Asia-Pacific Economic Cooperation

APEC Workshop on Bio-pellet Production, Handling and Energy Utilization

Biomass Briquette/Pellet Production, Handling and Utilization in China

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Outline

- Background
- Biomass densified fuel industry growing in China
- Biomass densified fuel production in China
- Biomass densified fuel related standards in China
- Biomass densified fuel application and emission
- Summary

1 Background

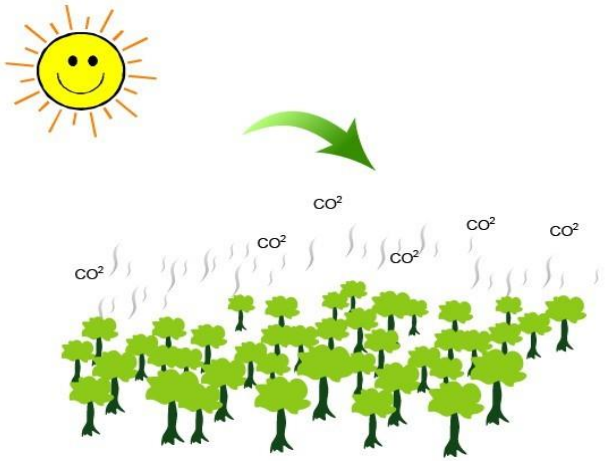
Sustainability

- Conventional energy resources and consumption (energy crisis and safety)
- Environmental pollution
- Rural development

Biomass densified fuel industry

1 Background

- Unlike fossil fuels, biomass crops are CO_2 neutral, in other words, they don't add extra CO_2 back in the atmosphere when they burned.
- Many scientists believe too much CO_2 is bad for the environment.
- Instead, they emit only the same amounts of CO_2 as they took in when they grew.



1 Background

Advantages of biomass densified fuel:

- Easy for storage and transportation
- Easy to use and sanitary
- High combustion efficiency
- Environmental friendly

Biomass densified fuel is a relatively clean burning process and as power producers move towards new technologies and leave their old boilers behind.

2 Biomass Densified Fuel Industry Growing in China

Every year, there are more than 700 million tons of crop straw in rural area of China, equivalent to 408 million tons of standard coal; 200 million tons of forestry processing residues which is equal to about 100 million tons of standard coal.

Every year, there are more than 2.5 billion tons of livestock and poultry feces and large amounts of organic wastes, equivalent to 300 million tons of standard coal.

Major Energy Crops

- **Starch and Sugar:**

  Corn, wheat, cassava, sweet potato, etc.;

  Sugar: sugarcane, sugar beet, sweet sorghum, etc.

- **Lipids**:

  Rape seed, sunflower, castor-oil plant, soybeans;

  Jatropha, palm, coconut tree, olive tree, tea tree.

- **Lignocellulose**:

  Eucalyptus, poplar, willow;

  Switchgrass, reed, bamboo reed, silvergrass, etc.

Taking advantage of barren, marginal and polluted land to cultivate energy crops.

Energy Crops

Bushy cellulose grass family which is rich in hydrocarbon compound.

- High yield of dry matter, it is perennial which benefits for long period after cultivation.
- Energy crops have strong stress resistance and are with good adaptability, low environmental requirements and low cost of production.
- Good ecological benefits, appropriate use of marginal land, can not only improve the ecological environment but also require no farmland.
- Renewable and clean energy, absorb CO_2 and little SO_2 emissions.
- Broad usage: cellulose ethanol, biomass briquette or pellet, bio-oils (pyrolysis), syngas (gasification), direct combustion for power generation.

Source：Beijing Prataculture and Environmental R & D Center

Components of Energy Crops

Grass Species	Hemi-cellulose (%)	Cellulos (%)	Lignin (%)	Ash (%)	Calorific value (MJ/kg)
T. sacchariflora	28.76	31.13	7.13	1.25	17.93
A. donax	27.16	32.62	8.08	0.51	18.23
P. americanum ×*P. purpureum*	20.11	36.04	8.89	2.14	17.00
Pa. virgatum	25.49	30.16	6.35	0.77	17.91

Source: Beijing Prataculture and Environmental R & D Center

Biomass Briquette and Pellet Market in China

Principle： Economic

Substitution： Natural gas, light diesel oil

District: Areas with high environmental protection pressure

Areas with serious pollution

Areas with coal forbidden areas

Application： Small and medium sized boilers

Small and medium sized industrial kilns

Tendency： Integration with other renewable energy sources and fossil energy

Source： Shiping Qin, 2013. Energy Research Institute, NDRC, China

Biomass Briquette and Pellet Policy in China

- The development of biomass briquette/pellet industry will be supported by policy for a long time.
- The economic incentive policy will shift from the end of **supporting fuel production** to the **application side** of the customer. The possible way is to switch from the **product subsidies** to **investment subsidies or consumer incentives**.
- The elimination of market barriers will be the focus of recent government work, including planning **objectives, guidance, technical guidelines, emission standards, testing standards**, etc.
- China will support the research and development of various biomass briquette/pellet production and application technology, in order to form a diversified technology system.
- The central government will encourage local governments, especially provincial governments, to introduce local support policies.

Source：Shiping Qin, 2013. Energy Research Institute, NDRC, China

Relevant Laws, Regulations and Industrial Policies

No.	Document	Contents
1	Renewable Energy Law	This law is designed to **promote the development and utilization of renewable energy**, increase energy supply, improve energy structure, protect energy security, protect the environment, and achieve sustainable economic and social development.
2	Medium and long term planning for renewable energy development	By 2010 and 2020, the annual biomass densified fuel utilization will reach 1 million tons and 50 million tons respectively.
3	Ministry of Finance	Interim measures for management of subsidy funds for crop straw energy utilization: 150 ￥ per ton of crop straw.
4	Opinions on speeding up the comprehensive utilization of crop straws	• Orderly development of straw based biomass energy. Actively use straw molding and carbonization and other biomass energy development, and gradually improve the rural energy structure. • Increase capital investment, the **production of biomass briquette/pellet derived from straw** to provide appropriate financial support.

Relevant Laws, Regulations and Industrial Policies

No.	Document	Contents
5	Development plan of agricultural biomass energy industry (2007-2015)	By 2010, the country built about **400** straw briquette/pellet production and application demonstration, straw briquette/pellet annual utilization is about **1 million** tons, to 2015, annual utilization of straw briquette/pellet reached **20 million** tons.
6	Energy development 11th Five-Year plan	The development of renewable energy resources, such as wind power generation, biomass power generation, **biomass densified fuel**, solar energy utilization, and other renewable energy resources, with large potential resources and basically mature technology, will promote industrial development with large-scale construction.
7	The 13th five-year plan for developing biomass energy	To speed up building heating project of advanced large-scale biomass pellet boiler with **low pollutant emission**. Take advantage of the low sulfur content molding fuel, and vigorously promote the 20-ton steam/hour and low emission biomass pellet boiler heating projects in the industrial park to reach the pollutant emission level of natural gas.
8	China's national plan for addressing climate change	One of the key areas to reduce the emission of greenhouse gases is to **promote the development of biomass energy**, biomass power generation, biogas, biomass solid fuel and liquid fuel as the focus, and vigorously promote the development and utilization of biomass energy.

3 Biomass Densified Fuel Production in China

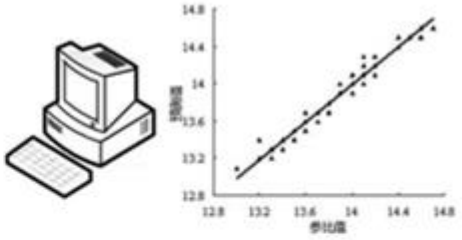
- Biomass Feedstock and Logistics
- Biomass Pre-treatment
  - Chopping & Shredding (Size reduction)
  - Dehydration & drying
- Biomass Densification
  - Briquette & pellet production
  - Charcoal production

Rapid Detection Technology of Physical Properties of Crop Straws

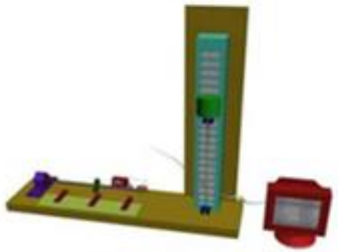
Straw Sampling

Electro-optic exam

Moisture content of conventional detection



Algorithm research and modeling for moisture content of electro-optic detection



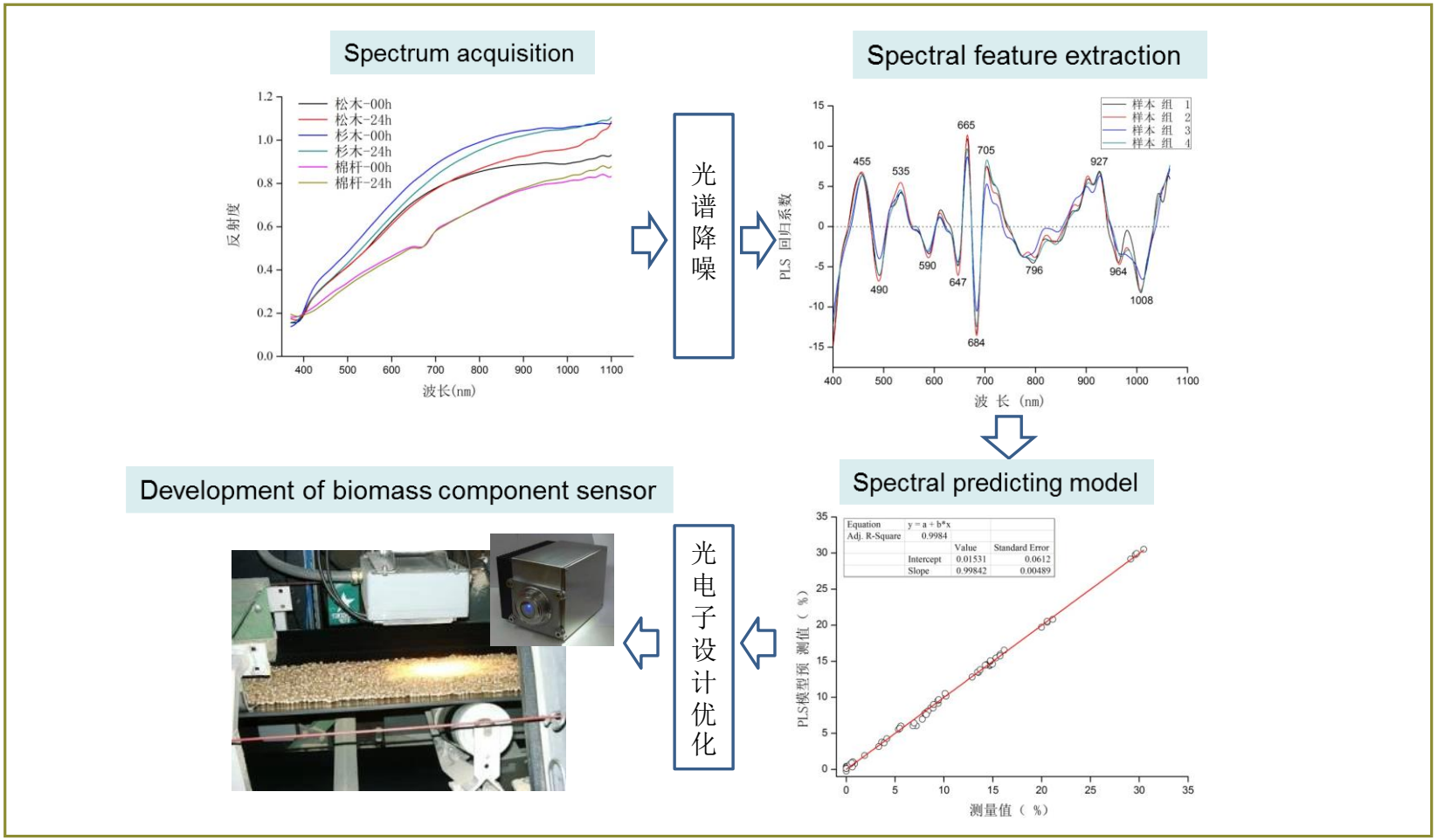
Physical property test

Main physical properties change and response rules before and after straw harvest

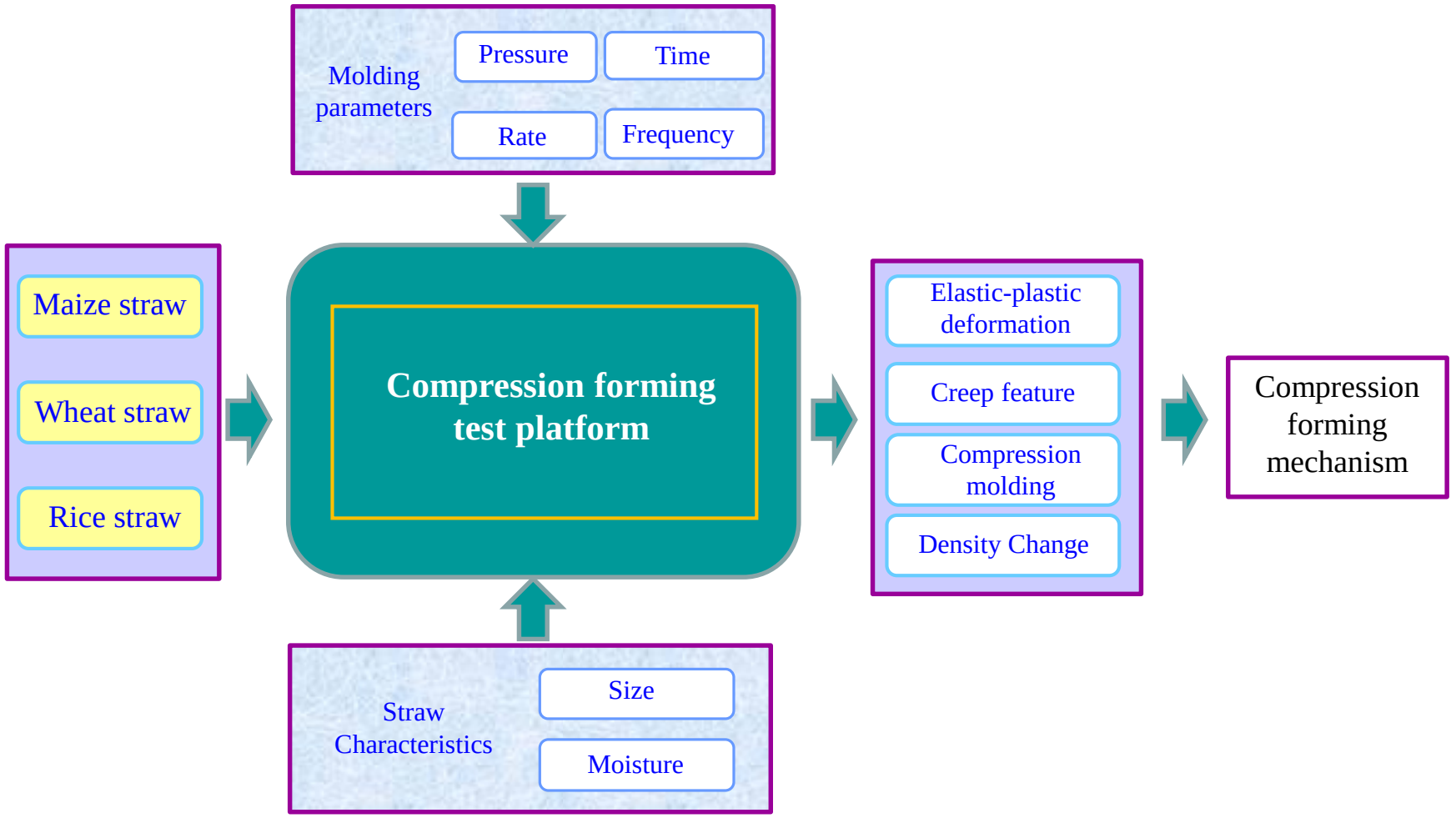
To establish main physical property relations

Rapid detection technology of main straw physical properties

Rapid Detection Method for Biomass Raw Materials and Fuel Product Component Based on Spectrum Technology



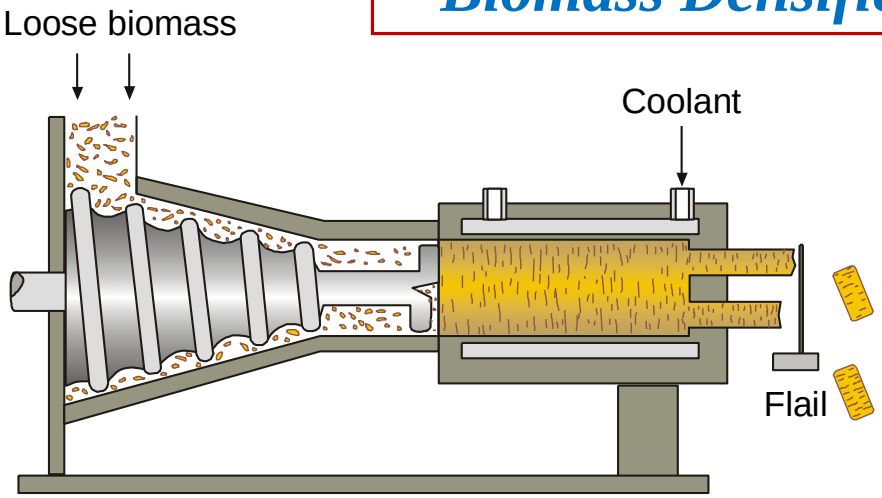
Biomass Compression Forming Test



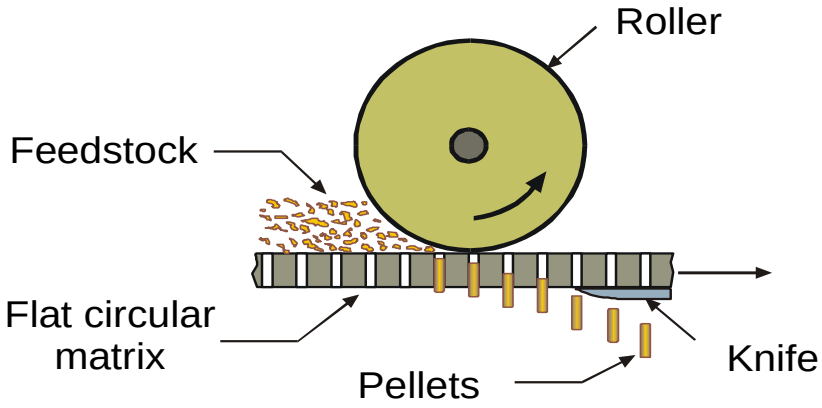
Crop Straw Collecting & Baling

Biomass Logistics

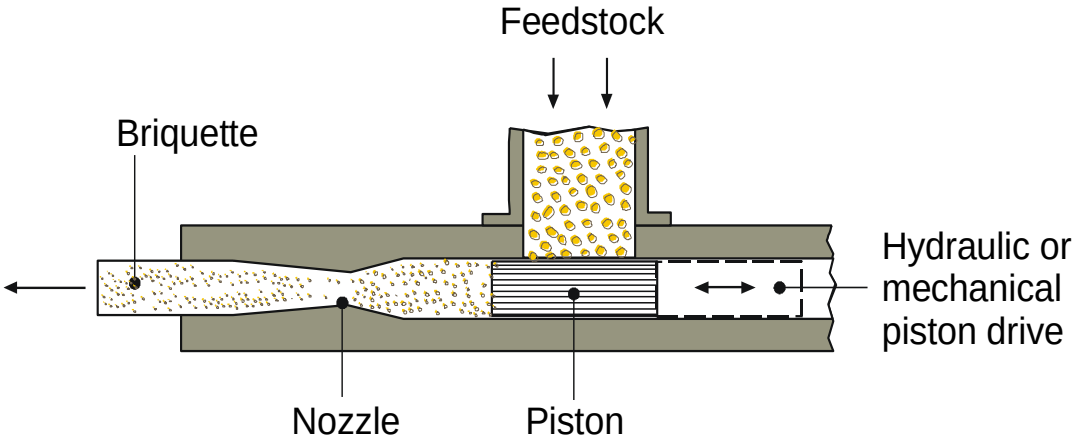
Biomass Densified Fuel Technology



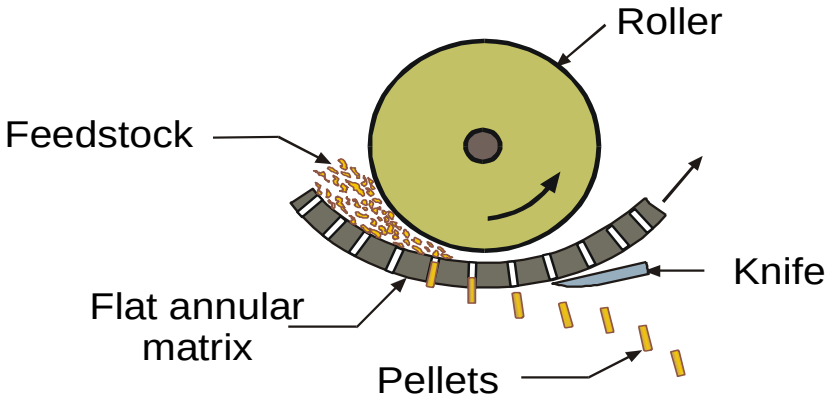
Cone-shaped screw



Plane matrix



Piston drive



Ring-shaped matrix

Source: Vinterbäck 1995

Biomass Briquettes

Wood Pellet

ϕ 6-8 mm

ϕ 8-10 mm

Crop Straw Pellet

Diameter: ϕ 25-30 mm

Rice Straw Pellet

Cotton Stalk Pellet

Corn Stalk Pellet

Raw Material Chopper/Shredder

Source: Jiaxing Xinjiao Machinery Co., Ltd., China

Biomass Extruders for Rodlike Fuel with Highly Density

Source: Jiaxing Xinjiao Machinery Co., Ltd., China

Screw Shaft and Die

Rodlike Biofuel Sample

Source: Jiaxing Xinjiao Machinery Co., Ltd., China

Rodlike Biofuel Production Line with Highly Density

1. Pneumatic Continuous Drying Equipment for Biomass Particles

2. Production Line for Biomass Rod Fuel by Highly Densification

Rodlike Charcoal Production by Kiln System

Purification Equipment of Exhaust Gas during Drying, Densification and Carbonization Process for Environmental Protection

- **Rodlike Biofuel**

- **Rodlike Charcoal**

Charcoal Briquette ►

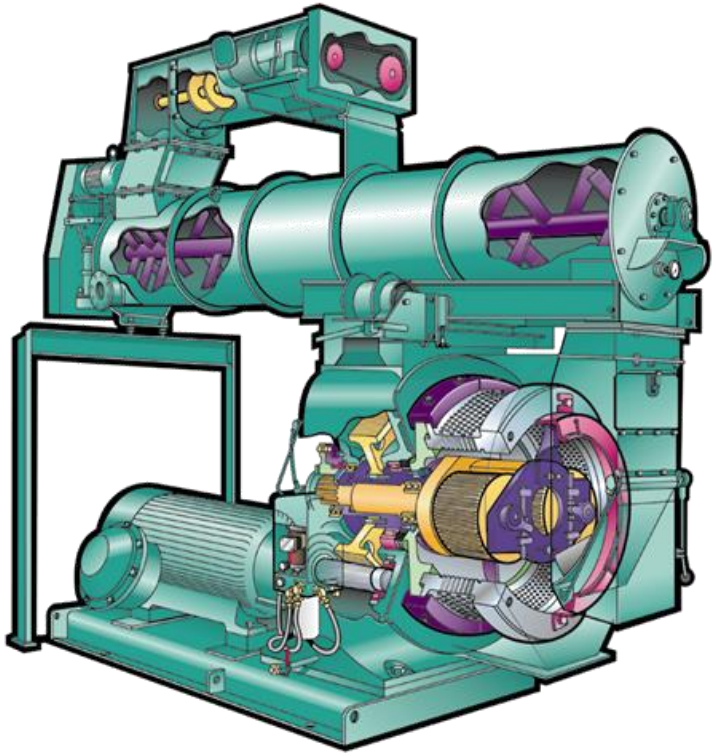
◄ Charcoal Wafer

Source: Forest Group, Zhejiang, China

Charcoal Briquette for Barbecue

Source: Forest Group, Zhejiang, China

Biomass Pellet



The volume of biomass pellet is small, and its combustion rate is homogeneous. The supply and continuous feed of fuel is easy to implement and control.

Biomass pellet Production from Agricultural and Forestry Waste

Source: Haiyan Jineng Biofuel Co., Ltd., Zhejiang, China

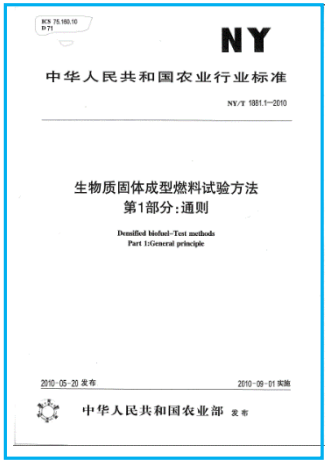
Biomass pellet Production Line

Hangzhou Hopman Agricultural New Energy Equipment Co., Ltd., Zhejiang, China

4 Densified Biofuel Related Standards in China

- Densified biofuel - Methods for sample preparation **(NY/T 1880-2010)**
- Method for preparation of solid biofuels sample **(GB/T 28730-2012)**
- Test standards of densified biofuel **(NY/T 1881-2010)**
  - — Total moisture
  - — Moisture in general analysis sample
  - — Volatile matter content
  - — Ash content
  - — Bulk density
  - — Density
  - — Mechanical durability

Note: NY -- Ministry of Agriculture;
NB -- National Department of Energy;
GB -- National Standard of China.



4 Densified Biofuel Related Standards in China

- Technical conditions for densified biofuel molding equipment **(NY/T 1882-2010)**
- Testing method for densified biofuel molding equipment **(NY/T 1883-2010)**
- Quality classification for densified biofuel **(NY/T 2909-2016, NB/T 34024-2015)**
- Criteria for densified biofuel plant **(NY/T 2881-2015)**
- Technical code of operation and maintenance for densified biofuel plant **(NY/T 2880-2015)**

Note: NY -- Ministry of Agriculture;
NB -- National Department of Energy;
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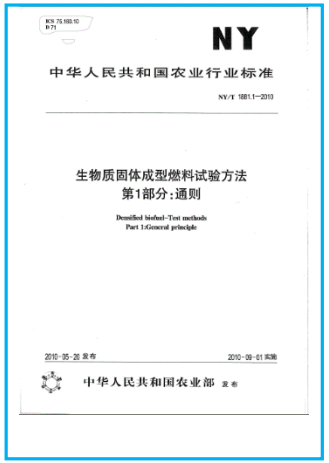


Test Standard of Densified Biofuel Performance

Items			Test Standard
Physical property	Bulk density, real density, Total moisture, Mechanical durability		LY/T 2378-2014 General technical specification of the woody biomass solid molding stove GB/T 28733-2012 Determination of total moisture for solid biofuels
Chemical property	Proximate analysis		GB/T 28731-2012 Proximate analysis of solid biofuels
	Elemental analysis		GB/T 28734-2012 determination of carbon and hydrogen in solid biofuels
	Heating value		GB/T 30727-2014 Determination of calorific value in solid biofuels
Combustion performance	Exhaust gas	CO emission	GB13271-2014 Emission standard of air pollutants for boilers
		SO_2 emission	
		NO_x emission	
	Smoke dust	Dust, PM 2.5	
Ash property	Ash fusibility		GB/T 30726-2014 Determination of ash fusibility of solid biofuels
	Fluxing		
	Ash component		GB/T 30725-2014 Determination of ash composition in solid biofuels

European Standard of Wood Pellet

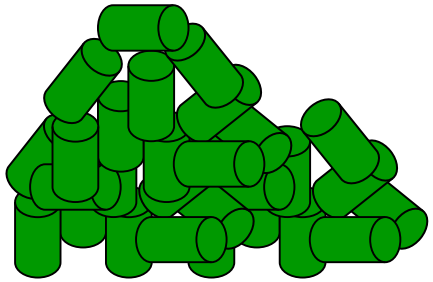
Items	Requirement	Items	Requirement
Diameter /mm	6~8	Ash /%	<0.5
Length /mm	<5×d	HHV/(MJ/kg）	>18
Density /(kg/dm^3)	>1.12	Sulfur /%	<0.04
Moisture /%	<10	Nitride /%	<0.3
Dust /%	<2.3	Chlroid /%	<0.02
Adhensive /%	<2		

Basic Performance Requirements of Densified Biofuel

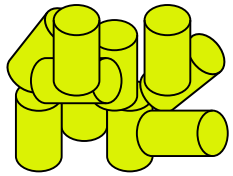
Items	Biomass pellet		Biomass briquette	
	Herbaceous feedstock	Woody feedstock	Herbaceous feedstock	Woody feedstock
Diameter or max dimension of cross section（d）/mm	≤25		>25	
Length /mm	≤4d		≤4d	
Density /(kg/m^3)	≥1000		≥800	
Moisture /%	≤13		≤16	
Ash /%	≤10	≤6	≤12	≤6
LHV /(MJ/kg）	≥13.4	≥16.9	≥13.4	≥16.9
Shatter rate /%	≤5			
Sulfur /%	≤0.2			
Potassium /%	≤1			
Chlorine /%	≤0.8			
Additives /%	≤2, non-toxic, tasteless, harmless			

5 Biomass briquette/pellet Application and Emission

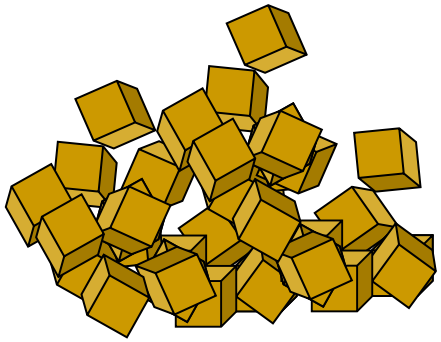
Wood Pellet



Straw Pellet



Straw Briquette



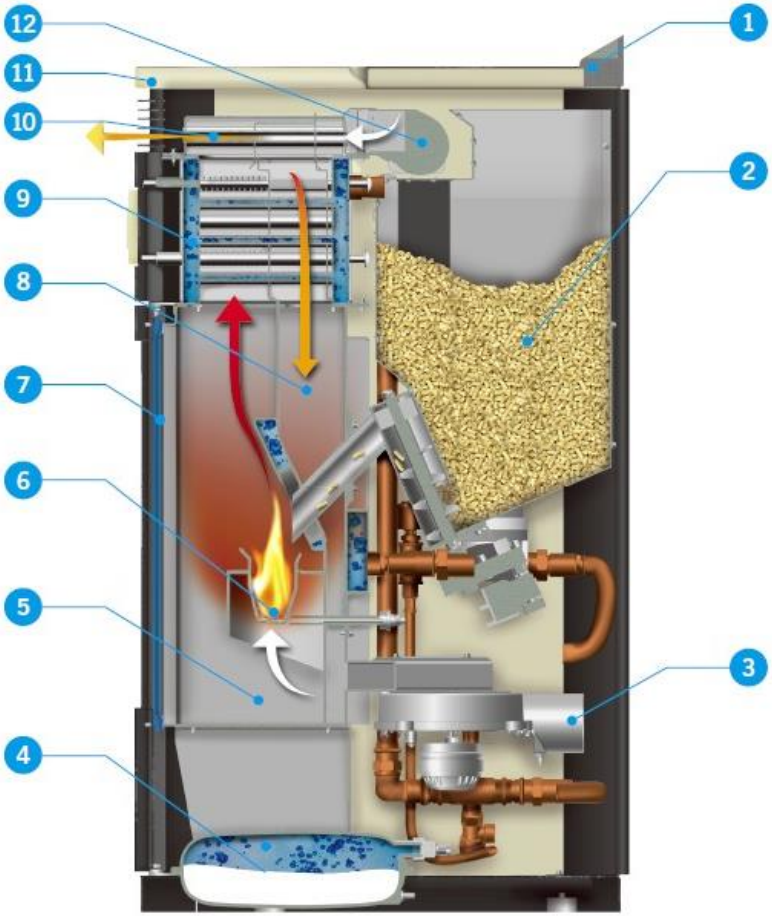
High-end Customer

- Industrial boiler to replace oil
- Non-electric central air conditioning
- Town bath boiler
- Town fireplace and furnace, etc.
- Others

General Customer

- Biomass power plant boiler
- Co-fire power plant boiler
- Industrial coal boiler, bath furnace
- Agricultural production，greenhouse
- Rural energy using，cooking, heating and bath,etc.
- Others

Domestic Fireplace Using Biomass Pellet



1. Cover of hopper
2. Bio-pellet hopper
3. Fume pipe
4. Expansion tank
5. Ash box
6. Combustion box
7. Pyroceram
8. Burning chamber
9. Heat exchanger
10. Air vent
11. Marble cover
12. Axial flow fan

Shanghai Yizimai Machinery Co., Ltd.

Central Heating

Central heating system based on flat-panel solar water heater and fireplace is widely promoted in European families. Operating costs are much lower than of conventional heating, in addition to increased environmental benefits.

Rice Straw Pellet

Cotton Stalk Pellet

Corn Stalk Pellet

For Cooking Stove

For Industrial Boiler

Biomass pellet used for cooking stove

Biomass pellet used for small scale boiler

浙江聚能锅炉制造有限公司
ZHEJIANG JVNENG BOILER MANUFACTURING CO., LTD

Parameters of 100 kg biomass steam generator	
Product model specification	LSG 0.1-0.7-S
Work pressure	0.7 MPa
Evaporation capacity	100 kg/h
Water capacity	29 L
Power consumption	350 W
Fuel consumption	20 kg/h
Storage capacity	100 kg
Boiler weight	559 kg
Size	1550*650*1480 mm
Air-blowing fan	85 W
Induced draft fan	250W
Water pump	750 W
Feeding motor	90W
Steam outlet diameter	25 mm
Chimney diameter	108 mm

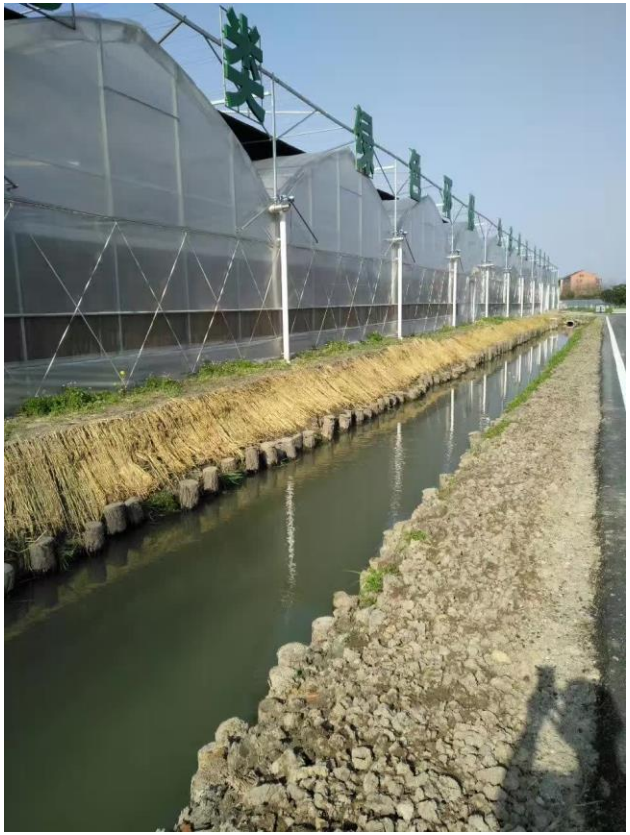
浙江聚能锅炉制造有限公司
ZHEJIANG JVNENG BOILER MANUFACTURING CO., LTD

Parameters of 500 kg biomass steam generator	
Product model specification	LSG 0.5-0.7-S
Work pressure	0.7 MPa
Evaporation capacity	500 kg/h
Water capacity	49 L
Power consumption	4600 W
Fuel consumption	100 kg/h
Storage capacity	200 kg
Boiler weight	2650 kg
Size	2150*1400*3000 mm
Air-blowing fan	1100 W
Induced draft fan	2200W
Water pump	1100 W
Feeding motor	200 W
Steam outlet diameter	40 mm
Chimney diameter	159 mm

Biomass pellet used for warming system in seedling greenhouse in winter season

Horticulture Greenhouse Warming System in Winter for Low Energy Consumption and Low Cost

Biomass pellet for Warming Insect Breeding Greenhouse in Winter



Biomass Gasification for Steam Boiler （2t/h）

Demonstration Project at Huzhou, Zhejiang by
Hangzhou Hantai Energy Engineering Co., Ltd., China

Biomass Gasifier Integrated with Boiler, Heating System or Cooking Stove

Source: Zhejiang Jiufan New Energy Co., Ltd., China

Detection and Analysis of Pollutant Emission

Densified biofuel combustion and emission

- Flue gas: CO, SO_2, NO_x
- Particulate Matter: $PM_{2.5}$

Portable detection instrument

Summary

- Governments encourage customers to use biomass briquette/pellets with incentives.
- To form and promote the industrial chain of biomass densified fuel.
- Bottlenecks: the cost of straw collection and transportation.
- Improvement of technology and equipment of biomass densified fuel.
- Environmental protection: combustion of biomass densified fuel has to meet the national emission standard to realize clean energy utilization.

Thanks for your attention

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