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Introduction

A tendency toward a decrease in coal quality is reported from various parts of the world, especially in the coking coal sector. In terms of steam coals, countries such as South Africa [1], India [2], Japan [3], or even China [4] report about utilization of coal with elevated ash content. According to MacDonald *et al.* [5] and the ISO 11760 classification [6], coals are referred to as "high ash" or "moderately high ash" if they have an ash yield greater than 20 wt% (wf). In terms of gasification, several disadvantages can be expected as the ash content increases:

1) The physical heating and cooling and melting of the ash material reduce process efficiency.
2) High ash content is detrimental to carbon conversion for reasons of carbon encapsulation.
3) Addition of fluxing agents to influence the ash behavior is limited.
4) Increasing amounts of vaporized ash compounds could increase fouling in downstream heat exchangers.
5) Coal preparation expenditures increase in terms of grinding, drying, or de-ashing.

Mineral matter reactions can additionally hamper the process, that is, oxygen consumption by substances that are not fully oxidized, such as Fe_3O_4 or FeS_2, or CO_2 release from carbonates. Special solvents might be considered to de-ash the coal [7]. However, because of recovery and regeneration problems, operational and capital costs increase while availability decreases and this option is mostly abandoned. As soon as the ash contains certain constituents (quartz and pyrite in particular), wear and abrasion in milling systems lead to extensive maintenance programs [8]. Thus, crushing should be kept at the lowest possible level.

The traditional approach to gasify such kind of feedstock is, of course, employing moving-bed systems featuring dry-ash removal, for example, Lurgi fixed-bed dry bottom (FBDB) gasification. But moving-bed technologies require a suitable grain size for bed percolation and can cope only with limited amounts of fine coal. In addition, modern mining technologies produce increasing quantities

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of fine coal and the high-ash content prevents acceptable agglomeration properties, for example, for briquetting. Consequently, vast amounts of high-ash coal fines are left over from moving-bed processes or other coal washing and beneficiation processes. These cannot be gasified efficiently using today's standard technologies [9].

The task of the present book is to investigate the capability of existing technologies and the potential of new concepts for processing high-ash coal. A study is carried out using a high-ash coal from South Africa – especially fines for pulverized coal application – compared to a baseline standard coal, which is American Pittsburgh No. 8 bituminous coal. To compare the different approaches, thermodynamic modeling and exergy analysis will be applied. The evaluation of the results should lead to the identification of the most promising concept, which is intended to be investigated in a case study.

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