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I. Introductory Statement.

Coal in the ground is one of the rather few natural resources which Japan has in reasonably ample amount. Although most of the Japanese coal is geologically young, many of the deposits have been subjected to so much underground heating that unusually rapid transformation has occurred. Thus Japan has almost all grades of carbonaceous minerals from peat, through lignite, subbituminous, non-coking bituminous and coking bituminous coals to anthracite and "natural coke", except that there is practically no low volatile coking coal, no low ash medium volatile coking coal, and only a very limited amount of high ash medium volatile coking coal. Also, Japan has no known large deposits of unusually cheaply available coal in very thick beds with relatively shallow cover such as the Fushun coal of Manchuria, some of the brown coal deposits of Germany and certain subbituminous coal deposits of India and of Montana, U.S.A.

The industrialization of Japan and its standard of living are such that coal consumption—and production—per capita is far greater than that of any other oriental country (although less than one fifth that of the United States after allowing for Japan's proportionately greater use of water power).

Also, Japan is so industrialized that its coke plants use more than one sixth as much coal as Japan produces, which is a larger proportion than that of many of the more industrialized countries. This relatively large coke consumption is due not only to the very considerable production of pig iron but, also, to the unusually large production of synthetic nitrogenous fertilizers, coke being an important raw material for both ammonia and cyanamid. Thus, for instance, in June 1951, Japanese coke plants used about 551,000 tons Japanese coal plus about 136,500 tons imported coal, anthracite and petroleum coke, —and Japanese mines produced about 3,700,000 tons of all kinds of coal. So the coke industry used Japanese coal amounting to about 14½% of total Japanese coal production, but the total coal used by the coke industry amounted to nearly 18% of total Japanese production, since the imported material for coke amounted to about 34% of the coal production or about 19½% of total requirements for coke.

Coal was decontrolled in September 1949, thus restoring the principle of free competition for the first time since 1937. Thus most of the younger men in the coal company organizations had had no previous experience with the competitive system. Nevertheless the coal industry has shown very healthy growth in the two years since decontrol, the production schedule having increased nearly 20% to 45,000,000 tons per year, and
employment having decreased by about 73,000 employees, or 15\%\%, to about 390,000 employees—so that the production per employee has increased by nearly 40\%. (During the 18 months from Sept. 30, 1949—shortly after decontrol to Mar. 31, 1951— the end of the last fiscal year.—coal consumption exceeded production by about 4,200,000 tons or about 7\% of production, stocks being depleted accordingly. In 1941, the record production of 55,600,000 tons was obtained with fewer “wage earners” than are now employed—but the “wage earners” worked more hours per week, and perhaps produced no more coal per working hour than at present.)

Perhaps the outstanding achievement of the two years since decontrol is the improvement in the quality of coal—especially the production at a number of mines of much lower ash coal than formerly for the coke industry. This has resulted in decreased ash in the coke in spite of some decrease in the proportion of low ash American coal used.

II. Urgent Problems.

The Japanese coal, coke and related industries now have the following three principal obvious and urgent problems:

1. The first problem is the need for more coal production. This need threatens damage to the coke and gas businesses and to various other important industries (including electric power generation) whose coal requirements since the beginning of the Korean war have increased much more rapidly, percentage-wise, than the increasing production of coal. Stocks are abnormally low. The official production schedule requires substantial increase of production for October-March (the last half of the Japanese fiscal year). And even if the scheduled increases are realized, various industries now seem likely to be damaged within a few months by having to slow down for lack of coal or by having to pay abnormally high prices for it. (The relative shortage has already permitted some Japanese coal prices to approach the prices of imported coal of the same heat value. Nevertheless, coal prices have not increased in nearly as great proportion as the prices of some other commodities. Thus, some other prices may drop considerably while coal prices may be maintained, or even increased in some instances.) This present situation may perhaps be relieved, of course, by means of one or more of the following:

a. Decreased demand, perhaps because of high prices or changes in the general business situation. But it is hoped that any such decrease may be only temporary, since the general trend is for an expanding economy in Japan.

b. Increased imports of coal—especially if the international situation can be prevented from developing in such a way as to impair ocean shipping by seriously increasing its cost or decreasing its availability.

c. Increased production of coal due to (1) increased labor productivity, perhaps including more overtime, (2) development of additional working places in the coal seams, and (3) further modernization of mines and equipment. (The last two require time.)

2. The second of these problems is the high cost of mining and distributing coal and the resultant high cost of rail transportation and of coke, pig iron, nitrogenous fertilizers and numerous other important commodities which are greatly dependent on solid fuels. One of the weakest features in the competitive position of Japan's
heavy industries in comparison with other industrialized countries is the high cost of Japanese coal. Although labor cost is a larger proportion of total cost in coal mining than in almost any other business, and although American coal miners are paid more than ten times as much per hour as Japanese coal miners, Japanese coal cost about twice as much at the mines as American coal. Also, Japanese distribution and transportation costs compare very unfavorably with such costs in the United States. It is hoped that this high cost burden on Japanese business will be considerably relieved by better utilization of both labor and capital in coal mining—which subjects will be discussed hereinafter.

3. The third principal problem pertains to materials for making strong metallurgical coke. For this, even more costly materials must be added to the costly Japanese high volatile coking coals. Such additives include certain Hokusho coals, semi-coke, anthracite, various imported coals, etc. Most of these materials are high in ash and/or have only limited or non-dependable availability. The imported materials, of course, require foreign exchange which is usually scarce. For instance, in June 1951, about 135,000 tons of imported materials were used for this purpose at a cost in foreign money equivalent to $3,600,000 (¥1,296,000,000). This problem will be discussed more fully hereinafter.

III. Economic Dependence of Japanese Coal and Coke Industries on Abnormal International Conditions and/or Shortage of Foreign Funds.

If international relations were normal and trade were entirely free from artificial restrictions and all foreign exchange rates were free to reach their natural levels, and if Japan were able to maintain a balance between exports and imports while importing any required raw materials which can be delivered in Japan at prices below Japanese costs, then nearly all Japanese production of coal for the railroad, steam, gas producer or general purpose markets would be discontinued because certain foreign sources, including the Fushun operations in Manchuria, could produce coal for these purposes which could be delivered below the costs at nearly all Japanese mines. Also, nearly all Japanese pig iron production would be discontinued because the United States (inter alia) could deliver pig iron in Japan below the local cost—providing that American capacity were not loaded up with a very abnormal defense program. (Perhaps a very limited amount of pig iron could still be made economically in Japan using pyrite cinder or other cheap local raw material.) Of course such extreme curtailment of pig iron production would eliminate about half of the coke production, but the gas plants might perhaps continue to make coke for foundry and miscellaneous uses and for making fertilizer constituents (especially synthetic ammonia), without much change. This might leave only a few of the good high volatile Japanese coking coal mines, and perhaps a very few other coal producers, in an economically justifiable position—and it is possible that even these might be unable to compete with good coking coal from north east Manchuria or from Sakhalin, especially if the cost of ocean transportation can be decreased in accordance with obvious possibilities.

Of course normally, Japan has to export at world prices in order to have essential imports of food, etc; and the foregoing is based on the assumption that Japan can develop enough export business in commodities which she can produce competitively,
so as to be able to pay for importing all her requirement of essential imports and of other commodities such as pig iron and coal (and perhaps basic foods) which can be produced much more cheaply elsewhere. That this has been impossible in the past is shown by the fact that although Japan controlled Manchuria for several years before the "China Incident" of 1935, and although some cheap coal in China was also available at various times—in not one of the last twenty-one years (at least) has the tonnage of coal imported into Japan exceeded about 13\% of Japanese coal production. (Currently, imported coal is about 3\% of Japanese coal consumption.) Nevertheless, Japan's international situation has been abnormal for at least the last sixteen years and, for both patriotic and business reasons, the Japanese coal industry should make vigorous efforts to prepare for severe future competition so that the coal and iron industries can continue through normal times, and so be available if foreign supplies should again be inadequate. Of course if any important industry ceases to be economically justifiable, there may be sociological and political reasons for continuing it temporarily on an artificial basis in order to maintain employment. When this is done except as a temporary expedient (or for too long a time), the cure sometimes becomes worse than the disease because the tendency is to keep costs and prices up and retard the improvement in the purchasing power and standard of living of the public. The ideal plan, of course, is to distribute labor between various industries in such a way as to produce the most wealth per man, and thus to develop the maximum possible markets and maximum employment and maximum public purchasing power (including the productivity and purchasing power of labor) but such a program takes time. At all times, however, there is no substitute for low production costs.

IV. Coal Costs.

There are, of course, three main aspects to the coal cost problem—geological factors, labor utilization, and capital utilization.

1. Geological reasons for high cost of coal. Many Japanese mines work two or more coal seams at once so that at the lower levels great care must be used to avoid subsidence and breaking of the upper coal beds. An unusually large proportion of the Japanese mines have one or more of the following adverse conditions: weak roof, thin seams of coal, numerous "partings" or layers of rock or "bone" in the coal beds, numerous faults, faults with unusual displacement, steeply tilted coal seams, unusually large amounts of water to be pumped per ton of coal, etc. One reason for such difficult average mining conditions is the fact that, due to the former use of extremely cheap forced labor (sometimes as cheap as, or cheaper than, slave labor) a number of mines were developed which had such adverse conditions that they would be considered definitely sub-marginal or non-commercial in countries with normal labor conditions. Thus, it is probable that future mine development in Japan will be in more easily workable coal than many of the old mines. Nevertheless the Japanese will probably always have to handle an unusual amount of rock and "bone coal" per ton of good coal in certain districts, and many of the mines will never be able to use the larger and heavier types of mining machinery to advantage. On the other hand, there are some localities where mining conditions are reasonably good and
costs are relatively low.

2. Labor Utilization. Coal produced per wage earner at American mines averages about as many tons in 16 working days as the Japanese coal production per wage earner in the entire year 1950. American working days per year are such that the output per wage earner per year averages about 13\(\frac{1}{2}\) times as much as in Japan in 1950. Japanese coal mining labor productivity and coal production have varied greatly and are now increasing as shown in the following:

<table>
<thead>
<tr>
<th>Year</th>
<th>Monthly average coal production (thousands of tons)</th>
<th>Average tons coal produced per month per wage earner</th>
<th>Rough estimate of hours per month per wage earner</th>
<th>Rough estimate of tons coal produced per hour per wage earner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1933</td>
<td>2710</td>
<td>18.9</td>
<td>336</td>
<td>0.056</td>
</tr>
<tr>
<td>1941</td>
<td>4634</td>
<td>13.5</td>
<td>336</td>
<td>0.040</td>
</tr>
<tr>
<td>1943</td>
<td>4628</td>
<td>12.5</td>
<td>364</td>
<td>0.034</td>
</tr>
<tr>
<td>1946</td>
<td>1698</td>
<td>5.4</td>
<td>208</td>
<td>0.026</td>
</tr>
<tr>
<td>1948</td>
<td>2822</td>
<td>6.1</td>
<td>221</td>
<td>0.028</td>
</tr>
<tr>
<td>1950</td>
<td>3205</td>
<td>8.6</td>
<td>234</td>
<td>0.037</td>
</tr>
<tr>
<td>Mar.</td>
<td>3835</td>
<td>11.0</td>
<td>234</td>
<td>0.047</td>
</tr>
</tbody>
</table>

The largest output per man-hour on record was in the depression year 1933. The largest total production on record was in 1941. Labor productivity per hour was lower in 1943 than in 1941 due to more use of forced Korean labor with many hours per man per month. In view of the better quality of coal now produced, the most recent labor efficiency apparently compares favorably with that of 1941, but there is considerable possibility of error in estimates of working time. The outstanding reason for the comparatively low output per month per man now is the comparatively small number of hours worked. In many places, the official eight hour shift means only about five hours work, since travel time from mine portal to working place and back is included in the eight hours. Until facilities can be provided for better transportation of men inside of the mine, a moderate increase of portal to portal time, with the usual higher wage rate for overtime, at some places is (1) making the jobs more attractive to the men, (2) increasing coal production, and (3) diluting fixed cost items and so decreasing total cost per ton.

Of course it is obvious that present wages in all industries throughout Japan, as compared with pre-war wages, (and the present standard of living in Japan as compared with other parts of the Orient) cannot continue under normal international conditions unless the output of Japanese labor per worker is much greater than before the war. Other countries pay more than the Japanese wage rates, and have much lower costs per ton of coal because the greater output per man much more than offsets the higher wages.

Of course there are two extreme ways to get very high labor productivity. One method is to force defenseless workers to long hard tasks, primarily by fear of punishment. (This is said to be used in U.S.S.R. with certain workers who are suspected of wrong politics.) In some countries it is possible for this method to be harsher and more effective than slavery because loss of a job might mean starvation and the employer has no investment in the worker,—while the intelligent slave owner would take good care of his human property. The other extreme method for obtaining very high labor productivity is to apply the best engineering designs to all production facilities, installing even more than the most economical amount of labor-saving
devices, and to pay the workers a very large proportion of the gross earnings of such
equipment. This method also can be carried to absurd extremes, resulting in exces-
sively complicated and costly equipment and permitting too small a proportion of the
gross earnings of the property to go to the public through price reduction for expand-
ing the market—or to the owners to promote further capital investment to maintain
progress and avoid obsolescence. Of course neither Japan nor America has used either
of these methods in the most extreme form. The present tendency in both countries is
to approach the latter method, many American coal mining companies having been
moving in this direction for a longer time, and with more money, the most Japanese
companies. This trend not only promotes, but is promoted by, increased wage rates.

One of the principal difficulties in Japanese coal mine labor utilizations is due to
the fact that the present system for labor-management relations is still very new
both in objective and in the way it functions, the American occupation having very
suddenly forced changes in these matters in Japan, such as would normally require
many years of gradual evolution. This was necessary, not only to take the country
out of the control of those who were more nearly responsible for the war, and to
democratize the country in accordance with the principle that the government exists
primarily for the sake of all the people, but also to decrease the long-range danger
of communism. There are two ways to stop the spread of communism. One way is
to shoot part of the communists and treat the rest of them as criminals. The other
way is to make sure, so far as practical, that no one takes unfair advantage of the
poorer people. Although the first method may be temporarily effective, the second
method obviously is necessary for permanent results. Many people think that the
Chinese experience proves this. Although the record of feudalistic and paternalistic
Japan is much better than that of China in regard to the status of the poorer people,
the world-wide trend toward betterment of the poorer classes (either by fair treatment
or by the delusion and false hope of communism) is so strong as to amply justify
the drastic changes made by the American occupation, both in agricultural land
reform and in industrial unionization. Some thoughtful observers believe that there
is still a strong communist element in Japan and that, after the withdrawal of
American influence from the Japan government, some of the short-sighted employers
may take undue advantage of the financially weak unions and their members, and
thus add very seriously to the threat of communism. The fact remains, however,
that the present system of union-management relations in Japan is so young that, in
too many places, a good businesslike spirit of mutual confidence and friendly cooperati-
on has not yet been developed. The lack of it, of course, hurts both sides. Although
the American experience with coal labor-management relations has been very bad
in some respects, there is one feature of the American coal union policy without
which the American coal business would perhaps have had the same fate as the
British coal industry, and America would not be shipping coal to Europe today. This
feature is the union's policy of encouraging mechanization to increase labor productiv-
ity per man, and so accepting the decrease of the number of miners employed—pro-
viding that a considerable part of the resultant saving is put into increased wage
rates. The union prefers to have some men retire or get other jobs, and have the
remaining workers live well, rather than to encourage what a Japanese Economic
Stabilization Board report calls "hidden unemployment," and to maintain a needlessly large number of men in a condition of poverty. This principle of encouraging low labor cost and high wage rates at the same time is one of the secrets of American prosperity and industrial strength—and it is largely a matter of labor-management policy. There is an instance in Japan, where the same kind of a coke car tilter, to save labor in unloading coke, was installed by two chemical companies, and then one company did not get the full benefit but had more than twice as many men as the other to do the same work with the same equipment. The company with the efficient unloading had recently built an additional new plant, and it had obtained all necessary labor for this expansion merely by improving the labor efficiency of the old plant. The ability to provide jobs for non-essential workers was a great help in the efficiency program.

One reason for the large amount of “hidden unemployment”, or non-essential labor, in Japanese coal mining is the fact that, after the end of the war, the heavy industries in Japan were required to increase employment beyond their requirements in order to help absorb the very large number of repatriates and former soldiers. This was made possible by government control of prices and marketing and, especially, by subsidies which, in effect, used tax money to make it possible for employers to pay unearned wages and to continue other uneconomical practices. These subsidies were sometimes very large. For instance, even after coal mining subsidies had been discontinued and the marketing of coal had been decontrolled, the producer's price of pig iron was about twice the consumer's price, the difference being paid by government. And so such a fundamental raw material business as pig iron production was about 50% business and 50% sociology and politics. Since taxes add to all costs and therefore to all prices, and therefore greatly burden the entire recovery, nearly all subsidies have now been eliminated, although an extremely serious amount of hidden unemployment still exists throughout Japanese industry.

The coal industry recently has been steadily getting out more coal with fewer employees and has recently approached the 1941 production per man-hour, but separation pay has been a heavy expense obstructing this improvement, and labor costs per ton coal are still for out of line with good foreign practice. Until last winter, the market did not permit much increase in coal production except at mines with comparatively favorable geological conditions or unusually good equipment. Also, the paternalistic (or so-called feudalistic) practice of Japanese employers tends to prevent throwing people out of work. So it appears that the problem of bringing costs in Japanese heavy industries into line with prices and costs in world markets may often involve the problem of expanding the economy or otherwise providing amply productive jobs for men who would otherwise be non-essential members burdening existing production organizations. The present time, with its increasing demand for coal, power, pig iron, etc., seems to present an unusual opportunity for further elimination of non-essential jobs and for transferring men, directly or indirectly, from non-essential to productive work. This may of course increase purchasing power of the population, which in turn tends to increase production still more. On the other hand, if an attempt is made to cut costs, not by increasing labor efficiency, but merely by cutting wages while permitting low labor efficiency, the resulting decrease in
labor’s purchasing power might decrease general business activity and require curtailment of production. In Japan, even more than in America, many production costs per unit of product are greatly increased by decreases in rate of production. Thus, in order to decrease costs, the relation between labor productivity and wages is far more important than the wage rate considered alone. Present labor productivity in coal mining, although improving, still seems to be too low for the present wage rates. But of course complete rationalization of labor utilization is impossible without judicious use of capital for good development and improvement of producing property.

None of the foregoing, however, changes the fact that the most important factor for labor productivity is mutual confidence, friendliness and fairness between miners and their bosses, and between companies and unions.

3. Capital Utilization. There are two parts to the application of capital to coal mining: first using the money and, second, getting the money. Success in the first, even in a small way, helps greatly with the second, both by permitting improvements to be financed from earnings and also by making it easier to issue stock or bonds at good prices.

Regarding the use of the money,—in addition to the obvious suggestion that familiarity with the best modern practice in Japan, America, Britain and Europe should be acquired so as to decide what is (and especially what is not) practical for local conditions—the following should perhaps be mentioned:

a. It is advisable to encourage and develop good, qualified, young members of an organization, by discussing various property improvement programs with them and asking them to comment and recommend.

b. It is especially advisable to consult in advance with those who are to be responsible for the use of new facilities.

c. In property improvement programs, it is advisable to have a reasonable relation between different kinds of expenditures such as coal cleaning equipment, mine development (including the provision of additional working places or even opening additional pits primarily to decrease cost by increasing production and diluting fixed charges), haulage facilities, cutting loading and conveying equipment, improvement of working conditions, transportation of workers, change and shower rooms for workers, more efficient pumping and ventilating systems, semi-portable air compressors, etc. For instance, it may be inconsistent to spend a large sum to make a moderate saving in the cost of hauling coal, and not add a smaller amount to make a greater saving by getting the men to the face in better physical condition and more quickly. Also, since electric power costs may be expected to increase, such matters as mining system, air leakage, size of air ducts, fan efficiency and pumping efficiency should be reexamined at some mines.

d. In some instances, contractors with special equipment can come in and drive entries or sink shafts more quickly and cheaply than the mining companies.

e. Although some experimental work,—such as investigation of the applicability of relatively new coal cleaning equipment, roof supports (including bolts), coal platters, etc., etc. to local conditions,—may be charged to cost, some such experimental work should be considered in connection with property improvement programs.

Regarding getting the money, of course the most obvious fact is that if there is no
money in the coal business it will be hard to get additional capital for it—so stock piles of coal should not be too very large nor prices too very low.

But Japanese coal prices are already so high as to promote the importing of coal and of oil products, and to cause such high cost of steel and other commodities as to jeopardize some of Japan's export markets under normal conditions. Also, of course, prices are mostly controlled by competition and by market conditions, and therefore are largely beyond the control of the management of any one company. So the principal way in which management can increase company earnings is to decrease costs. Thus one of the most obvious—ways to make it easy to get money for cost-lowering improvements is to show as low cost and as good earning capacity as can be obtained with the facilities already available.

Another way to promote modernization of coal mining properties is for the Japanese government to modify certain rulings regarding taxable income, and thus to encourage rather than hinder good engineering practices and sound property development. Of course all expenditures intended to increase output, or to decrease future costs, are properly considered as additional capital investments, and any of the company's gross income so spent is considered to be part of the company's taxable earnings. Thus, for every million yen of cash receipts put into such expenditures, the company is properly required to pay nearly another million yen in national and local income taxes. (In most instances, nearly all of the amount or such expenditures is the basis for approximately equal addition to depreciation or depletion charges which are added to the cost of coal for a sufficient number of years to cover the life of the improvement and therefore have relatively little effect on the immediate cash position.)

Now on the other hand, in addition to the above-defined capital expenditures, large amounts of money which must be spent merely for extension of workings, and not for increase of output capacity, after the mine has been brought into normal production are improperly treated as capital. Such extension of workings includes additional transportation and ventilation facilities, etc., as well as additional entries. And in some instances it is good engineering practice, and helps avoid increase in ventilation costs, etc., to adopt the retreating rather than the advancing system of mining, thus minimizing the total cost of utilizing the coal deposit. It would be helpful if the government would permit modification of accounting practices so as to permit treating those expenditures as costs or as reserves—but not as taxable additions to capital—when such expenditures are merely for extension of workings and not for cutting current costs nor for increasing output capacity. By thus decreasing the amount of gross cash receipts required for taxes, while merely maintaining output, more money would be available for real capital expenditures for cost reduction.

Another way in which the government can promote the immediate expansion and modernization of the coal industry is to permit unusually rapid depreciation of very profitable investments in improvements or extensions which are needed in the public interest for the present emergency. (Under Japanese conditions production increase usually means decreasing cost per ton.) This method has been used with good results in the United States, in emergencies, to promote rapid industrial build-up. If there is doubt as to long-range need for expansion, the government thus relieves the company of part of the risk. If the expansion is of long-range value, the government gets
high income tax after the cost of the new facilities has been written off. In many instances, it is better to put in completely modern new facilities than to spend money on old ones.

These two ways in which the government can be helpful are, of course, different from the former subsidy system because they do not transfer government money to private industry. Theoretically, at least, the coal companies would ultimately pay about the same total taxes for the same earnings per ton throughout the life of a property, but the proposed changes would tend to increase the earnings per ton, and so should increase the total tax—even though there might be some temporary decrease in taxes which should be more than offset by higher taxes in future. Of course the government subsidy method of solving industrial problems frequently defeats its purpose because it results in higher taxes, and high taxes increase almost all costs and all prices and so decrease the value of money and weaken the country’s position in international trade. For instance, an increase in a miner’s income tax rate means that he has to be paid higher wages, and these higher wages, together with any increase in a coal mining company’s income tax rate, mean that the price of coal has to be increased by more than that amount if the coal company is to continue to make barely enough return on the total money used in its business so that capital can be obtained for essential expansion or modernization—and the higher price of coal affects costs of coke and steel and nitrogenous fertilizers and power and transportation and hence many raw and semi-finished commodities whose higher cost must in turn add to the production expenditures on which makers of more finished commodities must show a reasonable profit, etc., so that each million yen of income tax collected from producers of a primary raw material, such as coal, may cause an increase of perhaps two million yen, or more, in what the public pays for finished goods.

V. Distinctive Features of the Japanese Coke Industry.

In addition to the dependence upon expensive Japanese coal whose high cost has just been discussed, the Japanese coke industry is influenced by the following somewhat distinctive features: (a) Japanese markets or uses for coke, (b) Preparation of coal for coke-making, (c) Importing materials for coke making, (d) Semi-coke (Sometimes called “coalite”) for coke making, (e) Other additives in coking mixtures, (f) Use of moderately weak coke for making pig iron, (g) Japanese coke oven practice.

(a) Japanese market and uses for coke. The present consumption of coke in Japan is about 460,000 tons per month, distributed by grade as follows during a recent three-month period:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Tons used per month</th>
<th>% of total coke used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundry</td>
<td>41,859</td>
<td>9.1</td>
</tr>
<tr>
<td>Lump</td>
<td>144,702</td>
<td>31.4</td>
</tr>
<tr>
<td>Small Lump</td>
<td>16,529</td>
<td>3.6</td>
</tr>
<tr>
<td>Breeze</td>
<td>26,927</td>
<td>5.9</td>
</tr>
<tr>
<td>(Total merchant coke)</td>
<td>(230,017)</td>
<td>(50.0)</td>
</tr>
<tr>
<td>Blast Furnace</td>
<td>229,739</td>
<td>50.0</td>
</tr>
<tr>
<td>Total Coke</td>
<td>459,756</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The distribution by use does not necessarily correspond to the grade of coke. It
averages about as follows:

- Blast furnace for making pig iron: 47%
- Foundry cupolas for making iron castings: 8%
- Water gas generators or gas producers for making ammonia, principally for fertilizers: 9%
- Gas producers for making public utility gas: 7%
- Electric furnaces for making calcium carbide, largely for cyanamid fertilizers: 7%
- Furnaces for non-ferrous metals: 3%
- Miscellaneous: 19%

The coke is made by the following kinds of companies:

- Pig iron makers: 48.7%
- Public utility gas companies: 30.4%
- Chemical and other companies: 20.9%

About 95% of the coke is made in by-product coke ovens about 4% is made in gas retorts, and 1% is made in bee-hive ovens.

(b) Preparation of coal for coke making. With the exception of Miike, part of Sakito and part of Oshima in Kyushu, and Kayanuma mine in Hokkaido, nearly all the Japanese sources of coal for coke making are quite low in sulphur by American standards. The sulphur in the Miike coal is nearly all in the form of organic compounds, and not subject to gravity separation. Thus Japanese coal cleaning is primarily for ash removal without much attention to sulphur.

Ash reduction is much more important economically for coal for coke making than for most other coals, since coke ash usually has to be fluxed with lime and heated to extremely high temperatures, (as in blast furnaces, foundry cupolas or calcium carbide furnaces) or, in the case of some gasification processes for making hydrogen for ammonia synthesis for fertilizer, the coke ash may have to carry large amounts of unburned carbon with it when it is finally thrown away. For making pig iron, it is estimated that the heat for melting the slag corresponding to 1kg. ash requires the burning of at least 0.8kg. fixed carbon at the tuyeres. On the other hand, coal for many other uses might carry more ash than at present with no more serious consequence than decreasing the maximum throughput capacity of fuel using equipment which seldom reaches full capacity.

Most of the Japanese coke plants, and also most of the mines producing coking coal, are equipped with Baum jigs, but a few mines—notably Yubari which produces more coking coal than any other mine in Japan—use the rheolaveur system. Although, in general, coal cleaning practice has improved greatly since decontrol of coal in September 1949, there is still room for considerable improvement in the cleaning of small size material about 10mm by zero. This is a large proportion of the coal used for making coke, and it could probably be cleaned better in hydrotators or on tables than in jigs or rheolaveurs. Also, in many instances, this size range could be handled better in the jigs if a special study were made of the jig performance so as to work out the most suitable type of pulsation for cleaning small sizes. This is in addition to the obvious need for better automatic controls on some of the jigs. (For improved jig operation, see pages 393 to 402 and 413 to 422—and especially “Principle 2”, page
Also, several additional froth flotation units for cleaning coal sludge are being installed and still more are needed.

(c) Importing materials for coke making. Japan has practically no low volatile coking coal, and its medium volatile coking coal is limited in amount, costly to mine, and cannot be economically cleaned to low ash content. Some of its high volatile coking coal (especially Chikuho) is rather low in "bitumen" or coking constituents. All Japanese high volatile coking coal undergoes so much shrinkage during the coking process that it makes weak coke of the “fingery” type, tending to break into narrow prismatic pieces. It is usual (both in Japan and in America) to blend medium or low volatile coal with the high volatile coal so as to get a mixture which will make stronger and more “blocky” (cubic rather than narrow-prismatic) coke. Usually, practically no coal is imported except for this purpose.

Low volatile coal is imported from the United States, usually Pocahontas or other west Virginia coal with less than 20% volatile matter and less than 7% ash. One plant, when using a very large proportion of high volatile coal from the Chikuho field, prefers about 24% volatile matter American coal.

Medium volatile coals, rather high in ash and sometimes requiring cleaning, are imported from India. Most of these coals cannot be economically washed down to less than 17 or 18% ash. (But exceptional shipments are better and perhaps future improvement in quality can be negotiated.)

Coal very similar to the just described Indian coal was imported from Kailan collieries in China, but is not now available. It was paid for in sterling through Hong Kong, since there was a considerable British financial interest in the collieries.

A limited amount of medium volatile coal of lower ash content than Kailan or Indian coal, is occasionally imported from Sakhalin (U.S.S.R.).

A comparatively small but increasing amount of raw petroleum coke of the very weak comparatively high volatile type—(about 9 to 13% volatile matter) is imported from California in the United States. Since it is produced and shipped at Pacific ports, it takes a lower ocean freight rate, and usually a lower delivered price, than American low volatile coal which is shipped a long distance by rail to Atlantic ports. This raw petroleum coke of the weak type is crushed, usually in disintegrators, and sometimes more finely, before blending with coal. It should not be confused with lump petroleum coke (used for carbide manufacture) nor with the devolatilized so-called ("shrunk" or "calcined") petroleum coke which is used in manufacture of carbon electrodes or Sodeberg paste. Although this raw petroleum coke in non-coking, a considerable quantity—usually about 10%—is used advantageously in coking mixtures. Of course it should be well crushed and mixed, since large particles would tend to make weak places and cross-cracks in the final product, and any part of a coke oven charge containing a big overdose of petroleum coke would be very weak and might even be hard to push out of the oven. Petroleum coke is nearly free from ash, and its low volatile content means a high yield of coke.

Rather large quantities of anthracite are imported from the Honge collieries of French Indo-China for use in blends for making foundry coke. This material is available in lump or small lump sizes at low ash content—possibly below 5%—at comparatively high prices, such material being used principally for calcium carbide production.
The smaller sizes of Honge anthracite are cheaper and are imported for making foundry coke, the ash content being usually held down to about 9 or 10% by including about 10 to 20% of small lump. A recent shipment contained 9% volatile matter. Of course this is non-coking material, and the use of too much would weaken the coke, but big blocky coke is preferred for foundry use and it is not unusual to use more than 25% anthracite in the mixture for making it.

Rather similar anthracite, but containing about 10 or 12% ash, is also imported from South Africa for the same purpose. A recent shipment contained 13½% volatile matter.

Recently, due to abnormal scarcity of Japanese high volatile coal, some American high volatile coking coal containing about 10% ash and 31% volatile matter has been purchased for import. This coal is shipped from Seattle on the Pacific Coast.

The proportion of imported coal which can properly be used depends not only on its effect on yields and on coke quality (both chemical and physical characteristics of coke) but also on the availability of foreign exchange. When dollars are readily available, high priced American coal is often more economical than cheaper Indian or Kailan coal because of the difference in quality. Whenever Japan requires American aid, dollars are not properly available for avoidable imports requiring dollars, and so the use of imported coal should be eliminated or greatly curtailed unless foreign money is available for importing inferior coal at a reasonable price without indirectly increasing the amount of American aid required. For instance, during part of the summer of 1950 Japan was receiving grain and cotton from the United States as aid, because of lack of dollars; but at that time there was no objection to importing Kailan coal for sterling, because sterling was available after buying all the basic food and cotton which was available for sale to Japan in, sterling countries. If, however, the sterling countries had been able to sell more food or cotton to Japan at that time, it would have been improper to buy Kailan coal with sterling which could then have been used to buy food or cotton so as to decrease the requirement for American aid. The same principle will of course apply when Japan is completely independent.

Also, of course, it is obviously advisable for the distribution of the limited amount of foreign exchange among various importing industries to be on a sound economic basis and not based primarily on politics.

Thus it is important to remember that the question of the proper proportion of imported coal for use in coking mixtures is not solely a technical question, but also involves price and economic considerations. Blast furnaces have been operated successfully in Japan using coke made with little or no medium volatile or low volatile coal, and various substitutes for such coals have been used. There is no assurance that the present situation with comparatively good supply of foreign and with some scarcity of Japanese high volatile coking coal, will permanent.

(d) Semi-coke for coke-making. Semi-coke is the solid product of the partial devolatilizing of bituminous coal, by heating to temperatures not exceeding perhaps 700° C (usually not exceeding 450° C). It is also called low temperature coke or, in Japan “coalite” or “X-coal”.

About 40 years ago, Dr. K. Shimomura discovered that pulverized semi-coke could
be used, instead of (imported) medium volatile coal, for blending with high volatile coal in order to make a mixture which would be suitable for making strong coke. A large amount of work has been done on this in America, France and Japan—resulting in commercial operations in France and in Japan.

Of course there is an optimum proportion of semi-coke which can be added to any high volatile coal, and too much semi-coke may be worse than none, although it would make a different kind of weak coke. The optimum proportion of semi-coke, and the strength of the resulting coke, both depend on the characteristics of the high volatile coal as well as on the volatile content, fineness, and uniformity of mixing, of the semi-coke. Preliminary studies of trial mixes are probably best made in modified Nedelman apparatus, observation of the “fingering” tendency (shrinking characteristics) being supplemented by simple grindability test in laboratory ball mill—all in accordance with work done at the Fuel Research Institute at Kawaguchi. These preliminary explorations may be followed by can tests of the most promising trial mixes in coke ovens, drum index being determined on the product. The best of these mixes may then be used in test coke ovens or put directly into plant use.

There are two commercial processes in Japan for making semi-coke, Fuji Seitetsu K.K using large externally heated rotating retorts at Muroran and Dai Ichi Kagaku using the Lurgi process near Wakamatsu. Both of these processes are continuous and require non-coking (or nearly non-coking) coal. The Muroran plant can use fine sizes of coal. The Lurgi plant was designed for rather coarse coal, but has been modified to run well on 18 mm x 0 coal, thus avoiding the sizes which are usually sold for steel plant gas producers. Semi-coke has been made experimentally in Knowles oven and in continuous vertical gas retorts, and the product, although not of uniform volatile matter content, has given fairly good results in coking mixtures.

Grinding the semi-coke to about 0.3 mm (50 mesh) improves the final product, but good coke is made with semi-coke which has been crushed in a disintegrator only, the ball mill operation being rather costly. Apparently very fine grinding is less important for semi-coke containing more than about 15% volatile matter than for lower volatile material. Although coke is very difficult and costly to pulverize, semi-coke crushes very readily, sometimes more easily than the coal from which it was made.

It happens that the cleaning of non-coking coal for making semi-coke has not been worked out in Japan as well as the cleaning of Japanese high volatile coking coal. More attention to this would greatly increase the value of the contribution which semi-coke can make to the Japanese coke industry. In one instance, decided improvement could be made merely by screening the very fine dust out of the coal and diverting it to other uses, but suitable long term contractual arrangements for such a change have not been made.

The economic evaluation of semi-coke (or of any other constituent of a coking mixture) should, of course, take into account the quantities of various by-products and the quantity and quality of coke (or quantity of “available fixed carbon”) contributed to the total products by one ton of the semi-coke (or other constituent of the coking mixture). This involves by-product yield tests of laboratory samples by standard methods (such as U. S. Steel Corporation method) but the yield and quality of coke contributed may be calculated from proximate analyses, remembering that a
ton of ash requires at least 800 kg. fixed carbon to melt the corresponding slag in the blast furnace. Also, the amount of justifiable premium which can be properly paid for extra coke strength depends on local blast furnace conditions.

Although, with fine grinding and with very good control of conditions and very accurate and uniform blending, coke with 15mm. drum index of 87 to 90 has been made experimentally from mixtures of high volatile coking coals with semi-coke and nothing else, it does not seem to be practical to get much better than a drum index of 80 from such mixtures in regular plant operation. Stronger coke is made with mixtures containing both semi-coke and low volatile or medium volatile coal.

(e) Miscellaneous materials for mixing with high volatile coking coal. Instead of coalite, the following other finely divided non-coking materials may be added to high volatile coking coal, usually with some low volatile or medium volatile coal to improve the resulting coke: anthracite, certain lignites or subbituminous coals, raw petroleum coke, coal sludge, and coke breeze. The use of anthracite has been common practice for good foundry coke for many years and is continuing. It was discussed in connection with the importing problem, although a limited amount of suitable Japanese anthracite is produced. Considerable tonnages of northern Hokkaido lignite or subbituminous coal were formerly used at Muroran, usually dried and ground very fine, and sometimes mixed with semi-coke. Some other subbituminous coals or lignites gave satisfactory experimental results, and some other were not suitable. Good low ash non-coking coals suitable for such use do not seem to be always amply available, but may perhaps be made available in future by better cleaning. (Of course these low rank coals give comparatively low yields of coke and by-products). Raw petroleum coke was discussed in connection with the import problem. It seems to be very economical, considering quality, when used in suitable proportion. Coal sludge from coal cleaning plant settling ponds or filters has been found to be a quite effective additive for making physically strong coke, but it should be cleaned, preferably by froth flotation, to decrease the ash. One plant has been using sludge with high volatile coking coal and some pitch when making foundry coke. Even after flotation, the cleaned sludge is usually high in ash. Although very fine coke dust is remarkably effective when used in small amounts (perhaps 5% of the mixture), its use for this purpose has not become well established in Japan industry, perhaps principally because of high cost of grinding.

(f) Moderately Weak Coke in Some Blast Furnaces. Although it is well known that the use of weak coke tends to increase the coke ratio and decrease the production capacity of blast furnaces, certain Japanese furnaces have operated for long periods with comparatively weak coke.

There are two outstanding facts regarding coke strength in blast furnace practice: diminishing returns, and variable value. For example of diminishing returns, an increase in drum index from 70 to 80 is much more effective than an increase from 85 to 95. (Also, an increase in low volatile coal in coking mixture from 5% to 15% is much more effective than an increase from 35% to 45%.) For example of variable value, it is well known that some furnaces with certain ores are less sensitive to changes in coke strength than other furnaces with other ores.

Any formula for evaluating coke solely in terms of chemical analysis and such tests
as combustibility, porosity, shatter index and drum index, is far from universal in applicability because coke consumption per ton iron and furnace production capacity are affected not only by coke quality but also by changes in various furnace operating conditions including, especially, changes in size-consist (screen analysis) and reducibility of the ore.

The two Japanese furnaces which have operated longest on comparatively weak coke are Wanishimachi No. 3 and Nakamachi No. 3 at the Muroran Works of Fuji Seitetsu K. K. Wanishimachi No. 3, a small furnace, has had better results in certain months on weak coke, made from a blend of two types of Japanese high volatile coking coal alone, than in certain other months when stronger coke was used. Nakamachi No. 3, a medium size furnace, has had lower coke ratio in certain months on 80 drum index coke made with semi-coke but no imported coal, than a very similar furnace at Kamaishi had in certain months on 88 drum index coke made with more than 50% imported coal. Then the Kamaishi furnace changed to better sintering practice and lower slag volume and coke made with less imported coal, and got lower coke ratio than the Nakamachi furnace.

The American experience is that where large proportions of fine ores are used, strong coke should be used, the use of weaker coke causing hanging and slipping unless the rate of blowing and blast temperature are kept low. On the other hand, in Colorado, Utah and California, where weak coke is much cheaper than strong coke, 80 drum index coke (or weaker) is giving excellent results providing that certain conditions are maintained.

The following conditions give good results with weak coke in the United States:

1. Coarse ore is crushed so that the largest pieces can be reduced by furnace gas in a short time.
2. All fine ore is sintered.
3. The sinter is of the readily reducible type—not glazed nor over-burned.
4. Coke is handled gently to avoid unnecessary breakage, and is well screened at the furnace.
5. In some instances, the furnace is charged in layers of material of rather uniform size so as to maintain a large proportion of void volume.

When all of these conditions are maintained, large furnaces may be operated at high production rates and low ratio of coke used to pig iron made, when using coke with drum index less than 80. To apply this practice in Japan, with its large number of ores, it may be necessary to improve some parts of the present rather complete ore crushing and screening systems. Much of the benefit of sintering will be lost if too much fine ore (such as Dungun and Samar which are difficult to screen) is charged without sintering.

Where it is impractical to eliminate fine ore sufficiently, it may be necessary to run more furnaces at lower rates of blowing with weak coke than with strong coke (but Japanese practice has been to avoid excessive blowing rates, anyhow.) There is a difference of opinion as to the advantage of small furnaces for weak coke. Many American and Japanese authorities believe that small furnaces will use weak coke better than large furnaces. Others, including Dr. T. L. Joseph of the University of Minnesota, think that the greater height from tuyere level to stock line in large
furnaces does not have much effect on the coke, and that, when weak coke is much cheaper than strong coke, the best practice is to continue to use large furnaces but to adjust blowing rates (and blast temperature if necessary) to suit the coke.

(g) Unusual features of Japanese coke plant practice. To an American, Japanese coke plant practice seems very unusual in two ways: (1) the extra-long soaking period in which the coke is held in the ovens after it is completely coked and (2) the high moisture content of the coal when charged. The first probably tends to increase heating cost per ton coke in addition to decreasing plant production capacity. The second also increases heating cost and is perhaps one of the reasons for the shorter life of coke ovens in Japan than in America.

A third interesting feature is the practice of crushing the coal more finely at most Japanese plants than at most American plants, often resulting in the Japanese making good strong coke out of rather poor coking coal.

VI. Supplement (Sent by a letter after the meeting)

1. Comparison of American and Japanese coal mine labor productivity in the Section 2. (Labor Utilization) of VI (Coal costs) is correct, but of course gives America credit for better geological conditions, (a) permitting a larger proportion of production by surface mining ("stripping") and (b) requiring the handling of less rock and refuse in underground miners per ton coal produced. A very rough comparative estimate for American and Japanese underground mining based on total output of coal and refuse taken out of the mines, shows less than 30 working days for the American worker equivalent to the entire year 1950 for the Japanese worker, and more than 8 times as much total output coal and refuse per year per worker as in Japan in 1950.

2. Regarding the use of semi-coke in France, mentioned in the Section (d) (Semi-coke for coke-making) of V (Distinctive Features of the Japanese Coke Industry), a description of an experimental plant recently constructed at Mariensu for carbonization of Lorraine coals may be of interest. The experimental work on Lorraine coal is based on 18 years' experience at Bruay in Pas-de-Calais, and the rotary retort includes a built-in ball mill at the lower end. (Cf: "Note Technique, No. 49/15, Centre d'Etudes et Recherches des Charbonnages de France")

3. Regarding high moisture in Japanese coal as charged into coke ovens, the following conditions favor lower moisture in coal charged into coke oven in America: (a) Many plants use a large proportion of raw coal—and many plants use nothing else. (b) Many American plants, which use large proportion of washed coal, use the natural mixture of nut and slack sizes, the coal mine usually belonging to the steel company and not being in the commercial coal business, but shipping nearly all of its output to the coke plant. (Of course the washed nut is crushed before charging into the ovens.) Water drains from nut coal more easily than from slack. At some plants nut is fed to a dewatering elevator and the finer sizes are then fed to the same elevator at a higher point so that the nut coal in each elevator bucket acts as a filter bed through which water drains the finer coal. (c) Many American plants use continuous centrifugal dryers for part of the fine coal, and settling basins or Dorr thickeners with continuous vacuum filters for the finest coal. The Bird centrifugal dryer has less upkeep
cost than the other types but perhaps does not do as thorough a job. (d) There are a few recent installations of Raymond Flash Dryers in which fine coal (about 6 mm × 0), containing 12 to 14% water, is conveyed pneumatically, by a stream of hot flue gas and air, into a cyclone separator and dust catcher, thus being dried down to about 2% moisture. Part of the dry product is re-cycled, being mixed with the fresh feed in a pug-mill type mixer. Automatic controls are used and the dryer is very satisfactory except for some dust loss.

日本の石炭及びコークス工業

——昭和 26 年 9 月 7 日燃料協会特別講演会講演——

総司令部 経済科学局 カレフ・デヴィス

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I. 緒言  II. 緊急問題。 1. 石炭増産の必要。 2. 高価な採炭及び輸送費。 3. 強い治金用コークスの原料問題。 III. 日本の石炭及びコークス工業の経済的依存と異常な国際情勢並外貨の不足。 IV. 炭価問題。 1. 炭価に対する地上での理由。 2. 生産の活用。 3. 資本の活用。 V. 日本のコークス工業の特異性。 (a) ホークスの市場及用途、(b) ホークス用炭の洗炭、(c) ホークス用原料の輸入、(d) ホークス用重油コークス、(e) 他の配合物、(f) 強いコークスによる高炉操業、(g) 日本のコークス炉操業の特異点。 VI. 追記。 1 労働生産性の比較。 2. フランスの重油コークス実験。 3. 製炭炭の水分について。

——摘要——

本文中の如何なる意見も著者個人の意見である。

I. 緒言——日本の天然資源に恵まれていないから、然し石炭はむしろ恵まれているものの一つである。日本は褐炭から無煙炭及び天然コークスに至る種々の炭種を持っているが、低揮発分の粘結炭及び灰分の少ない中揮発分の粘結炭が存在しない。唯一灰分の多い中揮発分の粘結炭が極少数存在するに過ぎない。日本人出炭量の8%以上をコークス工業に消費している。1951年6月には1,051,000 tの国内炭及び133,000 tの輸入炭を消費した。之に6月の出炭の18%に当る。コークスは製鉄の他に高炭素燃料合成用にも多少消費されている。

石炭銛鉄は1949年（昭和24年）9月の銛鉄製造以来2年間に非常に健全な生長を見た。生産量は年45,000,000 tに増加し、従業員1人当生産量は約40%増加した。又石炭の質が高上した。この結果として低炭分の米炭の使用割合を減じても然もコークスの灰分は減少している。

II. 緊急問題——日本の石炭及びコークス工業は3つの緊急問題に直面している。 (1) 石炭増産の必要に迫られていること。 (2) 採炭費及び輸送費が高価であること。 (3) 強い治金用コークスの原料問題。石炭増産のためには労働生産性の増進、炭炭の採炭場所の増加、設備の近代化が必要される。採炭費及輸送費の問題は労働と資本の活用により解決することが望ましい。（3）の問題は半成コークスや輸入炭の卸き高値のものを加えることであるが輸入炭は外国為替と関連する問題である。

I. 日本の石炭及びコークス工業の経済的依存と国際情勢——若し国際情勢が正常であるならば、石炭も鉄鉱も海外からの安価で供給され得るからこれらの日本の生産は中絶することはあろう。従ってコークス工業は約半分に縮小されるだろう。コークス工業での隠物用及肥料用コークスの製造は継続出来よう。日本の石炭及び製鉄
工業が正規時に発見されるために日本の石炭採掘は将来のきびしい競争に備えるために大に努力せねばならない。政治的措置によって解消することは一度のものであって恒久的な対策ではない。労力を、1人当最高の富を生ずるように、各産業に分配することか理性である。

4 炎価問題——石炭価格の問題には（1）地質上（2）労働（3）資本の三つの側面がある。1）地質上の問題について見ると日本の炭坑は不全な条件として弱い天井、深い炭層、無数の石灰層、無数の断層、異常で離れている断層、急傾斜の炭層、石炭層を出水量の異常にあることの一つまたはそれ以上を持つっている。（2）労働の活用について。日本に扱えば炭坑に於ける労働の生産性を見るに1人1時間石炭数の最高は不景気の1933年（昭和8年）の0.056である。1943年（昭和18年）には0.034に急低下した。最近は0.047と昇にして来ている。日本の労働生産性の低い理由は労働時間が短いことである。大正の8時間労働を実際には5時間しか働いていない。入坑から出坑までの時間は今少し増加し、急患時間に対しもし少し高い率で支払うようにすることの理由である。他国では日本の資本より多く支払して然も石炭1当りの経費は低く、例えば1人当りの出水量が遠く、それにより高資本を相殺しているからである。高資本を生産するための媒介的方法は、①合格下の強制労働、②施施設に最初の技術を用用することである。米国も日本もこれらのいづれをも含んでいないか、救助②の方向にたいしいある。

日本の労働関係法が新しいというか日本の炭坑に於ける労働活用の困難な一つの理由である。アメリカの日本の側は急速に変化を強調した。このことは国を民主化し、労働生産性を解消するために必要であった。共産主義の拡大を止めることを目的に恒久的な手段は「誰もより貪いな人々から不公平な利益を、取らない」ということを確実なあらしめである。米国の石炭労働組合政策には一つの特色がある。それは機械化を奨勧した政策であって、それに1人当りの労働生産性を増進し、多種の労働を減少し、財政の増加を招来した。「労働費を下げることを資本を高くすることを同時に行う」という原理は米国の労働生産力の一つの秘訣である。日本の炭坑に多数の潛在失業者（hiden unemployed)がある。潜在失業者に職を用意してやることに簡単化の上に大きな助けである。今日は石炭、動力、鉄鉱その他の需要を増大しつつあるからこそ潜在失業者を直接又は間接に生産的仕事に移す絶好の時機である。向っても言うまでもなく労働生産性について最も重要なことは、採掘者と指導者との間及び会社と組合との間の相互の信頼、友誼及び公平であるということである。2）資本の活用について。石炭採掘に資本を投げるには、①金を使うこと、②金を得ることの2つである。①の金の使用に関しても、世界各国における最後の現代的技術に精通することを必要とする。②の金を得ることに関して、その最良の方法は現在使用している設備をどのようにコストが低く又このように易入能力があるということを示すことである。尚採掘設備近代化のためには日本政府が課税について規則を改めることを望ましい。それは、単に作業の拡張（蒸気及び風呂設備等の）のために費されるたけであつて、コストの削減又生産能力の増大に費されるのではない場合には、かかる支出経費には課税しないことである。一つは大衆の利益のために必要であるところの改造又は拡張に使う投資に対しては異常な急津の償却を許すすることである。

日本のコックス工業の特異性——（a）の市場及び用途。現在コックスは月46t万消費されているおり、製鉄用47%，キューラ用8%，水性塗料も肥料アミノ＝9%，カーヘイも石炭酸塩用7%，都市ガス用9%，非鉄金屬用3%，その他19%である。コックスの95%はコックス炉で製造され、4%がカステルト、1%がビーハイフである。

（b）の炭坑用炭の洗浄。コックス用炭は他の目的の炭坑よりも経済的面から見て低炭灰であることが必要である。高炭灰は1kgの炭をスラッグにするのに少なく0.8kgの炭灰を消去される。大数のコックス工場はヘムノグを設備している。絶縁材料は洗浄は大なる進歩をしたが10mm以下の洗浄は未だ考慮すべき余地がある。ノグの工程をもと研究すべきである。発電には浮遊炭炭を設備する必要がある。

（c）コックス用原料の供給。低炭灰分の粘結炭は米国から輸入している。その発揮は20%以下、灰分7.5%以下である。中間灰分粘結炭は日本炭から輸入されている。灰分17〜18%である。灰分の割合の多いものは一部が輸入されている。灰分12%以下、灰分10%以下のものは一部が輸入されている。将来はたんに増加するであろう。10%配合すればコックスの強度が増進される。樹脂インドシナからホンケ炭が輸入され鉱物用コックスの製造に配合されている。灰分9〜10%配合、25%以上
は用いていない。南アフリカからも炭分 10〜12% の無煙炭が少量輸入されている。最近炭効的に高揮発分粘結炭が米国から輸入されている。炭分は 10%, 振発分 31% である。

輸入炭についてはその性質の外に外国為替の利用可能性について考えねばならない。日本は米国の採炭の必要としている間は、不急のものに対しドルは利用すべきでない。限られた外貨を各種工業用品の輸入に対し使用するのは堅実なる経済的基礎に立脚すべきであるが、政策的に取扱うべきではない。

日本の高圧は中丸低揮発炭の粘結炭を極少用いるか又は全く使わないで之に代る種々の組合物を使用して造ったコークスを立派に採用された。

(d) コークス用牛炭コークス・高揮発分粘結炭に半成コークスを合わせて堅牢なコークスが得られる。米国、日本、フランスで大きな努力が払われ、フランス及米国では工業的に成功した。日本では 2 種の方法で半成コークスを製造している。室蘭製炭所の外炭回転式と第一化学のルリヒ式炉である。半成コークスの微粉砕は未定要件ではない。半成コークス用原料炭は余り粘結されていなから注目される問題であるであろう。半成コークスと同時期産物の経済価値も考えるべき問題である。半成コークスを微粉砕し、非常に良い炭の下に造ったコークスは 1 5.15 mm 指数が 87〜90 の強度であったが実際作業では 80 以上にはならないようである。半成コークスの外に低又は中揮発分の石炭を併用すれば強いコークスが出来る。

(e) 共他に燃料の他に、無煙炭、褐炭又は延焼型、オイルコーケス、沈粉、粉コークス等が配合として使用される。之等中、無煙炭及びオイルコーケスは入炭問題に関係する。室蘭製炭所にて北海道の褐炭又は延焼型を使用していることも特筆すべきである。沈粉の添加によるコークスの強度は高められるかと炭分が多く、浮遊洗炭する必要があるが粉コークスは粉砕に費用がかかる。

(f) 弱いコークスによる高圧作業・日本を除く工場は比較的弱いコークスを相当長期間使用しておった。コークスを評価するにはケーキの化学分析、燃焼性、気孔率、ポラス指数、シャインター指数の他に高圧の作業状態、特に灰度（篩別試験）及び石灰の還元性が重要である。米国に於ける実験によると炭の多 角石を使用する時は強度の大きいコークスを使用しなければならない。若し弱いコークスを使用する時は還元量を少なく、還元温度を低くしなければならな。米国で弱いコークスと良い結果を示しているのは次の条件が必要である。①炭基石炭は、短時間でガス還元の出来を大小に至粉砕すること。②粉砕は全部燃結すること。③燃結は還元性を高める形態にすること。還元の燃結はいかにいたわる。④コークスの取扱は粉化しないように注意し、高圧入室前に篩別すること。⑥空隙が出来るよう粒子を揺れて装入すること。上述の条件を満たす大規模高圧でもコークスの強度 80 以下で高圧出鉄率と低いコークス比で作業することが出来るであろう。弱いコークスに対しては火力の高いコークスを即座に加え、向って用いるのが、大型高圧を使用し、そのコークスに合致するよう還元量を減すればよい。若し必要であれば還元温度を調節することも最良であると言っている。

(g) 日本のコークス作業の特殊点・日本のコークス作業は米国のそれに比べ特異の点は、①乾燥が乾燥しても間隔の間に置くこと。②装入炭の水分が高いこと。③装入炭の少し小さいこと。④ 及びは加熱用の熱源の消費を増大する。⑤は日本で弱い粘結炭を使用していながら比較的よいコークスを製造し、立派な結果となっている。

VI 追記——装入炭の水分の問題について一、二附加える。①多くのアメリカ工場では粉炭を用いては、連続式遠心機で脱水している。脱水に対しては連続式乾燥機を用いている。Bird 式遠心機は他の式より維持費は安いか、恐らく性能も劣るであろう。②最近 Raymond Flash Dryer かいつつ設けられ た。これは約 6 mm x 0 の大さの粉をフリューカスと空気との流れで運ぶ間に乾燥するので、サイクロン及び集塵器を備えている。水分 12〜14% のものを約 2% のものにする。