

## Bio-briquettes based on straw

*Development and testing of straw-briquettes for furnaces, normally used with wood pieces*

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### Projekt partners:

<p><b>RUF GmbH &amp; Co. KG</b> Hausener Str. 101, D-86874 Zaisertshofen Tel.: 0049 8268 909020; e-mail: info@brikettieren.de</p>	<p>Compression moulding, production process</p>
<p><b>Hartmut Wolf Schädlingsbekämpfung &amp; Biobrennstoffe</b> Am Schwanenteich 1, D-04668 Großbothen OT Sermuth Tel.: 0049 34381 42298; e-mail: wolf-sermuth@t-online.de</p>	<p>development of the system solution</p>
<p><b>GNS – Gesellschaft für Nachhaltige Stoffnutzung mbH</b> Weinbergweg 23, D-06120 Halle Tel.: 0049 345 5583754; e-mail: info@gns-halle.de with inclusion of <b>Forschungs- und Beratungszentrums für Maschinen- und Energiesysteme, FBZ e.V., An-Institut der HS Merseburg (FH)</b></p>	<p>scientific monitoring</p>

## 1. Main objectives

Production of bio-briquettes based on straw with the following properties:

- can be used in each furnace, in which normally log wood is burned,
- show a good scorching and burning without ash slagging,
- during the combustion the emission limit of 1. BImSchV (German law) will be kept,
- recognized as regular fuel for small stoves (< 15 kW),
- suitable as a decentralized system solution for procurement, production, use and distribution particularly for agricultural and industrial enterprises.

## 2. Technological solution

To create such a fuel with uniform quality and best possible conditions for a low-emission combustion, the following measures were implemented:

- straw with numerous varieties and mixtures with and without additives and with or without pretreatment (drying, size reduction) are prepared and burned.
- production of bio-briquettes with a specially adapted briquetting machine of RUF GmbH & Co. KG to achieve high density and strength.
- testing of a technological process chain from storage to bagging the bio-briquettes on the company Hartmut Wolf premises.
- physico-chemical study of the bio-briquettes by GNS and derivation of criteria for quality control.
- field testing with small-scale furnace to study the combustion characteristics and emission behavior by GNS and FBZ.



two strand chain briquetting machine



bagging the bio-briquettes

### 3. Properties of the bio-briquettes

<u>Raw material:</u>	rape straw, wheat straw, barley straw, triticale straw, rye straw, hay (establishing preferred straw mixtures)
<u>Pretreatment:</u>	bale breaking, size reduction, mixing, drying
<u>Additives:</u>	sugary solution (contain: max. 2%), to improve the combustion characteristics for use in small-scale furnaces

Parameter	Unit	Bio-briquette (average)	Bio-briquette (strip width)	<i>Straw pellets (FNR- measurement program)</i>
Size	mm	<b>62 x 63 x 71</b>		
Moulded density	kg/dm <sup>3</sup>	<b>0,8</b>	0,7 bis 0,9	
Abrasion <sup>1</sup>	%	<b>6,2</b>	3,6 bis 11,2	
Water content	%	<b>5,7</b>	4,9 bis 6,3	
Ash content (550°C)	% TS	<b>6,9</b>	6,1 bis 8,4	<i>3 bis 12</i>
Heat value H <sub>u</sub>	MJ/kg	<b>17,4</b>	17,2 bis 17,6	<i>16,8 bis 17,5</i>
Sulphur	% TS	<b>0,09</b>	0,07 bis 0,12	<i>0,04 bis 0,7</i>
Chlorine	% TS	<b>0,15</b>	0,1 bis 0,2	<i>0,02 bis 1,8</i>
Nitrogene	% TS	<b>0,6</b>	0,5 bis 0,7	<i>0,3 bis 1,2</i>
Kalium	% TS	<b>1,2</b>	1,1 bis 1,5	<i>0,4 bis 3,7</i>
Energy density	MW/m <sup>3</sup>	<b>3,7</b>	3,4 bis 4,3	
Ash melting point	°C	<b>&gt; 900</b>	> 900	

<sup>1</sup> by heavy loading of the Lignotester in accordance with DIN ISO 15210-2

#### Special features of the bio-briquettes

- good strength and low abrasion under proper storage and transport
- quality control of water-, N-, S- and Cl-content
- optimized formulation with effective reduction of ash slagging even without the addition of calcium carbonate
- good scorching by low water content and low-cost additives especially when used in small furnaces

#### so that:

- avoidance of unfavorable operating conditions with peak emissions during scorching and combustion of the straw-briquettes
- minimization of the emission disadvantages of straw-biomass to wood

**Basically, if Bio-Briquettes are used in suitable combustion plants than are no disadvantages expected compared to straw pellets.**

#### 4. Field tests on small manually driven furnaces

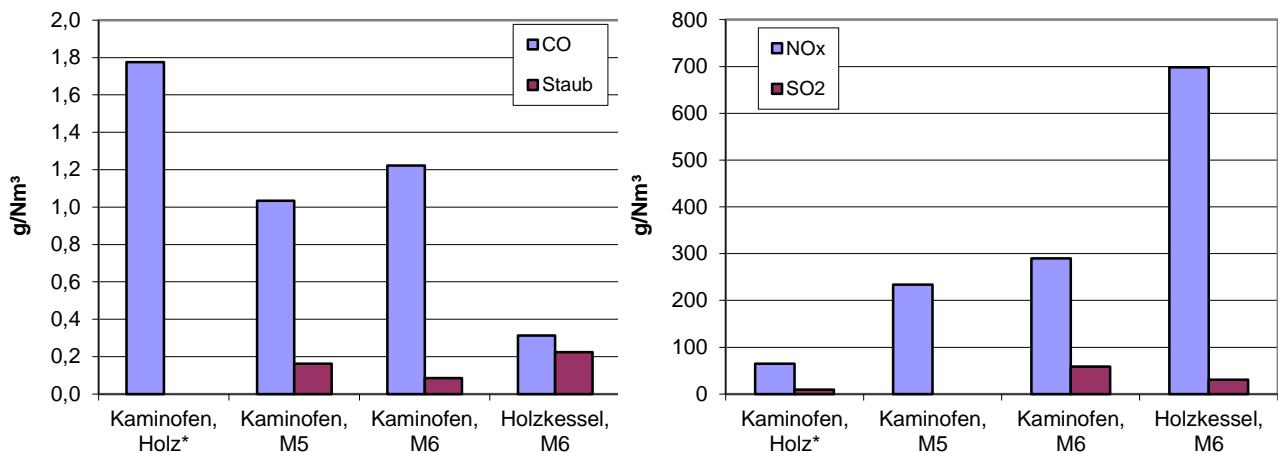
small furnace: 6 kW, provided by company Hartmut Wolf (in figure: "Kaminofen")  
 manually driven with primary and secondary air control  
 measurement according to 1. BImSchV (German law) on the location  
 of HS Merseburg (FH)

log wood furnace: 50 kW, Company Lopper Kesselbau GmbH  
 manual driving, with induced draft fan and afterburner  
 measurement according to 1. BImSchV (German law) on the location  
 of Lopper Kesselbau GmbH (in figure: "Holzkessel")

measurement: flue gas analyzer Testo 330 (15 min averages)  
 dust measuring device Föhdisch GMD 06 (1/2 hour averages)  
 (in figure: dust = "Staub")

#### Measurement results with optimized bio-briquette M5 (with additive) and M6 (without additive):

Emission results in reference to 13 Vol.-% of oxygen



\* comparison measurement

#### Evaluation of the emission measurements:

- Basically these Bio-briquettes can be used in small manually driven furnaces without any special control technology. The Bio-briquettes have proven since its first use.
- In manual mode, in small furnace optimum efficiencies of 78% and in log wood boilers up to 86% are achievable.
- The dust emissions were 55 to 223 mg/Nm³ mainly below 150 mg/Nm³ (German emission limit)
- With only one exception (log wood boiler) the limit of 600 mg/Nm³ for NOx-emissions could be significantly undercut.
- The CO emissions varied by an average of 1 to 2 g/Nm³. However, larger emission peaks up to > 10 g/Nm³ occurred both in wood- and in the straw-briquettes in the small-scale furnace. These emission peaks are not fuel related but the small-scale furnace with manual feeding is difficult to regulate for lower emissions. The scorching and burn down of the Bio-briquettes is comparable to that of wood.