

# **A View of Merchant Coke in Shanxi Province of China**

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Production of Merchant Coke and Shanxi Province of China are connected by inexorable reasons. This paper presents an overview about them. I would like to participate in the discussion of the related question in greater detail at the first opportunity.

## **1. The place of coke in China**

The Act of Economizing in Energy Resources of PRC stipulates in Article Two that the Energy Resources stated in this Act are raw coal, crude oil, natural gas, electric power, coke, coal gas, heating power, oil products, liquefied petroleum gas, biological power and others which can be obtained useful energy resources directly or by processing and transforming.

Coke is hard, porous, silver grey, lump carbon material with cracks, which is produced by the way of heating bituminous coal to high temperature about 950-1050 degrees centigrade in air-isolated condition. According to uses coke falls into several kinds like metallurgical coke, gasifying coke, calcium carbide coke etc. Blast furnace coke, foundry

coke, ferroalloy coke and non-ferrous metal coke are generally called metallurgical Coke and among them above 90% of metallurgical coke is used to produce pig iron in blast furnace. So generally blast furnace coke is called metallurgical coke.

Metallurgical coke is most important kind of coke as raw material and fuel in iron/steel production where it supplies and provides: (1)heat to melt iron ore; (2)reducing agent to supplies reducing gas required in ore reduction; (3)loose grid to sustain the furnace burden column for ventilation; (4)carbonizing agent to carbonize pig iron.

The production of pig iron in China is mainly via the technology of blast furnace, the ratio of crude steel making via blast furnace/converter and electric arc furnace will remain in 75% and 25% for a long time to come. Coke is energy resources in special place and plays the strategic part in economic development of China.

The consumption of coke in iron-steel making of China in 2002 was approximate 110 million tons and among which the consumption of merchant coke accounted for nearly 35%.

## **2. Production of merchant coke in Shanxi Province**

### **2.1 Raw material**

Shanxi is the biggest area of merchant coke production in China. The output of merchant coke is more than 90% of the total in Shanxi Province.

Except integrated iron/steel works that are self-sufficient in coke, supply over 90% of merchant coke are dependent on plants in Shanxi.

The proved reserve of coal for coking according to “The Table of mineral reserve in Shanxi Province” is 145000 million t. which makes up 58% of the total proved reserve in China. Kinds of coal for coking such as rich coal, coking coal, one-third coking coal, meager coal and gas coal are available in varieties and in quantity as well. The reserve of Li Liu Coal Mine Area of Shanxi Hedong Coalfield not quantity but quality is as known according to the profession, as the rich oil reservoir of the Gulf Countries. It is in the preliminary stage to launch a large-scale exploitation on remote grounds.

The rest share 42% of proved reserve in China is scattered in more than ten provinces and the gas coal accounts for 80%, the rich coal and coking coal are less than 20%. It is difficult to produce coke products up to standard.

## 2.2 Production of merchant coke before the year 1999

Coal deposits are widely dispersed in nearly 40% of the territory of Shanxi Province, amount to 61.9 thousand square kilometers and cover 94 counties and cities. Most of them lies on shallow coal seam and is easy to mine. Greater part of raw coal has strong caking capacity.

Along with increase of the domestic and international demand for coke

products, primitive coking factories scattered all over like stars in the sky or men on a chessboard and small-size coalpit mines as well. According to the report of Shanxi Province Government and statistics by the Second Designing Institute of the Ministry of Chemical Industry the output of coke of Shanxi in 1995 was 52.79 million tons, there were 25 million tons more than in 1993 and 10 million tons more than in 1994. Over 85% of the output was yielded by primitive coking factories, 53.97 million tons in 1996, 54.49 million tons in 1997. It accounted to 40% of the total output of China. There are 2416 primitive coking factories in Shanxi in 1996, only in Luliang Prefecture there were 573 ones. Large-scale or middle-scale modern coking plants were less than 10 in Shanxi Province then. Coking industry occupy the important place as mainstay industry. According to one report of Lishi Government tax revenue levied from coking industry accounted for 57% of the total in this city. According to one report of Jiexiu Government the coking industry accounted for approximate 85% of the total output value in this city.

“Primitive” imply that (1) Non-machinery: Coking pits originated from 15<sup>th</sup> century (Ming Dynasty of China) like making charcoal by piling up continued to be used up to 1980s. Brick troughs in rectangle shape have been spread when entering 1990s, they were simply and crudely without tops at the outset, covered movably with refractory bricks or cast iron plate when coking. Later on ones like linked-caves were built up which

were called beehive ovens. Input coal charging, ramming, quenching, coke outputting, conveying etc. are done by hand inefficiently. (2) Non-recovery: All volatile matters can be recovered were burned up and expelled into air, have wasted energy and polluted the environment. (3) Inferior products: There were mainly two problems of quality, ash content and strength. Quite a few factories have charged the raw coal into ovens without washing and cleaning. The primitive factories cost 200kg-600kg of raw coal more than modern ones for each ton of coke product due to incineration of raw coal, so consumption of equal raw coal the ash content of coke produced by the former is higher and more uncertain than the latter. It is hard to imagine blending raw coal for coking under the scientific direction in primitive coke factory. In Fact not a few factories made use of single kind of raw coal in the neighborhood for coking, which has more volatile matter (35%-37%) although the caking property is better. The coke product was easy to crack under pressure. (4) Low yield: It is obvious. For example, each cave of beehive ovens had capacity of 50-70 tons. The coking period is 9 days -12 days. It needed about 15 days plus the time of inputting and outputting etc. for one action circle. The majority of factories had capacity of less than 30 caves of beehive ovens. A small number of factories had an annual capacity of more than 100,000 tons.

Misuse of precious energy resources and production without order, cheap

labour and low capital cost, undersell competition lead to attractive price. Some clients gained profit from combining coke products of beehive ovens with high grade ones. Leaving the negative influence aside, on the other hand the principle of the beehive ovens had advantage in quality of coke products, mainly in mechanical strength because the temperature goes up slower and sharp shrinkage of semi-coke is avoided which is just disadvantage of modern ovens, the coke products, foundry coke in especial were in bigger size and with few crackles and while the other factors, like volatile matters in raw coal must be moderate. Several beehive coke factories enjoyed high reputation then that paid attention to the preparedness of raw coal.

Before 1999 clients were concerned with cold strength M10 M40 in specifications. Afterwards the property of coke in high temperature, like reaction property, strength after reaction CRI & CSR has been demanded increasingly on account of increasing of PCI and decreasing of coke ratio in blast furnace. It is difficult to go over 900 degrees centigrade in the final coking temperature of beehive ovens which might impair the micro-strength inside the structure of coke products. Modern ovens have stronger point than beehive ovens in the side of high temperature strength of coke on the basis of temperature.

### 2.3 Production of merchant coke after the year 1999

Production by beehive ovens has been increasing year after year when entering 1990s and reached a peak in 1995. From 1996 beehive ovens have been banned by formal decree. It has produced very little effect. According to statistics of Trade Department of Shanxi Government the output of coke was 49 million tons till 1999, most of them was yielded by beehive ovens. A massive banning action was launched in 2002, especially on June 5<sup>th</sup> 2000 by compulsory means. The capacity of nearly 20 million tons by beehive ovens has been shut down by the end of the year 2000. Short supply of merchant coke has arisen which has produced an impact to the market of China even the market of world. But the promptness by profit has made some beehive ovens revival up to 2003 which has been banned unceasingly.

Upgrade in the structure of coking industry was demanded then. Restrictions imposed by current policy of Shanxi coking industry are that the cokemaking capacity in Shanxi is limited within 30-40 million tons.

From 1996 simply-equipped machinery non-recovery ovens with the chamber of carbonization under 3 meters or 2 meters have been being built which is called "little machinery ovens". The average capacity is less than 40 thousand tons annually for each factory. The little machinery ovens have also been banned but have yet not disappeared.

According to the regulations of government the advanced machinery recovery ovens with the chamber of carbonization over 3 meters or 4

meters have been being built from 2000 which is called “large machinery ovens”. Most of the “large machinery ovens” have been built depending on combined investment from loan, state-owned enterprise and private because of the shortage of fund.

Meanwhile reconstruction of the remoulded beehive ovens that is called “clean beehive ovens” is approved in the remote coking area where beehive ovens amassed.

“Remoulded” imply that (1) Machinery: To a certain extent operations of the beehive ovens are done by machines more efficiently. (2) Non-recovery: Gas and volatile matters are collected and burned up which is called twice combustion. Discharge into air is reduced. Waste heat is stored up and reused. (3) Better products: Desulphurizing, removing of ash and pre-ramming are thought highly in the preparedness and handling of raw coal. Owing to the nature of beehive ovens coke in bigger size can be obtained with better mechanical strength. But the volatile matters of coke products are still higher due to the principle of the beehive ovens. (4) Higher yield: A clean beehive oven plant is remade on the basis of integrating many beehive ovens. Machinery operation is more efficiently. Coking period is shortened owing to reuse of waste heat. Their capacity can amount to 200 thousand tons -500 thousand tons annually.

Another kind of machinery and non-recovery “clean beehive ovens”

similar to “ovens of upside down flame ” emerged with approval of the department concerned. All of gas is used to heat horizontal ovens.

The cost of clean beehive ovens is much less. It is taken into account as interim measures during the upgrade of the coking industry structure of Shanxi Province. The total capacity of clean beehive ovens is limited within 10 million tons-15 million tons.

“Advanced” imply that (1) Machinery: Operations are basically done by flow process. Essential machines are coal charging machine(car), coke pushing machine(car), coke blocking machine(car), coke quenching machine(car) that are called “Four big machines or Four big Cars”, preliminary gas condenser, mechanical clarifying tank of tar and ammonia liquor, electrical catcher of tar droplet etc. (2) Recovery: Most of large machinery oven plants are built in two stages. Generally operation of coke products and recovery of coal tar are designed in first stage, surplus gas is burned up and expelled. Recovery of sulphur, crude benzol and ammonia from gas and making use of surplus gas to generate electricity is considered in second stage. Minority of them processes coal tar, crude benzol, ammonia etc. or makes use of gas to produce methanol etc. (3) Products: the preparedness and handling of raw coal is done up to standardization of technological process basically. Most plants blend raw coal only according to industrial analysis and experience, few does it according to lithofacies theory, but the composition of coke can keep

more steady. High speed coking can fully utilize the caking capacity of raw coal. High temperature can reduce the volatile matters in coke products and improve the high temperature strength. But the top charging ovens make the coke products in middle size mainly for blast furnace due to the nature of ovens. A few plants have produced foundry coke products via pretreatment of ramming raw coal into a coal-cake. (4) Yield: The plants that have capacity of annual 400 thousand tons-800 thousand tons account to approximate 80%. Several plants can yield one million tons annually. Several plants with capacity of annual 1.5 million tons-2 million tons are in construction by stages.

In the side of equipment most of Shanxi large machinery oven plants has a long way to go compared with foreign modern by-product recovery coke plants as the capacity of each oven as well.

According to statistics the total merchant cokemaking capacity of large machinery oven plants is more than 25 million tons by the end of 2002. Some demand more than 20 million tons in the market is supplied by clean beehive oven factories, little machinery oven factories or by primitive beehive ovens factories.

It is estimated that new large machinery oven plants of more than 10 million tons are in construction or design. It is worried that the random and unchecked construction, survival of beehive ovens and little machinery ovens will result in disorderly competition. The approved

plants will be limited to 50 or so according to the programme. The government has been being given attention to the problem and taken measures.

### **3. Supply and demand of merchant coke in Shanxi**

If the general trend of supply and demand of coke inclines to a decline the heart of balance is the matter of supply. Demand is subject to the market. This is an invisible hand. It is hard for us to answer exactly how much or how quickly the demand will change during a period. Supply may be dominated artificially. This is a visible hand. We can see the result within several months.

There are three markets for merchant coke of Shanxi, the market within the Province, other provinces of domestic market and foreign market. The output of pig iron in Shanxi is less than 10% of the total in China. Other provinces of domestic market occupy first place. An increase of output of crude steel has kept up in China. It is forecast that the pig iron capacity will increase by 17.5 million tons to satisfy the growth of steelmaking in 2003. The demand of metallurgical coke needs to increase by 6.52 million tons. Due to the short supply from Shanxi and inadequate transport capacity the voice of building coke plant in main producing area of pig iron and importing coking coal from Australia has risen. For example in the encouraged industries by foreign investment of Chengdu City the

coking industry ranks first in Act.

China has maintained 11%-13% of total output for export in recent years.

More than 75% has come from merchant coke of Shanxi.

Foreign market is influenced by three factors: the price of domestic market, export license and qualifications of plants for export.

Coefficient of comparative prices between foreign market and domestic market is 0.8 in 2002. Price difference has made more coke products put into domestic market. From May 2002 the price of foreign market has been forced going up continually and even so the demand of more than one million tons has not been satisfied. Exporters have been perplexed because plants have broken their promises of supply now and then. Negative influences have caught wide attentions. It is worried that the serious disequilibrium of supply and demand will make the comparative dominant position in foreign market impaired.

Export license and qualifications of plants for export are administrative means to an end of adjusting the proportion of export for the domestic market, remaining the price and quality stable and stopping excessive production etc. Export license and qualifications of plants for export incline to confer on big company or has strings attached. The opening and freedom of the market may be restricted to a certain extent.

It is forecast that the output of merchant coke in Shanxi will come up to

new level within two years and so will the output of raw coal by approved coal mines. The relative stable situation between supply and demand will be maintained under the power of artificiality and spontaneity.