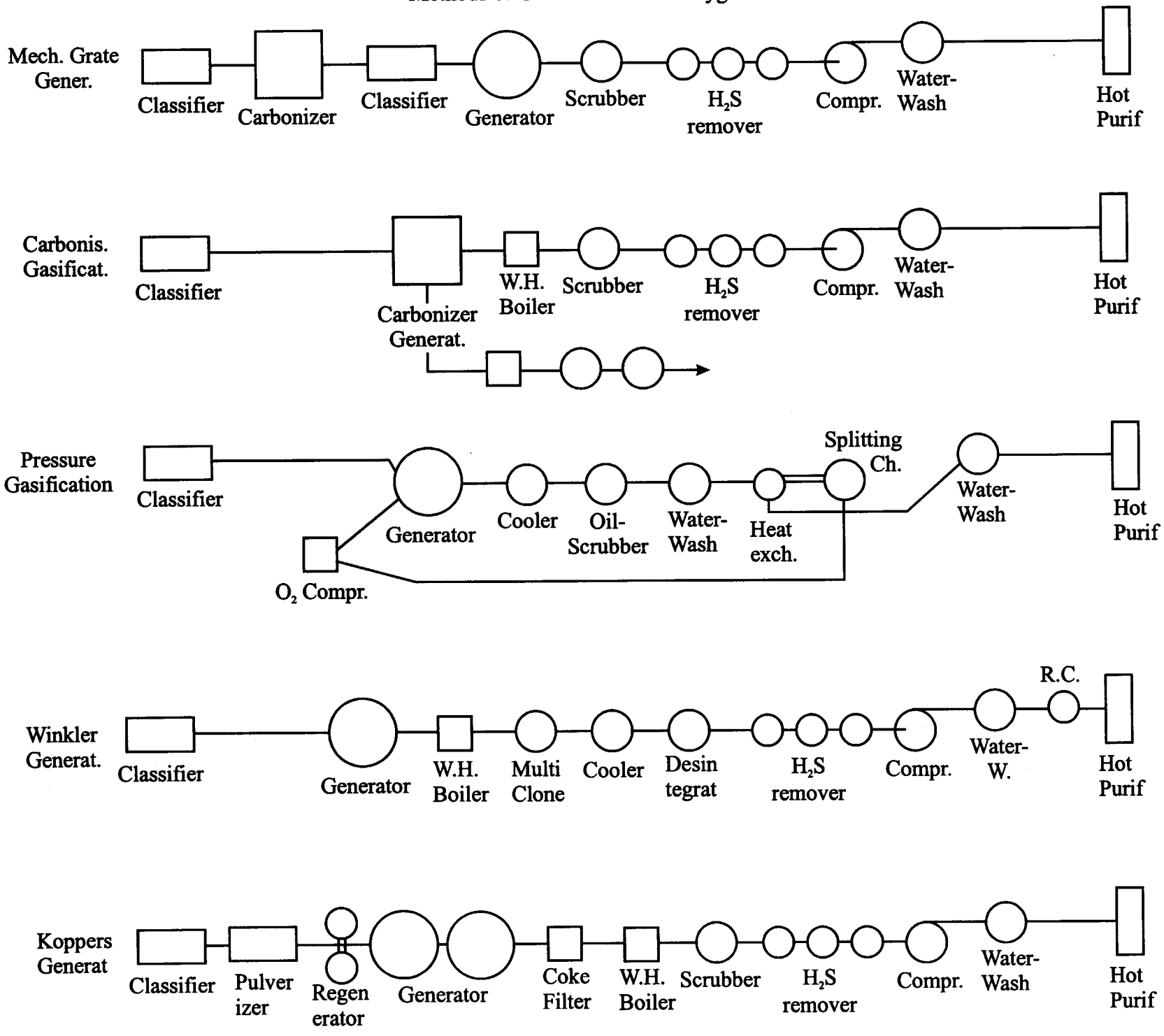
for the selection of the most economical

FLOWSHEETS OF GAS PRODUCTION OF THE VARIOUS METHODS (Table 1).

Considering the fact that the preparation of the coal and the composition of the primary gas are different with the various methods, and that the difference in pressure, sulfur content, and resins requires different means of purifying before the gas is suitable for the synthesis process, it is very instructive to compare the flowsheets of production of each method. They start from run-of-mine coal and oxygen under atmospheric pressure and end with the purified gas before entering the synthesis reactor. These flowsheets also refer to the production of hydrogen for hydrogenation in which the primary stage of gasification might be operated with more steam, except for an additional shift reaction and a second water wash which are equally required for each method. A comparison of these flowsheets shows that the gasification and purification of the gas are relatively simple when a carbonized fuel is gasified in a fixed fuel bed under atmospheric pressure. Removal of the hydrogen-sulfide at atmospheric pressure cannot be avoided though the water

Table I
Methods of Gasification with Oxygen



wash may be used for the last traces. Carbonization needs additional equipment and must be paid by the recovery of the tar and benzine, and the removal of most of the sulfur, especially the organic one and the gum formers.

For non-caking coals, with high tar content and especially if high in sulfur, carbonization and gasification must be considered the most economical method. Combined carbonization and gasification can be operated with lower investment and labor costs and with higher efficiency.

Slightly caking coals can be used in the LURGI carbonizer.

Gasification under pressure, so far feasible only for absolutely non-caking coals in the LURGI pressure generator, also allows the recovery of by-products. The flowsheet, coal preparation included, is most simple for the production of city gas. An additional splitting of the hydrocarbons is required for the production of synthesis gas or hydrogen. There, a 2-stage gasification takes place, with the same total amount of oxygen required as with other methods in the 1-stage gasification. The second stage of gasification (splitting of hydrocarbons) as an operation with clean gas under pressure needs very little equipment and little operation costs, which do not exceed the otherwise required costs for the removal of H_2S, organic sulfur, and gum formers. At the same time, the splitting operation allows the carbon monoxide content of the synthesis gas to increase, according to the requirements of the synthesis.

The Winkler generator and the Koppers generator do not allow c recovery of by-products, except in a separate, preceding carboniza- on plant (this was the case in all the Winkler generators operated n Europe). The flowsheets of these two methods are slightly more com- licated than the preceding ones. However, operating with carbonized fuels for these two methods should be considered only with non-caking coal of a very high tar content because only in this case, the cost of carbonization and quality of by-products are favorable and because in the direct gasification of coal, the volatiles of a fuel are gasified and converted into CO + H_2 without an additional oxygen consumption. With carbonized or low-volatile fuels, a higher amount of oxygen per unit of gas is required.

A relatively low heat efficiency, a high temperature of the gas, and a relatively high content of ungasified carbon in the gas require a number of special apparatus for the recovery of waste-heat, the recovery of unburned carbon and the cleaning of the gas from a fine dust, and the removal of hydrogen sulfide for the protection of the compressor. An additional removal of organic sulfur and gum-formers may be necessary in case of the Winkler generator. With the Koppers method, pulverization of the coal and eventually additional drying require additional equipment.

With cheap fuels, such as strip-mined subbituminous coal, the costs of pulverization alone may be equal to some 20 to 30 percent higher heat loss of other methods, and the economic superiority of the method generally seems doubtful.

As the only method of gasifying caking coals directly, it should have a wide field of application of its own.