CONCLUSIONS

The comparison of investment and production figures of the various methods shows that investment and operating costs, oxygen and power production included, are lower with methods using a fixed fuel bed.

The methods using a fluidized fuel bed or a powdered fuel require additional costs for a lower efficiency (conversion of carbon, consumption of oxygen), and higher investment costs for the necessity of handling very large volumes of gas with a high dust content.

The pulverization of the coal requires further costs which may run up to 50 percent of the coal costs in case of cheap coal. These costs cannot be compensated by higher efficiency, and they show clearly why the method of gasifying pulverized coal must be more expensive than other methods.

The costs of pulverization can be compensated only if cheaper coal can be used than with other methods. This may very often be the case where slack coal is available at a lower price than run-of-mine coal.

Gasification of pulverized coal is the only method of utilizing caking coals for the production of synthesis gas. Therefore, it should be developed as the most important base of a large-scale synthesis industry in the eastern coal fields.

The Winkler process (fluidized fuel bed), though slightly cheaper in operating costs, may lose its interest as soon as the pulverized coal gasification has been developed further, especially if this later method could be operated under several atmospheres pressure.

For the gasification of non-caking coal or coke, gasification methods operated with a fixed fuel bed are more economical. The recovery of by-products from highly volatile coals can decrease considerably the production costs of gas, and may increase the production of liquid fuels by 30 to 50 percent per ton of coal.

A separate carbonization and gasification of the coke in a mechanical grate generator or slagging generator as practiced in Germany may not be equally interesting in this country. The slagging method, using the same high-grade coke as the water-gas process, cannot be considered superior to this process except in case

a very high carbon monoxide content is needed or cheap oxygen is used with an expensive coke. The relative advantages of slagging generators and mechanical grate generators depend on the physical quality of the coke and the fusion point of its ash.

A combined carbonization and gasification of coke in one unit has great advantages; the investment costs would be lower and the loss of fines and heat in the handling of the coke would be avoided. A separate treatment of the carbonization gas and the gasification gas facilitates the purification of the gas considerably. Lower production costs for the synthesis gas can be expected from this method of gasification.

In case a higher heating value of the gas is wanted as for heating purposes (city gas, long distance supply), or in case the synthesis of hydrocarbons can be combined with the production of a high-quality gas, the gasification of non-caking coal under 20 to 25 atmospheres pressure (Lurgi pressure gasification) is more economical than other methods.

The production costs of synthesis gas per gallon of motor fuel can be expected to be lowest with the present methods of gasification about 9 cents per gallon from subbituminous Wyoming coal and about 13 cents per gallon from caking coal in the eastern coal fields.

Roughly, the total production costs of the gas can be subdivided into the following items:

	Percent
Coal	15 - 25
Labor	15 - 20
Capital costs	60 - 50
Miscellaneous (water, material, administration)	10 - 5.

It seems possible to reduce the labor costs in large plants by increasing the units and by mechanizing their operation. With reduced labor costs, a reduction of the gas production costs by 10 percent may be expected after many years of experience.

The capital costs with at least 50 percent are the largest item among the production costs of the gas. They may be subdivided further, after a deduction of 3 million dollars for by-products, as follows:

	Percent of capital costs	Percent of production costs
Coal handling, gasification, cooling	20-30	10-15
Water wash, CO_2 removal	20-15	10-75
Oxygen production (includes power production)	35-30	17.5-15
Energy production (excludes oxygen)	10	5
Miscellaneous, buildings, pipes, compressors	15	7.5
	100.0	50.0

In the capital costs and in the total production costs, the percentages of water wash (CO_2 removal) and oxygen together are 50 percent and 25 percent, respectively. These costs exceed the costs of coal, without considering that part of the costs of coal, 10-15 percent, which is caused by power consumption for water wash and oxygen production. A reduction of the oxygen consumption and elimination or reduction of the water wash would be important for decreasing investment and production costs. Oxygen production and water wash also require one-third of the total labor costs, so the proportionate costs of oxygen production and water wash amount to 30 to 35 percent of the total production costs of the synthesis gas.

entering the synthesis are available as a high-grade and clean gas under pressure, and the experience that natural gas used in the gas fields is the most economical resource for the production of synthetic fuels, and probably will become more expensive for long distance supply, will create a good market for the residual gas of a synthesis plant provided such a plant is not too far away from industrial and domestic consumers. It even seems worth while to consider the production of city gas as the main product and of synthetic gasoline as a by-product with a synthesis method of less efficiency but very low operating costs.

The flexibility of such production according to fluctuating consumption of heating gas is another advantage of such a combination.

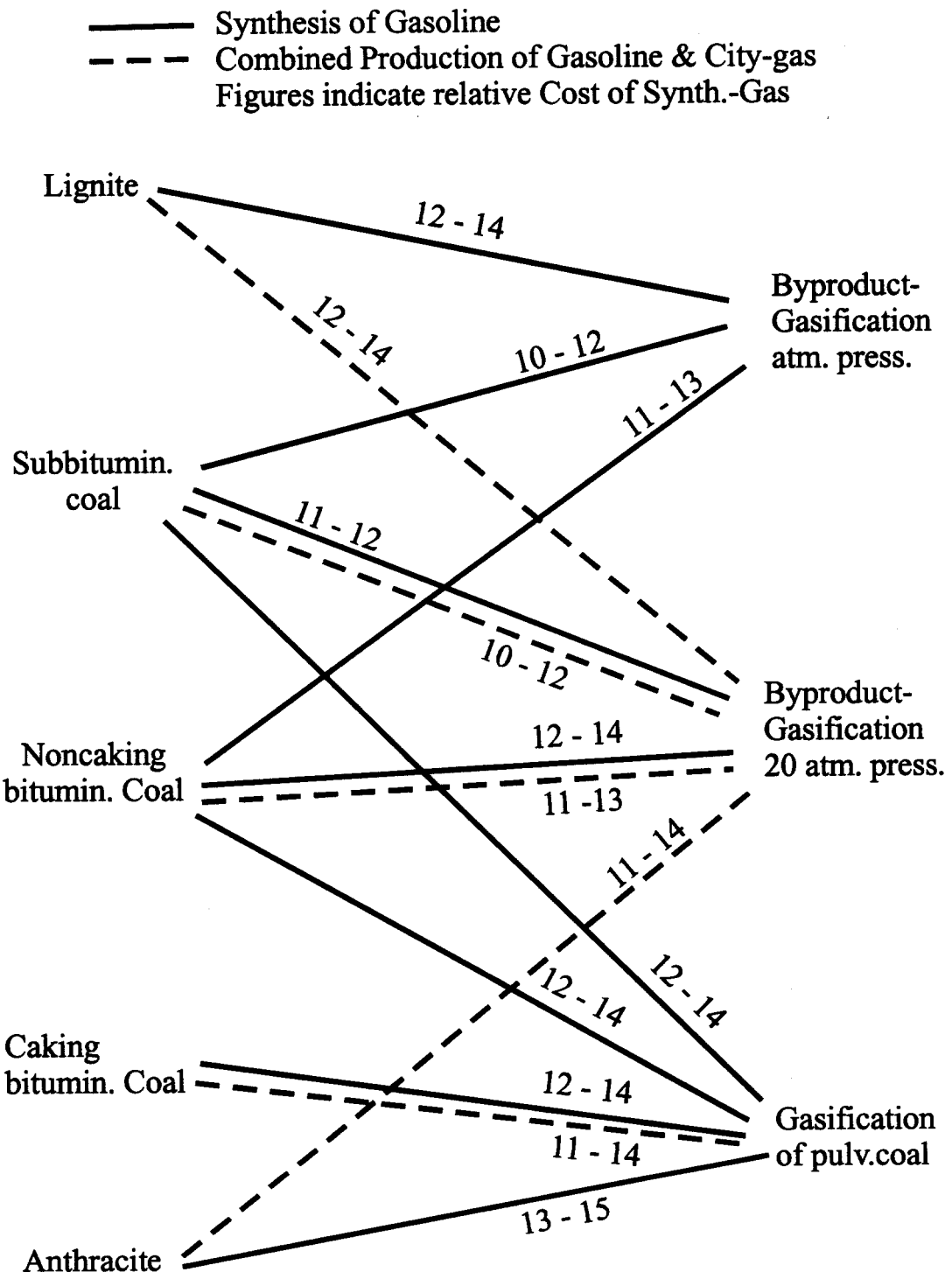
Table 6 shows the suitability of the various methods for the gasification and utilization of the different kinds of coal, for the production of only liquid fuels, or for a combination of city gas and gasoline, respectively.

The value of the gasification methods with regard to production costs of the synthesis gas is indicated by Figures 10 to 15, which roughly might correspond to the relative costs of CO + H_2 per gallon of gasoline under medium conditions. (Table 6, cents/gallon)

The value of by-products from gasification makes by-product gasification more economical in proportion to the tar content of the coal and to the quality of the tar. The possibility of selling the residual gas of the synthesis also favors by-product gasification because the presence of methane even in the primary gas is an advantage, and [illegible] makes gasification under pressure superior to other methods [illegible] oxygen consumption and high heating value of the resid[illegible]

Table VI

Suitability of the Gasification-Methods for Various Fuels and Various Products



The following fields of application of the three principal methods of gasification can be clearly recognized:

By-product gasification under atmospheric pressure.	Lignite, subbituminous coal, non-caking bituminous coal, mainly for synthesis.
By-product gasification under high pressure.	Lignite, subbituminous coal, non-caking bituminous coal for city gas and combined synthesis and city gas production.
Gasification of pulverized coal.	All caking coals for synthesis and combined synthesis and city gas production.

All three methods seem to be important for future production of synthetic fuels, the by-product methods for the cheap coals of the Central region, and the gasification of pulverized coal for the bituminous coal fields of the East, where higher production costs are partly compensated by lower transport costs for the products (gasoline and gas).

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