OPERATING PRINCIPLES OF THE VARIOUS METHODS

Gasification with pure oxygen can be operated in the same way as gasification with air. However, it allows a wider range of temperatures. Reactions can be intensified, but the danger of slagging and the necessity of an efficient control of operating conditions are increased. Operation of slagging producers with a fixed fuel bed is facilitated by oxygen.

The various methods may be classified according to the operating principles as follows:

- **Fixed fuel bed**
  - Low temperature
    - mechanical
      - Atmospheric pressure
        - Viag-I.G.
          - Leaside
            - Lurgi carbonization gasification
    - grate
      - High pressure
        - Lurgi pressure gasification
  - High temperature slagging
    - Isuna
    - Thyssen-Galoczy
- **Fluidized fuel bed**
  - High temperature
    - Winkler process
      - Winkler generator
- **In suspension**
  - high and low temperature
    - pulverized coal
      - Koppers process

There are several technical features connected with each of the above processes which are most decisive for the suitability of any one of them in a special project. These features concern the quality of coal which can be used and the composition of the primary gas which can be produced with the process in question.

Gasification in a Fixed Fuel Bed with a Mechanical Grate.

This gasification must be operated with a relatively low -perature depending on the fusion point of the ash. A high through- t without clinkering troubles can be expected only with a high fu- on point of the ash, a uniformly medium-sized, non-caking coal or ke, and a high amount of steam, introduced with the oxygen. Conse- ently, a relatively high content of hydrogen and carbon dioxide in e gas is unavoidable. In case the producer is operated with carbon oxide which must be recycled into the fuel bed, a high carbon mo- oxide content of the gas is reached also in this method.

Recovery of by-products can be combined with this method hen non-caking coal is used, but a certain amount of hydrocarbons CH_4) is unavoidable in this case, and a separate carbonizer plant s therefore advisable.

When operated under pressure, smaller sized coal can be sed with an increased throughput and a high heating value of the gas, but for hydrogenation or synthesis purposes, the CH_4 of the primary gas must be converted into $CO + H_2$ by an additional thermic splitting.

The production of a hydrocarbon-free gas mixture directly from coal is possible in a 2-stage generator, in which a separate carbonization zone is combined with a gas producer zone operated with oxygen and steam. A relatively high carbon monoxide content of the gas can be reached in this case by a partially parallel opera- tion of oxygen and fuel.

Gasification in a Fixed Fuel Bed with Slagging Ash.

A safe and controllable operation with slagging ash requires a solid lumpy fuel with a low or medium fusion point of the ash. Sometimes even an addition of limestone or other fluxing material is needed to keep the ash sufficiently fluid. A high throughput and high velocity of the gases in the fuel bed are necessary for a sufficient control of the slugging. Gasification of bituminous and subbituminous coal is not feasible under such conditions because purification and handling of a gas with much dust and heavy tar is difficult and expensive. The advantage of a hydrocarbon-free gas would also be lost when operated with coal. The content of hydrogen in the primary gas is limited to approximately 30 percent with respect to the slagging operation.

A 95-percent carbon monoxide gas can be produced with the slagging method if carbon dioxide is available from some other resource.

Gasification with a Fluidized Fuel Bed (Winkler gas).

Small-sized, disintegrating coal or char can be gasified with a very high gasification rate. However, by-products cannot be recovered. The consumption of oxygen is high and the thermal efficiency relatively low, the moreso with less reactive bituminous coals and coke from such coals. Only a gas with a high hydrogen content can be produced, and the carbon dioxide content of the gas is so high that a water-wash is unavoidable for any utilization. The amount of blown-over fuel is also high.

Gasification of Pulverized Coal (in suspension).

In this process, any coal which can be pulverized at reasonable cost, can be gasified. The recovery of by-products is not possible. The composition of the gas can be changed in a wide range between 2:1 and 1:1 CO to H_2 ratio. A relatively high content of carbon dioxide (above 10 percent) probably makes the elimination of carbon dioxide unavoidable, even with the 2:1 ratio. Until now, it is the only method available for a direct gasification of caking coals.

UTILIZATION OF THE GAS AND THE QUALITY REQUIRED.

It has been mentioned before that the method of gasification determines certain features of the primary gas. In order to estimate the advantages of the gasification methods, it is necessary to analyze the requirements of the gas-consuming industry.

Heating- Public Utility Supply.

At present, this field of consumption is supplied by natural gas of 900 to 1000 B.t.u. or by carburetted water gas of 500 to 550 B.t.u./cu.ft. Supposedly this consumption is increased or has to be replaced by gas from coal. Then a gas of 500 to 800 B.t.u. is needed with 30 percent hydrocarbons and 30 to 40 percent hydrogen. Probably the gas has to be under a pressure of 10 to 20 atmospheres because carbon dioxide must be eliminated and a larger plant would be erected at the mine where production costs are lowest.

Hydrogen Gas for the Hydrogenation and Ammonia Synthesis.

For hydrogenation, practically pure oxygen is needed. Compression of the raw gas and the elimination of carbon dioxide are unavoidable. A high hydrogen content of the primary gas is of great advantage. Hydrocarbons are a great disadvantage and should not exceed one and one-half percent. Organic sulfur is of no great importance.