

High-pressure briquetting of iron ore fines & sponge iron fines

Introduction –

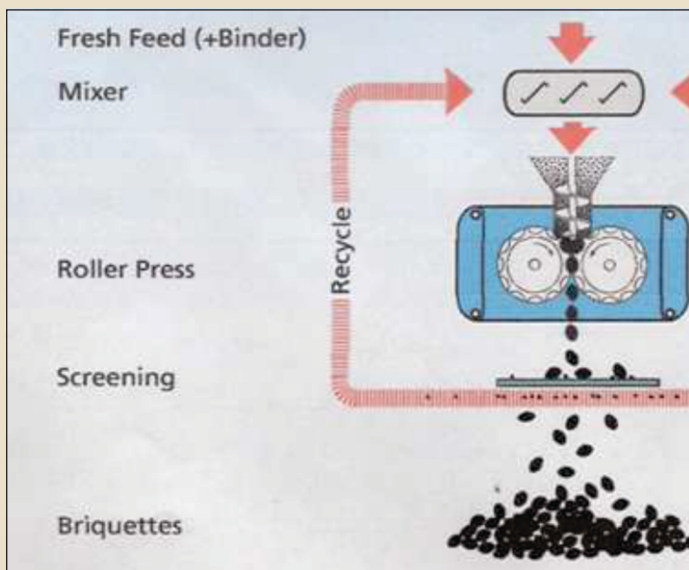
GoodRich MAGMA Industrial Technologies Limited is a public limited company based in Bangalore, providing technologies & equipments for industrial projects from China, Russia & Europe.

GoodRich offers a high-pressure briquetting plant from China, which is capable of briquetting both iron ore fines & sponge iron fines.

The roller briquetting press –

The term “briquetting” is defined as the compaction of loose agglomerates by the application of external pressure in a closed mould, with a view to producing high-strength, high-density pieces of equal size. The performance & price of the briquetting press is always related to its capacity to generate very high hydraulic pressures.

The high-pressure briquetting machine comprises of two rollers that have synchronous rotation in opposite direction - one is fixed roller and the other is pressure roller. Material is fed from the top of the rollers by a force feeder with conical screw & continuously delivered into the middle of the rollers at high pressure. After the material forms into compact briquette, it is discharged from the bottom, through an in-built conveyor.



Briquetting is an agglomeration process, similar to pelletizing or sintering, but without the need for thermal processing. More than 100 manufacturers provide briquetting equipments in China, which are however meant for agglomerating coal / limestone / other minerals for low-pressure applications.

Ultra high-pressure roller type hematite iron ore briquetting plant is available only from 2 manufacturers throughout the world - one from Germany & the other from a large and specialized company in China, which is 26 years old.

GoodRich has tied up for exclusive marketing with the Chinese company, which has already supplied more than 500 briquetting presses in China. The total pressing pressure can be up to 800 tons & the line pressure can be designed up to 21,000 kgs/cm. The plant capacities are from 25 tons to 600 tons per day.

With continuous research, testing & improvement since 1989, the briquetting technology from the Chinese manufacturer has reached the same level of international leader in this technology in terms of structure, performance, quality & service life. The manufacturer has also exported such machines to Belgium, Brazil, Indonesia, Iran, Romania & other countries.



A view of the manufacturer's factory



A view of the design office



Roller making in operation



Assembling the Rollers

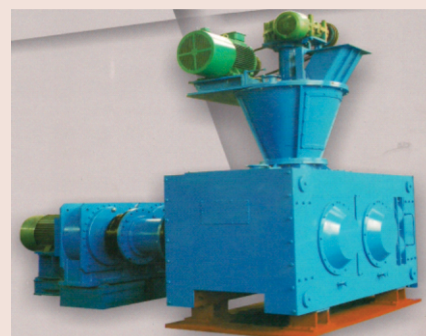
Roller briquetting was the first method found for agglomerating iron ore fines & was used widely until the 1930s. Briquetting still has several advantages over sintering & pelletising such as lower agglomeration temperatures, flexibility, lower waste, lower operating & capital costs and lower pollution.

The importance of briquetting is increasing again now. Between 2000 & 2010, at least 50 patents have been applied for iron ore briquetting all over the world.

The briquetting press can be used for iron ore, bauxite, dolomite, limestone, manganese, chromium, sponge iron etc. The roller skin of the briquetting press is made up of special bearing steel with 6,000 hours of ultra wear-resistant material. Completely sealed gearbox is used for the reducer, for low noise and for prevention of oil leakage.

GoodRich has installed a high-pressure briquetting press line for iron ore fines & two high-pressure briquetting lines for sponge iron fines / manganese ore fines / ferro alloy dust.

Photos of high-pressure briquetting press



Iron ore briquettes for rotary kiln / blast furnace applications



Manganese ore briquettes for submerged arc furnace



Briquettes from sponge iron fines with a density of 5 grams/cc

Models & capacities of the briquetting press lines -

Sl No.	Model	Roller width (mm)	Linear pressure between the rollers (kgs/cm)	Power (KW)	Plant capacity (tons per hour)		Standard sizes of briquettes (mm)		Weight of the equipment
					For sponge iron fines / manganese ore fines	For iron ore fines / ferro alloy dust	For sponge iron fines / manganese ore fines / ferro alloy dust	For iron ore fines	
1.	BP 520-150	196	8,000	80	2	1.4 - 1.6	32X25X14	20X12 or 32X25X14	12.5 tons
2.	BP 650-220	205	11,000	115	5	3.5 - 4	32X25X14	20X12 or 32X25X14	18.5 tons
3.	BP 800-380	350	11,000	251	10	7 - 8	38X26X16	20X12 or 32X25X14	37 tons
4.	BP 1000-500	600	10,000	358	16	11 - 13	46X34X19	20X12 or 32X25X14	56 tons
5.	BP 1200-800	900	8,000	607	30	21 - 25	46X34X19	20X12 or 32X25X14	105 tons

Note: The briquette size of 20 x 12 mm is suitable for 50 TPD and 100 TPD rotary kilns, for making sponge iron. The briquette size of 32 x 25 x 14 mm is suitable for 350 TPD and 500 TPD rotary kilns and also for blast furnaces.

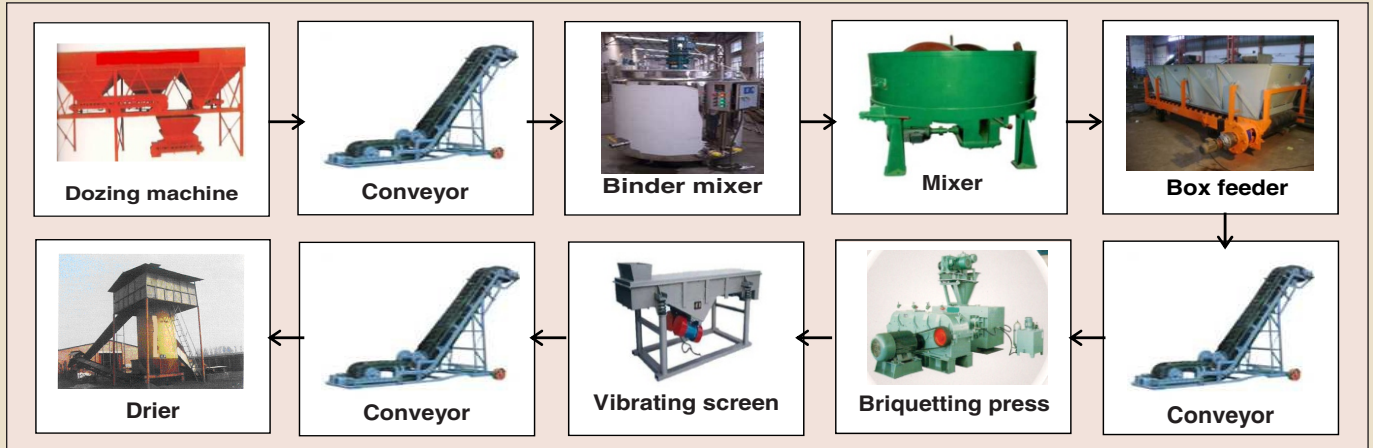
Description –

BP 520 - 150



IMPORTANT- The capacity of the briquetting press is in proportion to the roller dia, roller width & the briquette size. Strength of the briquette is related to the raw material fineness, binder technology & pressure. Performance & price of the briquetting press is related to its capacity to generate high pressures.

Process flow of briquetting -



Working principle -

During pressure screw feeding into the briquetting press, there is an external compacting of the material caused by reduction of the spaces between the particles. The particles themselves are compressed & deformed and a molecular bond is created between the particles. High pressure briquetting at the end of the process causes a transition from elastic deformation of the particles to plastic deformation, which strengthens the briquettes & enables them to retain a given shape.

Technical features of the briquetting press -

- 1) Good material squeezing effect & high strength of briquettes.
- 2) Good roller surface with a long service life, reaching the internationally leading level.
- 3) To improve the precision of the double-roller, fully enclosed transmission is provided & the reduction gear has dual-shaft structure. To minimize the size and to improve the service life of the gear box, all the gears are made as hard tooth-faced gears.
- 4) For single force feeder with conical screw, frequency converted, speed-control electro-motor is provided.
- 5) All consumable parts are easy for dis-assembly and replacement & are surface-welded by alloy steel to improve their service life.
- 6) Hydraulic system is separately given, which has a high reliability.

Applications of the briquetting press line -

Following are the three main applications of the briquetting press line -

- Iron ore briquetting, reaching a density up to 3 grams/cm³;
- Sponge iron fines briquetting, reaching a density up to 5 grams/cm³;
- Manganese ore fines / ferro alloy dust briquetting.

Briquetting of iron ore fines -

By using appropriate binder technology & by employing the right temperature for reduction, iron ore briquetting can replace pelletisation process at lower costs, with the following advantages-

- a) Iron ore fines of 0-2 mm size can be briquetted directly. Due to the coarser sizes of iron ore fines, voids are created inside the briquettes & the porosity becomes similar to pellets.
- b) The conversion cost of briquetting is Rs. 1,500 per ton, which is lower than pelletisation.
- c) Investment on the plant is also lower, i.e., 3.5 - 4 tons per hour iron ore briquetting plant needs an investment of Rs. 3 crores, while 7 - 8 tons per hour plant needs an investment of Rs. 5 crores.
- d) The same plant can be used for briquetting the sponge iron fines of 0-3 mm size; for manganese ore fines & for ferro alloy dust.
- e) The entire briquetting plant can be commissioned in 6 months' time.

Parameters for achieving high strength of briquettes -

Since the iron ore is not sintered at high temperatures in the briquetting process, following parameters contribute to the hardness of briquettes-

- a) Pressure at which the briquettes are formed – higher the pressure, higher is the strength;
- b) Particle size of the raw materials – the finer they are, the stronger they are;
- c) Binders used – binders contribute maximum to the hardness of the briquettes. A combination of binders including hot-setting & cold-setting; organic & inorganic are used. The requirement of binders is 4.5% at present, which can be reduced to 4% in future. After making briquettes, reduction in the total Fe will be 1.5% (for example, iron ore fines containing 60% Fe will have 58.5% Fe, after briquetting).

Note: The fines generation is around 20% after briquetting. These fines go back to the briquetting system & re-cycled. Fines are generated due to the gap between the rollers, where there is no cavity. Similarly, around 5% fines are generated in the drying process, which are re-cycled back, but need glue-mixing again.

Cost of production & profitability -

Reference cost of production & savings in 7 tons per hour iron ore briquetting plant (125 tons per day) is given below –

Cost per ton	
Iron ore fines of 62% Fe grade, in 0-2 mm size	Rs. 3,000
Cost of binders, power, labour & maintenance	Rs. 1,500
Interest & depreciation @ 30% on the total investment of Rs. 5 crores (production capacity is 37,500 tons per year)	Rs. 400
Total cost of production for 60.5 % Fe grade iron ore briquettes (Fe content will reduce by 1.5% after briquetting)	Rs. 4,900
Savings -	
Cost of pellets per ton	Rs. 7,000
Cost of briquettes per ton	Rs. 4,900
Effective cost of briquettes (1.10 tons of briquettes are needed to replace 1 ton of pellets)	Rs. 5,390
Savings per ton	Rs. 1,610
Output of briquettes per year in 125 tons per day plant	37,500 tons
Savings per year	Rs. 6 crores
Investment	Rs. 5 crores
Pay-back period	1 year

Briquetting of sponge iron fines -

Sponge iron has a strong tendency to spontaneously ignite due to its high porous structure, which needs passivation by way of briquetting to facilitate the storage, transportation & proper melting.

For briquetting the sponge iron fines of 0-3 mm size, usually the binder employed is 2% sodium silicate ($\text{Na}_2\text{O SiO}_2$) + hydrated lime (Ca(OH)_2) as hardening accelerator. Sodium silicate softens at temperatures of around 600°C & becomes fluid in the temperature range of 730-900°C. This behaviour is considered advantageous for melting the briquettes.

Sodium silicate is an effective binder which is inorganic, has high final strength, water & fire resistant, cost effective, ready to use, quick-setting & has enough green strength for handling in curing or in heat treating stages. When applied, the silicate solution dries to form a tough, tightly adhering inorganic bond, which is non-flammable, odourless & non-toxic.

For cold pressing, specific pressure in the range between 100-110 kN/cm (10,000-11,000 kg/cm) is required. It is also possible to make sponge iron into solid briquettes without the addition of binding agents by using very high pressures, provided the material is free from carbon. Free carbon which is normally present in the sponge iron fines acts as a lubricant & prevents the cold welding of individual sponge iron particles under pressure.

Sponge iron briquettes can be used in place of sponge iron fines for melting. With high density, they penetrate deeper into the induction furnace & melt completely. In the presence of adequate carbon in the melt, most of the FeO in the sponge iron briquettes will get converted into Fe.

Briquetting of sponge iron fines increases the melting capacity of induction furnace & reduces the dust and metal losses. They cannot be oxidised easily on the surface. Since the briquettes are dense, they are heavy & their melting rates are high.

Use of sponge iron briquettes in place of sponge iron fines will result in higher steel recovery, lower energy consumption, lower cost of melting, lower slag formation & higher lining life.

GoodRich has installed 2 briquetting press lines in India for sponge iron fines. By using a line pressure of 10,000 kg/cm, these briquettes have reached a density of 5 grams/cc.

GoodRich offers ultra high-pressure roller briquetting press line for sponge iron fines. The cost of briquetting is about Rs. 700 per ton & the entire investment can be recovered within a year.

Cost of production & profitability -

Reference cost of production & profitability in 5 tons per hour (90 tons per day) sponge iron briquetting plant is given below –

Cost of per ton	
Labour, power, binders & maintenance	Rs. 700
Interest & depreciation @ 30% on Rs. 2.50 crores of investment / 27,000 tons of production per year	Rs. 300
Conversion cost of making sponge iron briquettes per ton	Rs. 1,000
Notional value - addition per ton, after briquetting (price difference between lumps & fines, for the same metallic Fe content)	Rs. 2,000
Net profit margin per ton	Rs. 1,000
Production per day (based on average 18 hours of working)	90 tons
Production per year (based on 300 days of working)	27,000 tons
Profit margin per year	Rs. 2.70 crores
Estimated investment (without drier)	Rs.2.50 crores
Pay-back period	1 year



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