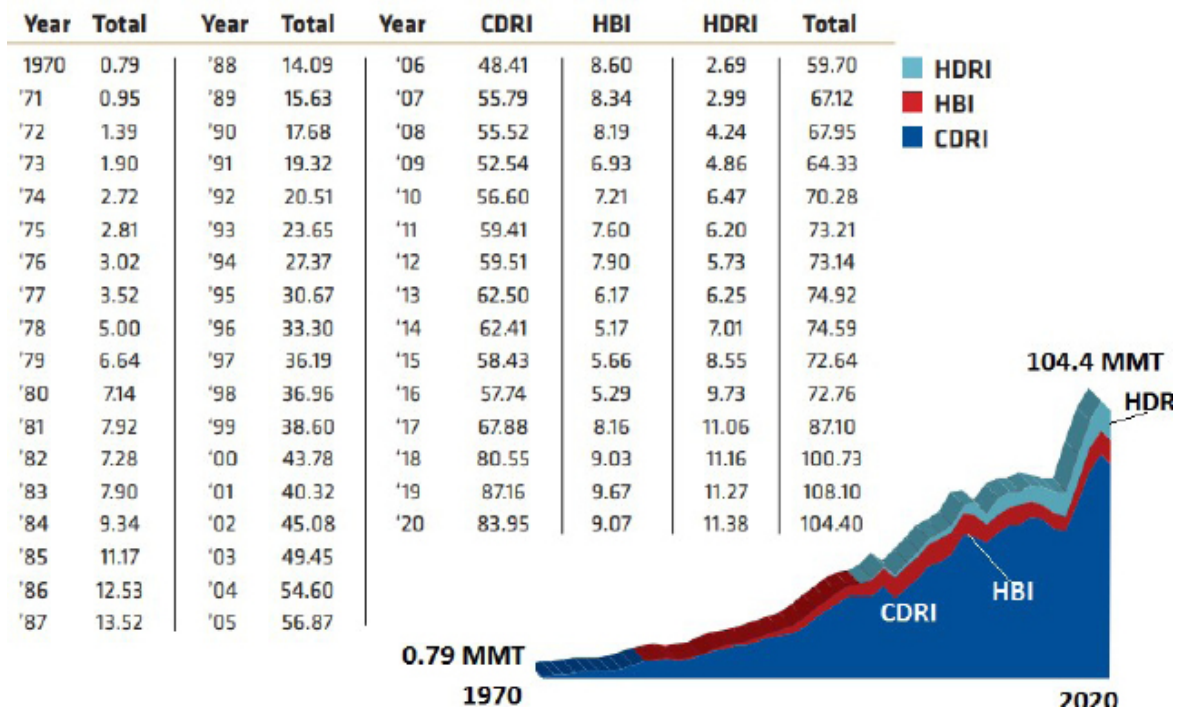


Fig. 7. Production process of cold, hot and briquette sponge iron.

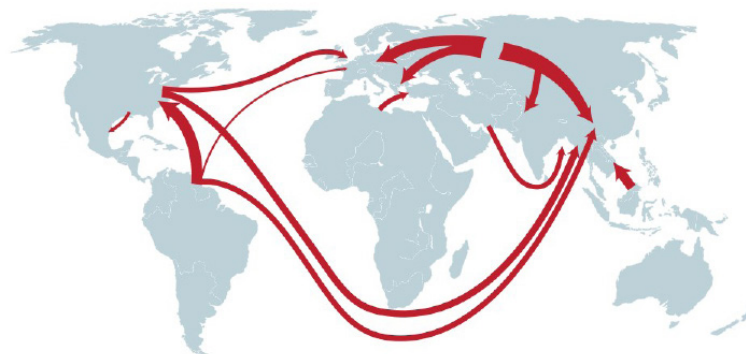


Fig. 8. Directions of global sponge iron and hot briquette exports in 2020.

Figure 9 also shows the trend of export of sponge iron (including hot bricks) through land (14.2 million tons) and water (6.86 million tons) to different parts of the world last year (total 06/0 21 million tons).

The world exported hot briquettes last year was 8.67 million tons. Figure (10) also shows the trend of global cold sponge iron and hot briquette exports. It is noteworthy that one third of the sponge iron produced in India is transferred to steel smelters located in 5-10 km of direct

reduction units.

The use of HDRI in electric arc furnaces reduces electricity consumption by 140 kWh per ton of steel compared to HBI (20 kWh per ton of steel per 100 ° C). Meanwhile, the consumption of graphite electrode and refractory arc furnaces are reduced by 0.55 and 1.9 kg / ton of molten steel, respectively. On the other hand, the efficiency of electric arc furnaces increases by 15-20%. Table (7) shows the increasing trend of hot sponge iron

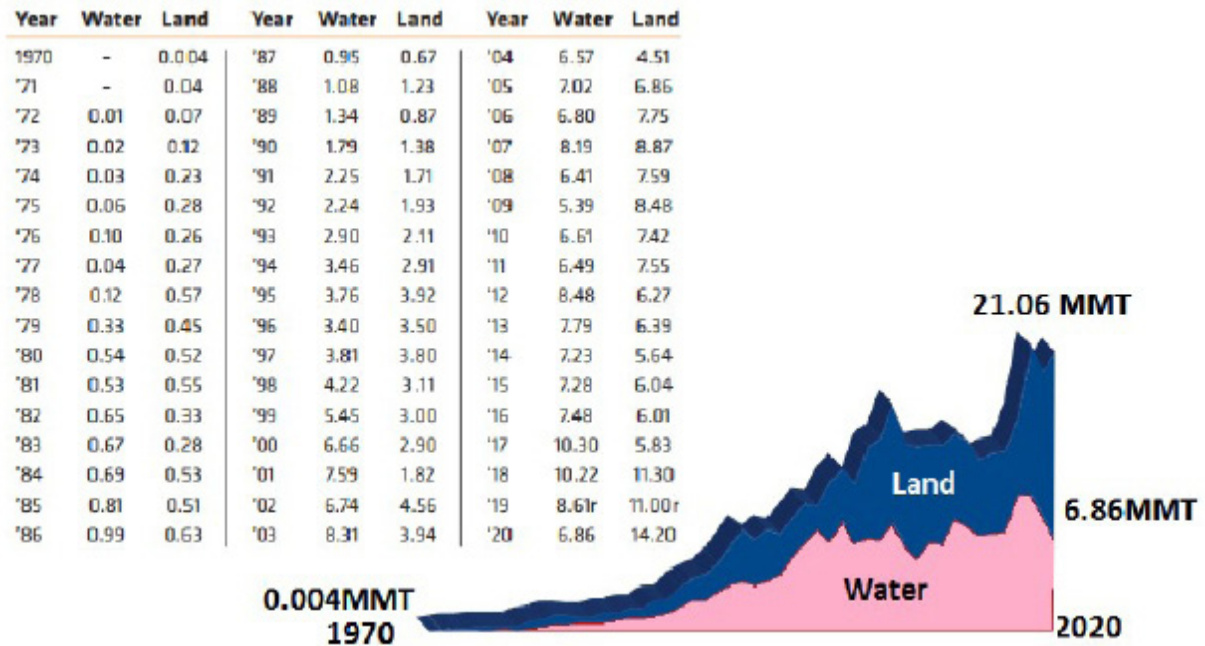


Fig. 9. Export trend of sponge iron through water and land (million tons).

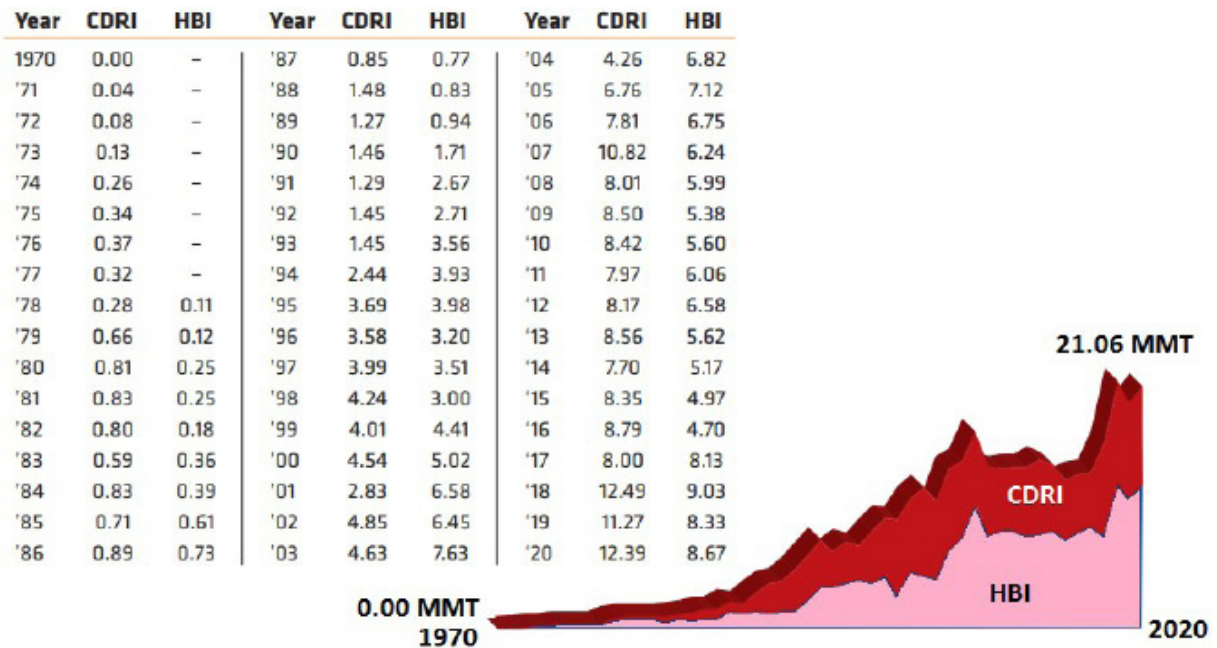


Fig. 10. The process of exporting cold sponge iron and hot briquettes of the world.

charge in electric arc furnaces of the world. India, Malaysia, Saudi Arabia, Mexico, UAE, Oman, Bahrain and Egypt all benefit from sponge iron hot charge technology in electric arc furnaces. The world's largest sponge iron module with a capacity of 2.5 million tons is being used by the company Tosyali Algeria. Tosyali's production of sponge iron in Algeria last year was reported to be 2.33 million tons. This production of sponge iron in a single module is a world record. The production of sponge iron of Jindal Oman Company has been registered at 1.73 million tons. In the previous year, 93% of the sponge iron produced by this company was loaded as hot charge of sponge iron in nearby steel mills. Pasargad Company has launched a hot charge of sponge iron in an electric arc furnace with a capacity of 1.8 million tons per year. Hot sponge iron charging unit in Iranian electric arc furnaces is to be built in Gol Gohar with a capacity of 1.8 million tons per year. On the other hand, Ardakan Steel Company

(Chadormelo Company) has launched a sponge iron unit with a capacity of 1.55 million tons by hot-charge method of sponge iron in an electric arc furnace. Considering that the share of sponge iron in ferrous materials of Iranian steelmakers is 85.9% (Table -8), the use of sponge iron hot charging technology in electric arc furnaces will save more than 25% of electrical energy. The share of sponge iron, steel scrap and hot metal in the steel materials of the world's steelmakers is 5.01, 63 and 31.99 percent, respectively (total weight of input iron bearing materials 2019 million tons). Therefore, the variety of input ferrous materials in steel mills in the world and Iran is completely different, and as a result, the amount of specific energy consumption of steel production in Iran is higher than the average specific energy consumption of steel production in the world. Table (9) shows the consumption of ferrous materials in the world steel industry.

Table .7. Charging trend of HDRI in arc furnaces of the world.

Year	Pro. MMT	Year	Pro. MMT
2003	1.83	2012	5.73
2004	2.43	2013	6.27
2005	2.6	2014	7.01
2006	2.69	2015	8.55
2007	2.99	2016	9.73
2008	4.24	2017	11.06
2009	4.86	2018	11.16
2010	6.47	2019	11.27
2011	6.22	2020	11.38

Table 8 The share of sponge iron in ferrous materials of Iranian steelmakers in 2020.

Input	MMT
DRI	29.37
Hot Metal	2.52
Scrap	2.3
Total	34.2

Table 9. Consumption of ferrous materials in world steelmaking in 2020.

Material	(MMT)	%
Hot Metal	1314	63
Scrap	664.4	31.99
DRI	104.4	5.01
Total	2082.8	100

Conclusions:

- In 2020, the production of sponge iron products in the world with a 3.4 percent reduction in production reached 104.4 million tons.
- India, Iran, Russia, Mexico and Saudi Arabia are the world's largest producers of sponge iron.
- Last year (2020), world production of sponge iron was 104.4 million tons. 11.38 million tonnes of hot iron (HDRI) are charged in arc furnaces.
- Mobarakeh Steel Company (Iran- Isfahan) is the world's largest producer of sponge iron with a pro-

duction of 7.25 million tons.

- The production process of Iranian sponge iron (PERED) is expanding.

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