Briquetting press as an alternative feeding system for pressurized gasification reactors

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1. Introduction

Aim of research:
Test of already known technical solutions for their function as an alternative, lock-free, continuous working feeding system

Disadvantages of currently used feed systems:
- Discontinuous operation mode (lock systems)
- Complexity of apparatus (wear and sealing problems)
- Impairment of energy efficiency by gasification using the transport gas

Reactor
Pressurized gasification reactor (up to 65 bar)

Feed system for solid fuel
Briquetting press:
- Well known technical solution
- High throughput
- High feeding pressure

Challenge:
Avoidance of the gas escape from the gasification reactor to the environment
2. Briquetting press as an alternative feeding system

Basic research on the hydraulic stamp press equipped with specially test rig

**Test rig:**
- simulates the function of the briquetting press with open press channel
- allows the creation and loading of the briquette plug with gas pressure

**Preparatory studies on the hydraulic stamp press**

**Test rig:**
- simulates the function of the briquetting press with open press channel
- allows the creation and loading of the briquette plug with gas pressure

- gas tightness tests with briquette plugs in static and dynamic state (resting and moved briquette plug)
- measuring the cross-bracing of briquette plug in the press channel
- tests for determination of the optimum press channel geometry
3. Studies on the tightness of a briquette plug

aim of investigations in this test series:
study of the briquetting parameters influence on the gas tightness of the briquette plug

<table>
<thead>
<tr>
<th>Briquetting parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Briquetting pressure</td>
<td>1000, 1400, 1800 bar</td>
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<tr>
<td>Gas pressure</td>
<td>10, 30, 55 bar</td>
</tr>
<tr>
<td>Particle size of coal</td>
<td>0-1 mm and 0-4 mm</td>
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<tr>
<td>Water content of coal</td>
<td>13 and 20 %</td>
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</table>
Creation of the briquette plug with the test rig and applying of the gas pressure

briquette plug tightness measurement with gas pressure
3.1 Gas flow measurements using pure brown coal

The influence of the briquetting pressure on the tightness of the briquette plug

The improvement of the gas tightness through:
- Reduction of the dwell time of briquetts in the press channel
- High briquetting pressure (max. 1400 bar)
The influence of water content on the tightness of the briquette plug

The improvement of the gas tightness through:

- Short dwell time of briquetts in the press channel
- High briquetting pressure (max. 1400 bar)
- High water content of brown coal
- Minimizing of the gas flow in edge region through successive pressing of new briquetts – maintaining of high cross bracing level

- Study of the gas flow through porosity through permeability measurements:
  - Optimum parameter constellation to improve the structure tightness
  - Determination of the gas flow proportions in the total gas flow
Principle of the permeability measurement

The permeability \((k)\) characterizes the diffusion of a gas under pressure through the porosity of material.

\[
k = \frac{2\dot{V}\eta Lp_0}{A(p_E^2 - p_A^2)}
\]

- \(\dot{V}\) - volume flow
- \(\eta\) – dyn. viscosity of gas
- \(A\) – area
- \(p_E\) – input pressure
- \(p_A = p_0 = p_{Atm}\) – output pressure
- \(L\) - length

The pressure compensation occurs through the porosity of specimen.
Results of the permeability measurements

Grain size 0-4mm, Water content 20%, Briquetting pressure 1200 bar

Grain size 0-1mm, Water content 13%, Briquetting pressure 1200 bar

In the beginning (first 5-10 seconds after briquetting) the gas flow occurs only in the edge region

Successive creation of new briquettes is required!
Confirmation of the gas flow measurement results on the test rig according to the influence of briquetting parameters through permeability measurements

Influence of water content

Influence of the briquetting pressure
3.2 Gas flow measurements using brown coal with additives

**Aim of the investigations with additives:**
Improving of the brown coal briquette plug tightness especially for dry brown coal (13% water content)

**The studies were carried out with:**
- additives widely used in the agglomeration technologies and brown coal briquetting
  - Starch
  - Molasses
  - Montan resin
  - Slaked lime
- substances, that are not commonly used in agglomeration
  - HSC-residue
  - Ash

**Additive content: 5%**
The influence of additive molasses:

Molasses is a residue of sugar production, contains around 60% sugar

Without additives

With 5 % molasses

The significant increase of the brown coal briquette plug tightness using additive molasses can be observed
The influence of additive HSC-residue (High Conversion Soaker Cracker):

The HSC is a residue from oil processing and can be used in the coking of coal.

The significant increase of the brown coal briquette plug tightness using additive HSC can be observed
Confirmation of the gas flow measurement results on the test rig according to the influence of additives through permeability measurements

**Briquetting pressure 1200 bar**
Grain size of coal 0-1mm
Water content 13%

**Briquetting pressure 1000 bar**
Grain size of coal 0-1mm
Water content 13%

![Bar graph showing permeability measurements for different additives at 1200 bar and 1000 bar pressures.](image)

![Line graphs showing gas flow over time for molasses and ash at 1200 bar and 1000 bar pressures.](image)
4. Summary

Gas flow measurements
Improvement of the briquette plug tightness can be achieved through:
- Use of coal with higher water content (20%)
- The briquetting pressure should not exceed 1400 bar
- Short dwell time of briquetts in the press channel
- Use of additives for dry coals (13% water content)

Permeability measurements
- Determination of the gas flow proportions in the total flow
- Confirmation of the influence of briquetting parameters and additives on the tightness of the briquette plug

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