HOW TO MAKE COKE AT ACME STEEL COMPANY

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Coal is made-up principally of the remains of vegetable matter which has been partially decomposed in the absence of air. It is mostly a complex mixture of organic compounds, and contains some inorganic compounds as well. When heated to high temperatures, in the absence of air, the complex organic molecules break down to yield gases, liquids, and carbonaceous residue (coke). Metallurgical coke, therefore, is the residue from the destructive distillation of the carefully blended coals in order to obtain certain desirable physical properties. Structurally, it is a cellular, porous substance.

Delay petroleum coke is one of the cheapest carbon sources in the States, and is the end product in the oil refining business. Through fractional distillation, jet fuel, gasoline, heating oil, lubrication oil --- were separated from crude oil. The leftover from this process is called residue. This residue is either (1) hydro-treated and cracked down again and again to extract more salable hydrocarbon products until it becomes uneconomical to continue this process. Then send it (Petroleum Pitch) to delay coker, or (2) fed directly the crude residue to delay coker. More low-boiling point hydrocarbons, as well as petroleum coke, were generated there. Petroleum coke has been used in cokemaking by various steel mills, but few were successful.

Metallurgical coke used in the Blast Furnace serves two main functions: (1) as a fuel to supply energy and provide reducing gases for the reduction of oxides of iron, manganese, silicon, etc., and (2) provide permeability and support for the burden. Usually, it is not hard for coke to fulfill the first requirement. However, the second requirement requires the coke to maintain certain size until ready for combustion. Generally, coke in the Blast Furnace is degraded by mechanical forces, alkali attack, and CO_2 attack. Mechanical degradation is due to the abrasion and compression. CO_2 attack on coke is the result of solution loss reaction which is expressed by the following reaction:

$$C + CO_2 \longrightarrow 2CO$$

In other words, usable and expensive coke after reacting with CO_2 is lost into top gas. Alkali can be absorbed by certain carbon forms as an intercolation compound and speeds up the gasification reaction, thus breaking up the coke structure.

Coal melts and undergoes nucleation process between 400°C and 500°C. The oxygen containing side chain tends to be nucleus during crystallization. The lower the oxygen content and the higher the fluidity, the larger is the grain size in coke structure. When the grain becomes too large, it turns into flow type carbon form. Large size carbon form is usually more vulnerable to alkali attack.

Various coals, as well as petroleum coke, display differently underneath the microscope. Each kind of coal, or petroleum coke, usaully produces a unique coke structure. Using this character, steel mills have no problem in doing quality control --- knowing ahead of time, the raw materials putting in and coke supposed to be pushed out. Oxidation of coal is a big problem. After coal gets oxidized, the oxidation film never melts and only binds poorly with its surrounding. Degree of oxidation can be checked before hand chemically. Too much oxygen during cokemaking also reduces the tar yield which is considered to be a kind of by-product. The cost effect of ash content, sulfur content, moisture content, and the predicted coke strength can be computed through computer programming. Mechanical strength, as well as other physical properties, behaves and can be evaluated the same way as other materials.

Acme's furnace coke normally contains four main carbon forms; namely, isotropic, mosaic, flow type and pet-coke type. It is well-known that "Flow-type gives the strength and mosaic supplies the binding". Their characters are as follows:

	Mechanical Damage	CO_2 Attack	Alkali Attack
Istropic	Weak	Weak	Strong
Mosaic	Medium	Strong	Medium
Flow-type	Strong	Medium	Weak
Pet-coke	Weak	Weak	Weak

In one word, to make cheap and sound coke needs the knowledge of both chemistry and material science. Lots of basic principles in chemistry and material science used elsewhere can be adopted here easily. Cokemaking is one of the oldest industrial techniques developed by human beings, however, very few research has been done, especially in the United States. The operation of a coke plant is still, mostly, in the hands of geologists who know very little about chemistry and material science.

Acme Steel Company (former Interlake, Inc.), due to the impact of foreign competition, decided to do more research and quality control work in coke in order to survive. A coal/coke laboratory was set-up during 1979. Stringent quality control and unprecedented cost cutting, which other steel mills still do not know, is the key word in Acme's successful cokemaking. This effort helped Acme Steel Company to become the most financial stable steel operation in the United States. The coke made at Acme now has the best quality and lowest cost in the States.

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