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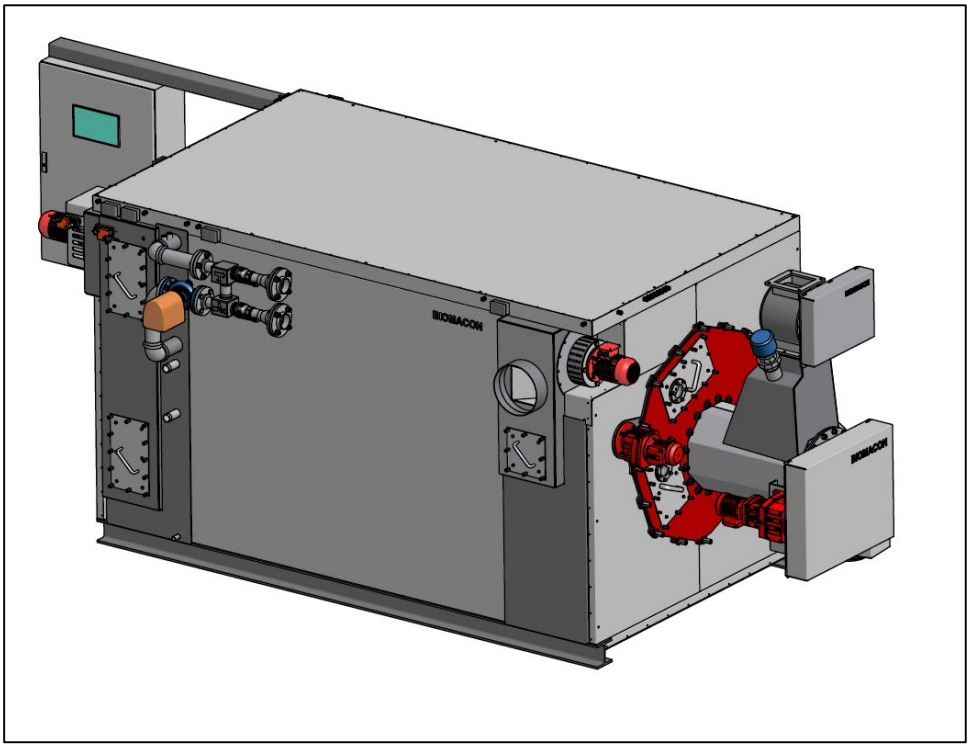
11/11/2018

BIOMACON
COMPACT CONVERTER:

SYSTEM EXPLANATION



CE

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Content

1. System Explanation:

Climate change, resource scarcity, soil desertification and groundwater pollution are the big challenges of the 21st century. The BIOMACON technology constitutes one important component as far as dealing with these challenges is concerned. Apart from systematic resource conservation, there is currently no other promising solution to these challenges.
Biomass is one of the most important global CO2 storages, besides water, soil and atmosphere. In conventional use of biomass for energy generation, the amount of CO2 that is released always equals the amount that is previously bound by the biomass. The BIOMACON technology, on the other hand, only uses the hydrogen contained in the biomass for energy generation. Chemically stable carbon is systematically decoupled as biochar. Biochar is an important tool in the fight against climate change. One kilogram of pure carbon binds 3.6 kg CO2 for more than 1000 years. Biochar is also a strong tool for the prevention of soil desertification. By replacing nitrate containing fertilizers with biochar, surface water and groundwater are actively protected.

2. General Information about function units

2.1. Compact Converter

The converter is designed for lignin –containing materials with a maximum water content of less than 50%. Under these conditions, the converter can fully utilise the in-build technical innovations.

- The compact converter requires only small amounts of space and can therefore be easily integrated into existing buildings.
- The compact design ensures maximum heat efficiency and minimal radiation losses.
- The ceramic lining allows for extremely high process temperatures. The result is low-emission high-quality bio char
- Compact converters are heat driven and designed according to required heat consumption. They are available in different sizes. The modulating output control automatically adapts to the required heat consumption.

Through the sector gate, the raw material reaches the converter screw, which then transports the biomass through a combustion chamber. Within this chamber, the biomass is dried, pre-heated and pyrolised, and further energy is added in the reformer chute. As during the production of active carbon, a very hot gas mixture passes through the smouldering biomass. The residence time is extremely long and leads to an exceptionally clean biochar.

2.1.1. Heat shield Technology

The Heat Shield technology developed by BIOMACON uses an internal water jacket which surrounds the entire converter. In that way, the thermal efficiency complies with the latest standard of modern heating systems and is therefore a pioneering tool for resource conserving use of biogenic raw materials.

2.1.2. Dialogue control

Even untrained personnel will find it easy to work with the BIOMATRONIC dialogue control. In the dialogue menu, separate programs are stored for the various applications. The machine can be switched to the different modes simply by tapping on the menu buttons. The standard version has stored the following programs:

- HEAT CONTROLLED SUMMER AND WINTER SERVICE
- HIGH QUALITY, PREMIUM AND COMMERCIAL BIOCHAR SERVICE

BIOMATRONIC is permanently connected with the BIOMACON server and the customers' machines. Remote control via computer or smartphone is included in the basic configuration.

2.1.3. High temperature reformer

The production of biochar with high quality is enabled through long retention time within the high temperature reformer. Optionally, the machine can be equipped with a gas or steam activator. The temperature in the coal can then easily rise to above 1000°C.

2.1.4. Start stop control

The electronic START-STOP control works independently, the machine automatically adapts to heat consumption. Apart from some electric power for ignition, no additional energy input is required. The start-stop control automatically turns itself off and on.

2.1.5. Mono Screw

The BIOMACON MONO SCREW with double bearing is extremely robust and requires only one movable component. Metal-on-metal friction is ruled out. Chrome and nickel remain in the machine and are not absorbed in the biochar.

2.1.6. Low NOx burner

Through recirculation of exhaust gases, the Low-NOx burner's flame temperature is electronically regulated to temperatures of 950° to 1050°, resulting in extremely low concentration of nitrogen oxide. Low-NOx means 'small amount of nitrogen oxide". Long dwelling time in the afterburning chamber enables the complete reaction of all gas. All these measures ensure excellent emission values.

2.2. Feeding Unit

- The feeding unit shall be placed inside a 20' high cube open top shipping container. With the access road as indicated in drawing A109-C100-001 the wheel loaders needs to have enough access the feeding unit needs to be able to easily manoeuvre.
- The feeding screw conveyer tube shall be square shaped. This avoids raw material to rotate with the conveyer screw and therefore prevents clogging of the feeding conveyer system.
- The open top of the feeding container needs to have a flexible tarpaulin that prevents the feeding material of getting wet.

2.3. Compact Converter Unit

- The Compact Converter that is delivered by Biomacon GmbH shall be placed inside an 20' high cube side door shipping container.
- The side door allows easy maintenance access
- The front door can be used for regular O&M works
- The high cube allows for less heat development inside the container
- **It is important to place 3000l hot water buffer tank close by the Compact Converter.** The buffer is indicated in Drawing 005 as part of the hydraulic system.This buffer tank needs have good insolation and an integrated electrical heating cartridge to prevent freezing in winter during system down time.

2.4. Discharge Unit

- The discharge unit consists of a flexible screw conveyer and four big bags for biochar collection
- The flexible screw conveyer has the big advantage that only one electric motor is necessary to drice the screw conveyer. This saves installation complexity and costs.
- The big bags are connected to the screw conveyers with gate valves that can be closed before biochar is removed with a fork lift
- There is no necessity for biochar cooling or moisturizing after the biochar is discharged. The Big bags need to be placed 5m apart from the Compact Converter Unit. The slow moving conveyer screw allows the biochar to cool down before the biochar enters the big bags.

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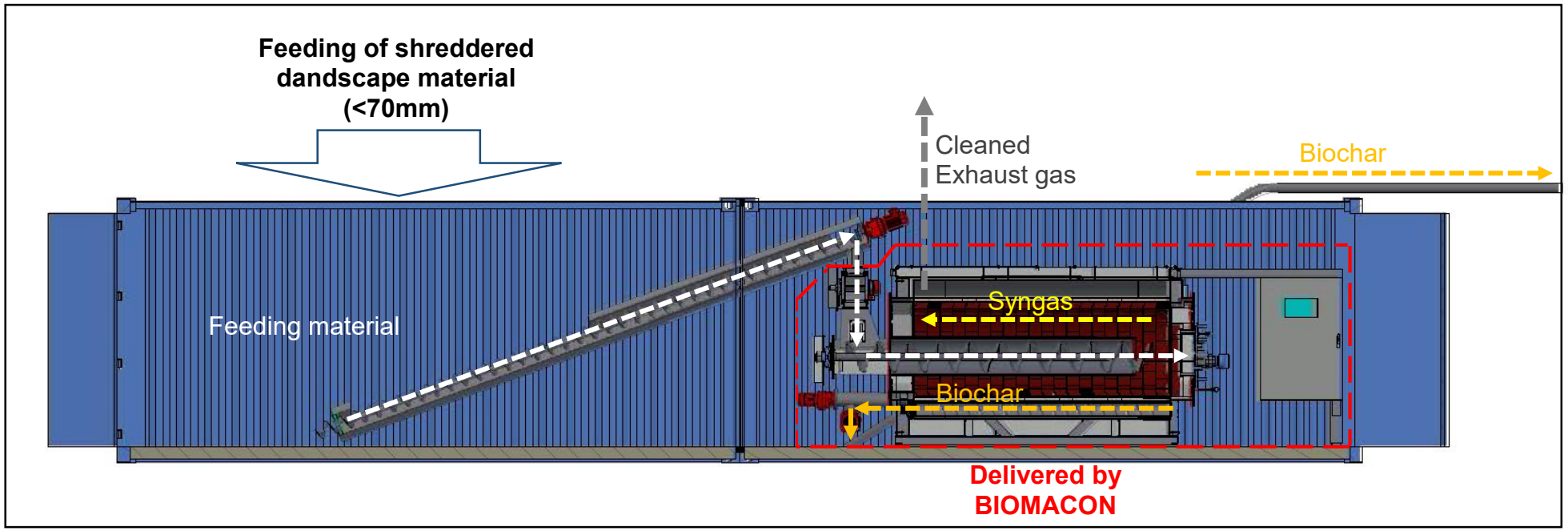
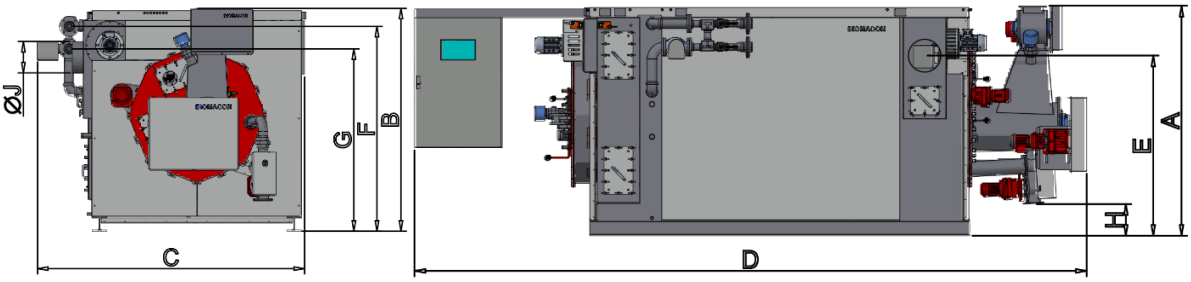
3. Compact Converter Process



4. Dimensions of Compact-Converter



Typ	C40-3	C63-3	C100-3	C160-3	C250-3	C400-3
Feed-In hight A [mm]	1.744	1.760	1.760	2.118	2.283	2.283
Total hight B [mm]	1.767	1.768	1.770	2.127	2.803	2.803
Width C [mm]	1.902	1.902	1.902	2.554	5.150	5.150
Transport width [mm]	1.902	1.902	1.902	2.554	2.554	2.554
Gate width (A) for installation room [mm]	2.102	2.102	2.102	2.754	2.754	2.754
Total depth D [mm]	4.684	5.169	5.400	6.192	8.716	10.258
Diameter exhaust gas pipe [mm]	180	180	180	300	300	300
Biochar discharge [mm]	165	196	225	293	408	408
Weight[kg]	4.763	5.562	7.310	9257	14.600	17.607
Nominal power [kW]	40	63	100	160	250	400

5. Operating and Maintenance Requirements

The BIOMACON compact converters are designed for everyday continuous operation. In addition to top quality materials, a coherent and consistent design is indispensible for. Our systems do not require gas pipes. Depending on the quality of the raw material, cleaning intervals of over 2000h are not unusual. The BIOMATRONIC displays the degree of contamination and suggests an additional timeframe for the next cleaning interva

5.1. O&M – Introduction

Read the operating instructions carefully in order to ensure the safe, trouble-free and economical operation of the system. Before commissioning the system, all safety conditions must be fulfilled. Only qualified and trained persons of the company BIOMACON or their representatives may work on the plant. Only high-quality and correspondingly expensive materials were used in the construction of the carbonization plant. Due to a high water content in the raw material, the materials used are strongly

stressed. This does not mean that such moist materials cannot be carbonized, but that when such raw materials are carbonized, the service life of the machine will be reduced. The same applies to inorganic constituents in the raw material. Inorganic fractions consist essentially of quartz grains. Quartz grains are very abrasive and cause premature wear.

5.2. Security

All persons involved in the installation, commissioning, operation and maintenance of the system must read the safety instructions and the hazard assessment. In particular, follow the measures for the prevention of hazards according to the hazard assessment. Observe the warnings on the machine parts.

5.2.1. General safety instructions

Failure to observe safety instructions can result in death, serious injury, and / or property damage.
Please note the following general notes:

- Have repairs carried out by qualified personnel only
- Do not remove any safety covers during system operation
- Do not bridge any safety switches
- Switch off the system before carrying out any cleaning or maintenance work

5.2.2. Intended Use

The plant is designed and built for the carbonization of organic material with a lignin content above 15% and celluloses content of above 35%. The carbonation of other raw materials will void all warranty and liability on the part of BIOMACON.

5.2.3. Hazards, hazards and avoidance of accidents

- **Doors in the carbonization plant:**

It is strictly forbidden to open the doors of the plant or at a standstill. Only the company BIOMACON or their representatives may open these doors!

- **Enter the container roof**

It is strictly forbidden to enter the roof of the container.

- **Persons inside plant container**

The operator has to make sure that nobody is in the plant container. After this, the door must be closed and secured against unauthorized access by a padlock.

- **Revision opening of screws**

The covers of the inspection openings of the discharge **conveyor screws** may only be opened if the main switch on the control cabinet is in the O **(Off)** position. The switch must be secured with a padlock to prevent it from being switched on again by

unauthorized persons. Before removing the lock, check that all guards, covers, inspection openings, etc. are properly closed.

- **Authorized operators**

Persons under 18 years of age are not allowed to use the carbonisation system. The system may only be operated by trained personnel
The operator of the system must make the operating instructions accessible to the operator and make sure that he has read and understood them. Only then the operator is allowed to commission the system.
The operator must ensure that only authorized personnel work on the system.
The system must be protected against unauthorized use.

- **Emergency stop**

The operator has to inform himself about the positioning of the emergency stop switches. When pressing one of the emergency stop switches, all mechanical drives are immediately switched off. To prevent damage to the system, the fans are switched off only after 15 minutes. The pumps continue to run continuously.

- **Personal protective equipment**

We recommend wearing protective gloves, protective helmets and safety shoes for work on the system.

Only the raw material may be carbonized according to the tender

6. Documentation of exhaust emissions (in German)

Bericht Nr.: 42286/421600/12821/552133129/1

Hauptvolumenstrom an der Messstelle	
Auftraggeber :	Freie Universität Berlin
Projektnummer :	552133129
Standort :	Botanischer Garten
Anlage :	Karbonisierungsanlage
Messstelle :	Reingas
Messtermin :	19.10.2015

Emissionstechnische Daten		
Luftdruck	1008	hPa
Mittlerer Sauerstoff-Gehalt	7,8	Vol.-%
Mittlerer Kohlendioxid-Gehalt	12,7	Vol.-%
Mittlere Abgastemperatur	211	°C
Abgasfeuchte (trocken)	164,6	g/m^3
Abgasfeuchte (feucht)	17,0	Vol.-%
Abgasdichte (Betriebszustand)	0,708	kg/m^3
Abgasdichte (Normzustand, trocken)	1,357	kg/m^3
Statischer Druck	-35	Pa
Kanalquerschnitt	0,042	m^2
Mittlere Strömungsgeschwindigkeit	33,7	m/s
Volumenstrom (Betriebszustand)	5092	m^3/h
Volumenstrom (Normzustand, feucht)	2857	m^3/h
Volumenstrom (Normzustand, trocken)	2371	m^3/h

Geschwindigkeitsprofil im Kanal [m/s]:	
Achse 1	33,6 34,0
Achse 2	33,4 33,7

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Kontinuierliche Probenahme - O_2 / CO_2 / NO_X / CO / Methan

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Messtermin :	19.10.2015

Messung - Nr.		1	2	3	4	5	6
Start Messung	[hh:mm]	11:23	11:56	13:10	13:56		
Ende Messung	[hh:mm]	11:53	12:26	13:40	14:26		
Messdauer	[hh:mm]	00:30	00:30	00:30	00:30		
Luftdruck	[hPa]	1008	1008	1009	1009		
O_2	[Vol.-%]	11,6	9,4	8,4	7,8		
CO_2	[Vol.-%]	9,1	11,2	12,1	12,7		
NO_X (NO + NO_2, gerechnet als NO_2) - Massenkonzentrationen und Massenströme							
NO_x - Gehalt	[ppm]	99,9	152,8	186,2	199,8		
NO_x - Gehalt	[mg/m³]	204,8	313,2	381,7	409,6		
NO_x - Gehalt, *EB	[mg/m³]	217,9	270,0	302,9	310,3		
Massenstrom	[kg/h]	0,486	0,743	0,905	0,971		
CO - Massenkonzentrationen und Massenströme							
CO - Gehalt	[ppm]	13,5	15,5	10,8	10,7		
CO - Gehalt	[mg/m³]	16,9	19,4	13,5	13,4		
CO-Gehalt, *EB	[mg/m³]	18,0	16,7	10,7	10,1		
Massenstrom	[kg/h]	0,040	0,046	0,032	0,032		
Methan - Massenkonzentrationen und Massenströme							
CH_4 - Gehalt	[ppm]	< 0,5	< 0,5	< 0,5	< 0,5		
CH_4 - Gehalt	[mg/m³]	< 0,4	< 0,4	< 0,4	< 0,4		
CH_4 - Gehalt, *EB	[mg/m³]	< 0,4	< 0,4	< 0,3	< 0,3		
Massenstrom	[kg/h]	< 0,001	< 0,001	< 0,001	< 0,001		
*EB-Emission, bezogen auf den Bezugssauerstoffgehalt von 11 Vol.-%							
Weitere Stoffe - Volumenkonzentrationen ohne Sauerstoffbezug							
H_2O (feucht)	[Vol.-%]	12,0	14,7	16,1	16,6		
$NO_{2\ (trocken)}$	[ppm]	2,4	5,4	7,0	6,9		
N_2O (trocken)	[ppm]	1,1	0,6	< 0,5	< 0,5		
NH_3 (trocken)	[ppm]	< 0,5	< 0,5	< 0,5	< 0,5		
HCl (trocken)	[ppm]	< 0,5	< 0,5	< 0,5	< 0,5		
Acetylen (trocken)	[ppm]	< 0,5	< 0,5	< 0,5	< 0,5		
Ethen (trocken)	[ppm]	0,7	0,5	< 0,5	< 0,5		
Ehtan (trocken)	[ppm]	< 0,5	< 0,5	< 0,5	< 0,5		
Propen (trocken)	[ppm]	< 0,5	< 0,5	< 0,5	< 0,5		
Propan (trocken)	[ppm]	< 0,5	< 0,5	< 0,5	< 0,5		
Benzol (trocken)	[ppm]	< 0,5	< 0,5	< 0,5	< 0,5		
Toluol (trocken)	[ppm]	< 0,5	< 0,5	< 0,5	< 0,5		
Xylol (feucht)	[ppm]	< 0,5	< 0,5	< 0,5	< 0,5		
Formaldehyd (trocken)	[ppm]	< 0,5	< 0,5	< 0,5	< 0,5		

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Diskontinuierliche Probenahme - Stoffe

Auftraggeber:	Freie Universität Berlin
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Messung Nr.:		1	2	3	4	5	6
Start Messung	[hh:mm]	11:23	11:56	13:10	13:56		
Ende Messung	[hh:mm]	11:53	12:26	13:40	14:26		
Messdauer	[hh:mm]	00:30	00:30	00:30	00:30		
Luftdruck	[hPa]	1008	1008	1009	1009		
Sauerstoffgehalt	[Vol.-%]	11,6	9,4	8,4	7,8		
Schwefeloxide [SOx als SO2] - Massenkonzentrationen und Massenströme							
Temperatur Gasuhr	[°C]	11,7	12,6	17,5	16,8		
Teilgas, Betrieb	[l]	57,4	56,7	59,1	58,0		
Teilgas, norm	[l]	57,3	56,5	57,9	57,0		
Analysen	[mg/Pr.]	0,5	0,8	1,1	1,2		
Massenkonzentration	[mg/m^3]	8,2	14,7	19,0	21,1		
Massenkonz., *EB	[mg/m^3]	8,7	12,7	15,1	16,0		
Massenstrom	[g/h]	19,4	34,9	45,0	49,9		
- Massenkonzentrationen und Massenströme							
Temperatur Gasuhr	[°C]						
Teilgas, Betrieb	[l]						
Teilgas, norm	[l]						
Analysen	[mg/Pr.]						
Massenkonzentration	[mg/m^3]						
Massenkonz., *EB	[mg/m^3]						
Massenstrom	[g/h]						
- Massenkonzentrationen und Massenströme							
Temperatur Gasuhr	[°C]						
Teilgas, Betrieb	[l]						
Teilgas, norm	[l]						
Analysen	[mg/Pr.]						
Massenkonzentration	[mg/m^3]						
Massenkonz., *EB	[mg/m^3]						
Massenstrom	[g/h]						

*EB-Emission, bezogen auf den Bezugssauerstoffgehalt von 11 Vol.-%