Safety aspects in the Production and Separation of Hydrogen from Biomass

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SAFETY ASPECTS IN THE PRODUCTION AND SEPARATION OF HYDROGEN FROM BIOMASS

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1. Introduction

**BIOMASS**
- Universal
- Renewable
- Zero balance CO₂
- Great diversity

**GASIFICATION**

**HYDROGEN**
- Combustion without CO₂
- Numerous application
- May be produced by different processes

Safety
2. **Hydrogen from biomass: the process**

- Process to obtain a combustible gas from organic solid material

  **Biomass ⇌ Gasification ⇌ Syngas** \((H_2, CO, CO_2, CH_4,\ldots)\)

  - Temperature: 800-950 °C
  - Biomass feeding: 15% HR; 2mm ps
  - Substoichiometric conditions
  - Gasification agent: air, oxygen or steam
  - High efficiencies

### Table 1: Synthesis gas composition according to gasification agent.

<table>
<thead>
<tr>
<th>Gasification agent</th>
<th>Low Calorific Value (Kcal/m³)</th>
<th>Gas Composition (% vol) Dry based</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(H_2)</td>
</tr>
<tr>
<td>Air</td>
<td>&lt; 1,500</td>
<td>15</td>
</tr>
<tr>
<td>Steam</td>
<td>3,000-7,000</td>
<td>52</td>
</tr>
<tr>
<td>Oxygen</td>
<td>3,000-7,000</td>
<td>32</td>
</tr>
</tbody>
</table>
2. Hydrogen from biomass: the process

Figure 1: Chain of H₂ production via biomass gasification.
2. **Hydrogen from biomass: the process**

- **Biomass**
  - **850°C** Dolomite
    - Gasification \( \text{O}_2/\text{H}_2\text{O}, \text{cat} \)
      - 43% H\(_2\), 22% CO, 25% CO\(_2\), 1% CH\(_4\), 9% tars
  - **800°C** Cat Ni-Al\(_2\)O\(_3\)
    - Tar Craking
      - 49% H\(_2\), 25% CO, 24% CO\(_2\), 1% CH\(_4\)
  - **900°C** Cat Ni-Dolomite Steam
    - Steam Reforming
      - 57% H\(_2\), 22% CO, 21% CO\(_2\)
  - **350°C** Cat Fe-Cr Steam
    - CO-shift
      - 68% H\(_2\), 20% CO\(_2\), 3% CO
  - Max 250°C
    - Membrane separation
      - H\(_2\) (~98%)

**Figure 2:** Hydrogen concentration along the process.

**Exhaust emissions possibility**

**Procedure to establish the technical requirements and the recommended practices to ensure the highest level of safety**

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**Tecnalia Research & Innovation**

**International Conference on Hydrogen Safety**
3. Safety aspects

Valuable point in the process

Gas Mixtures

Easy ignition

ATTENTION!!!

Uncontrolled combustion of hydrogen mixtures

Figure 3: Gasification plant of Tecnalia
3. Safety aspects

Specific attention to:

- Hybrid mixtures: a combination of a flammable gas and dust
- Ignition sources: sparks
- Product gas from gasification: auto-ignite at temperatures above 600-650°C and in the presence of oxygen

Steam gasification → very limited presence of air

Steam gasification is safer compared with air gasification
4. References

4. [www.h2bestpractices.org](http://www.h2bestpractices.org)
THANK YOU FOR YOUR ATTENTION!!!