ICSE

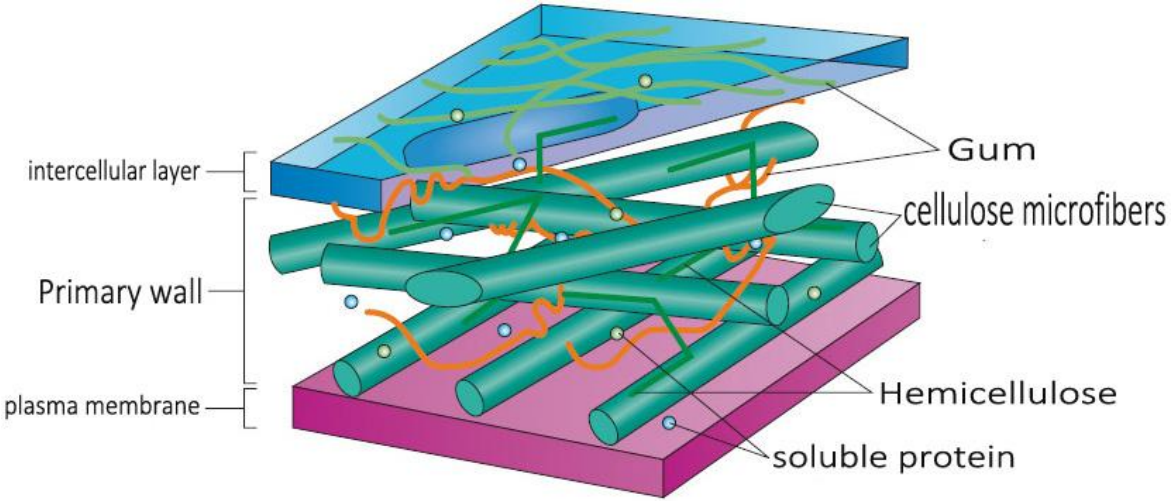
Advanced Pretreatment Technology for biogas and biomethane

Watson Chan

OPPS GROUP LIMITED.

Principle Innovation

I. Biomass conversion barrier

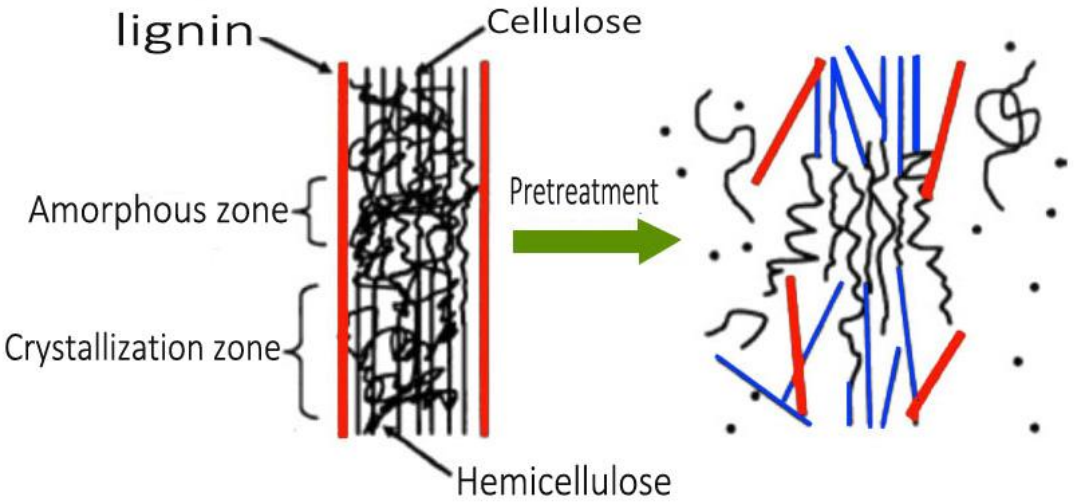


Schematic diagram of cell wall structure

- Conversion object:: Organic cell body
- Barrier No.1： Three Layer Wrap for cell.
- Barrier No.2： crystal structure
- Other Barrier:cell wall, epidermis, waxy layer, etc

Principle Innovation

II. Pretreatment Mechanism

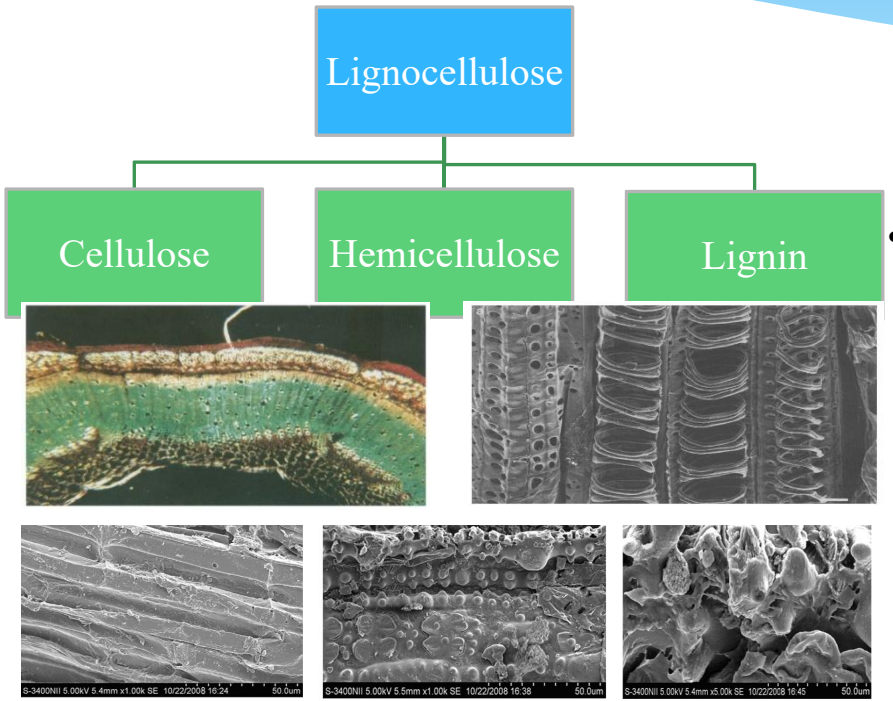


Schematic diagram of pretreatment mechanism

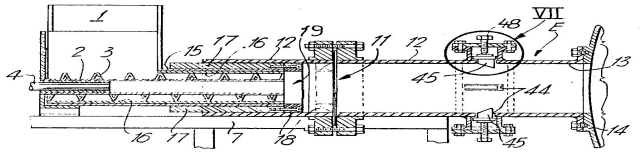
* Break the wall
* Three element separation
* Break down the structure
* Reduce crystallinity
* Increase porosity
* Improve accessibility
* ……

Principle Innovation

III. Technical Mechanism

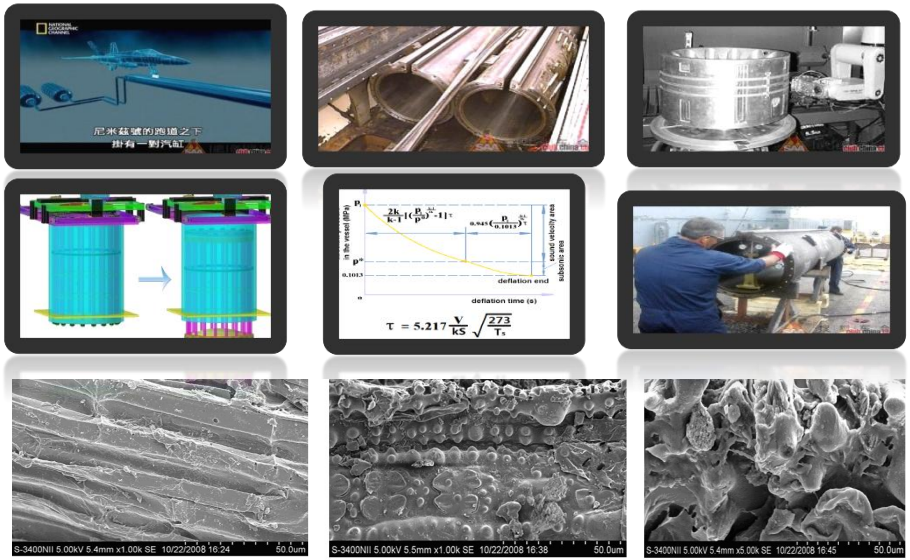


- The lignin, cellulose, and hemicellulose in the biomass are instantly exploded by water vapor after being fully softened, and the three-element winding structure achieves complete separation.
- Not only does it go beyond the simple ripening and puffing processes, but the macromolecular level breakage has also brought revolutionary changes to biological fermentation and animal digestion.



Core Technology

* Supersonic instantaneous ejection steam explosion technology



- Instantaneous ejection steam explosion (ICSE) technology is derived from the aircraft carrier aircraft accelerated take-off device
- The burst speed reaches 0.00875 seconds
- The instantaneous blasting power reaches an astonishing 22MW, while foreign thermal spray tank technology is only 0.026MW;
- Ultimately, it is possible to instantly break the microstructure of biomass with low energy consumption, allowing it to be rapidly degraded;
- From principle innovation to equipment research and development, all are independent innovations, with independent and complete intellectual property rights.

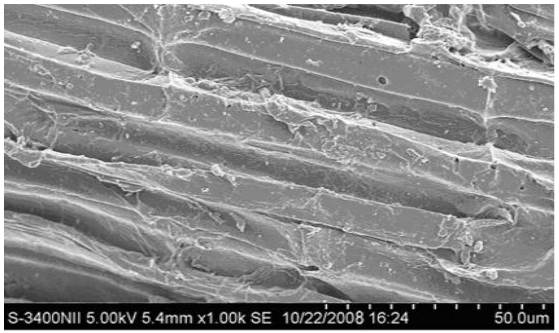
Core Technology

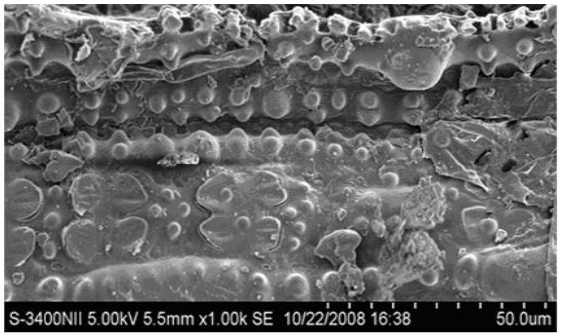
Revolutional Technology for Pretreatment of Biogas Production.

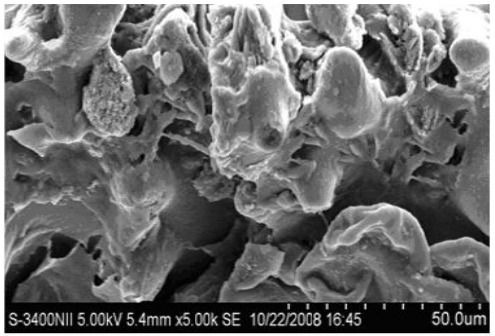
a.The effect is most significant. The indexes of wall breaking degree, crystallinity and hydrolysis degree are significantly better than other technologies

b.Large processing scale. The standard production layout has a daily processing capacity of 1,000 tons.

c. Purely physical operations. It works with high-speed shock waves without adding any chemicals in the whole process.

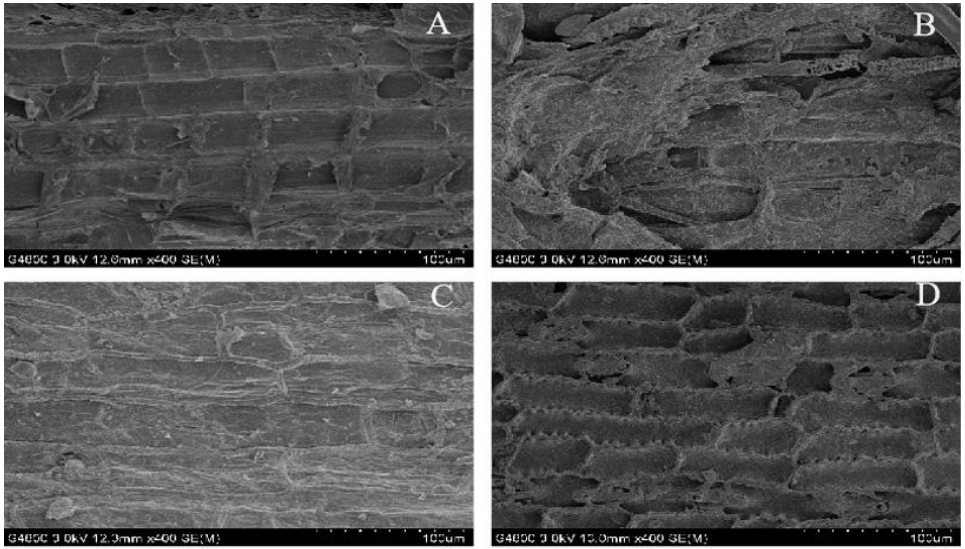






Essential changes in biomass

IV. Microstructure



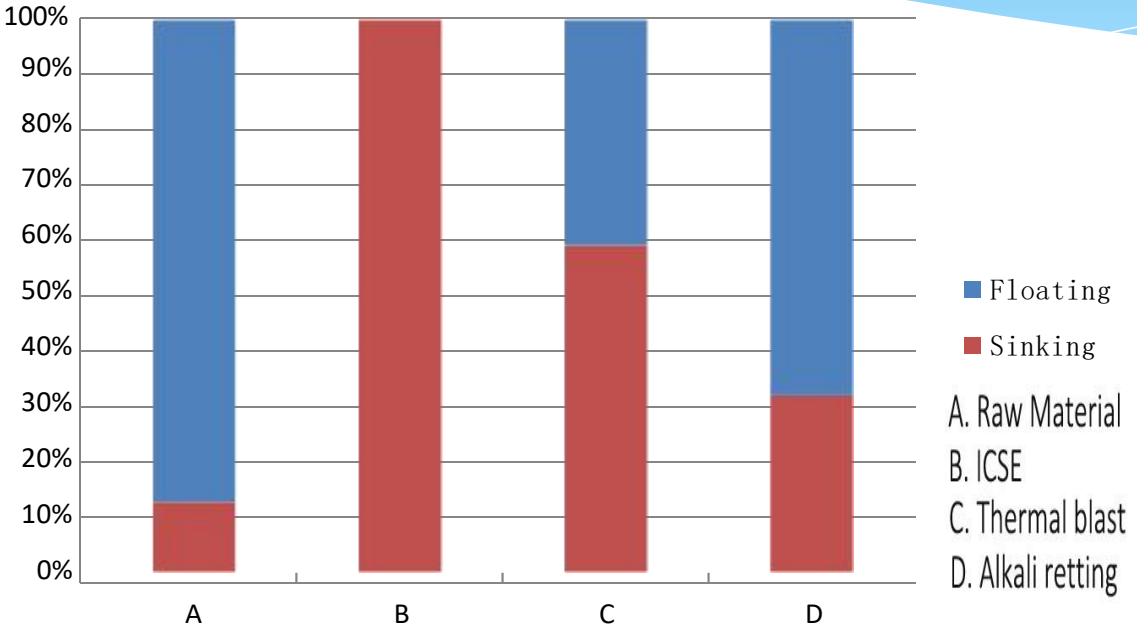
A.Raw material B. ICSE C. Thermal blast D. Alkali retting

SEM photos of four samples

* ICSE causes the cell structure to break and become tissue fragments.
* The thermal blast from Europe causes the cell walls to break but still retain their shape.
* The alkali retting caused the cell wall to shrink without breaking or dissolving.

Essential changes in biomass

V. Sedimentation characteristics

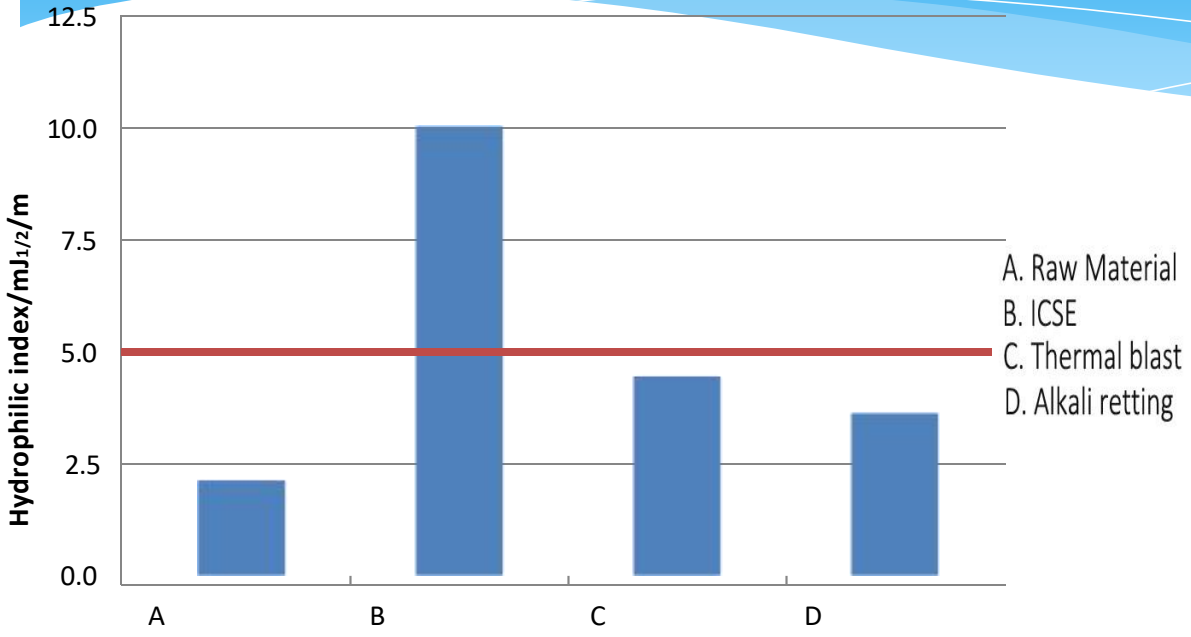


Floating and sinking mass ratios of four samples in water

* All ICSE sinks to achieve complete miscibility with water.
* The thermal blast from Europe has sedimentation ratio is 0.592: 1.
* The alkali pile retting settlement ratio is 0.32: 1
* raw material alone sedimentation ratio 0.127: 1

Essential changes in biomass

V. Hydrophilic/Hydrophobic Characteristic Index



Hydrophilicity index of four samples

* ICSE is the only one among the four samples with a hydrophilic index greater than 5, indicating that the material characteristics have changed from hydrophobic to hydrophilic.
* The results are consistent with the measurement results of settlement characteristics, indicating that settlement characteristics are closely related to surface energy characteristics.

Essential changes in biomass

VI. Solid surface free energy properties

Table 6-3 Surface energy parameter of silage corn straw mJ/m^2

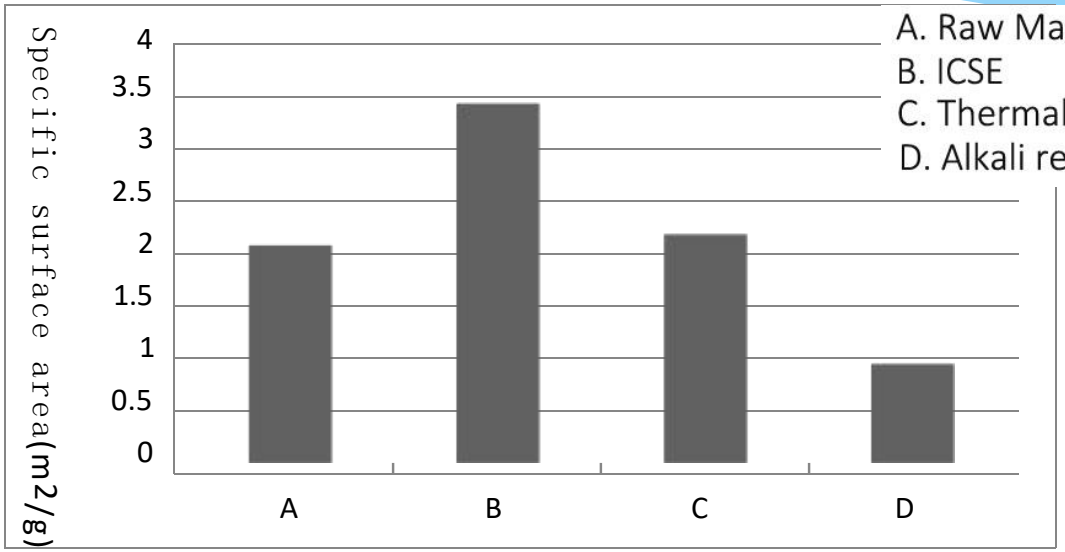
Surface energy parameters	A	B	C	D
γ^{LW}	50.0689	44.5765	49.1948	50.4639
γ^{+}	0.0564	2.4376	4.4597	1.7407
γ^{-}	3.5760	72.1750	5.4859	5.3431
γ	50.9667	71.1044	59.0873	56.5633
$\sqrt{\gamma^{+}}+\sqrt{\gamma^{-}}$	2.1284	10.0569	4.4540	3.6309

Solid surface free energy parameters of four samples mJ/m^2

* ICSE increases γ 39.5%, the hydrophilic index increased by 372.5%.
* γ specific thermal blast and alkali pile retting are higher respectively 20.3% and 25.7%.
* The hydrophilicity index is 125.8% and 177.0% higher than that of thermal spraying and alkali retting respectively.

Essential changes in biomass

VII. Specific surface area

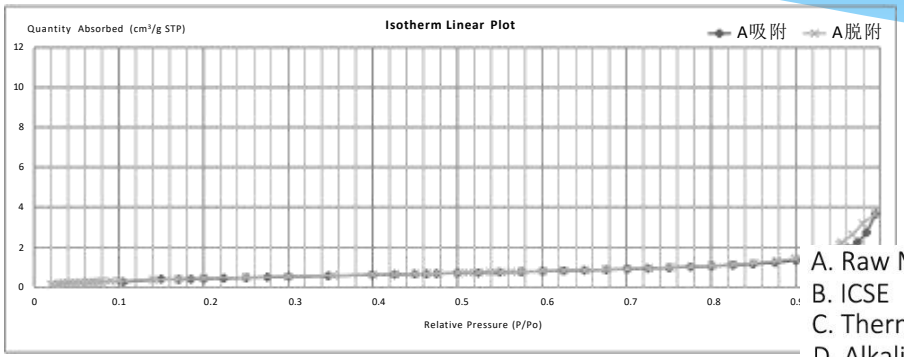


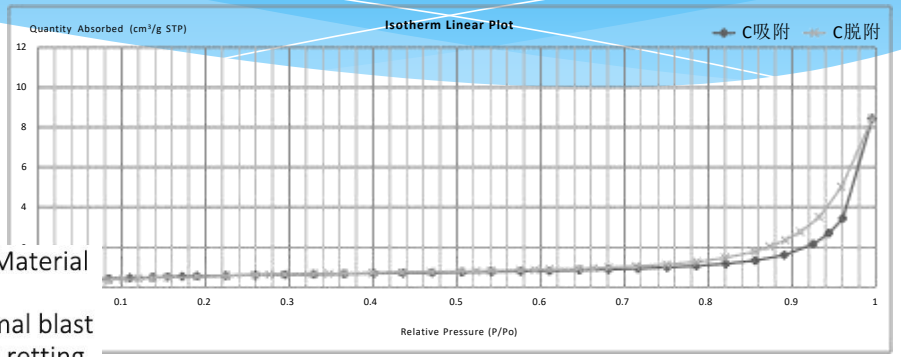
Specific surface area of four samples

* ICSE enables raw materials to increase by 65.2%
* After thermal blast, it increased by 5% compared with before treatment.
* After alkali retting, the concentration was reduced by 45.5% compared with the raw material.

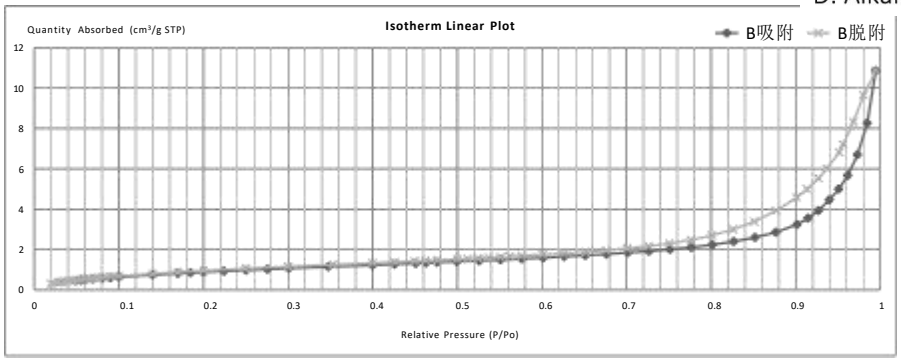
Essential changes in biomass

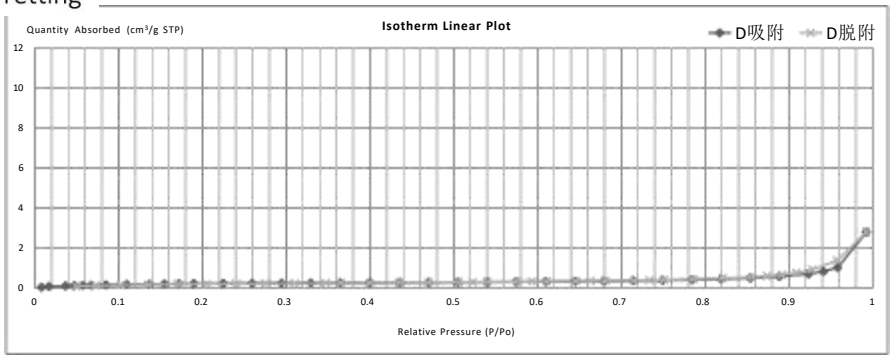
VIII. Adsorption and desorption characteristics





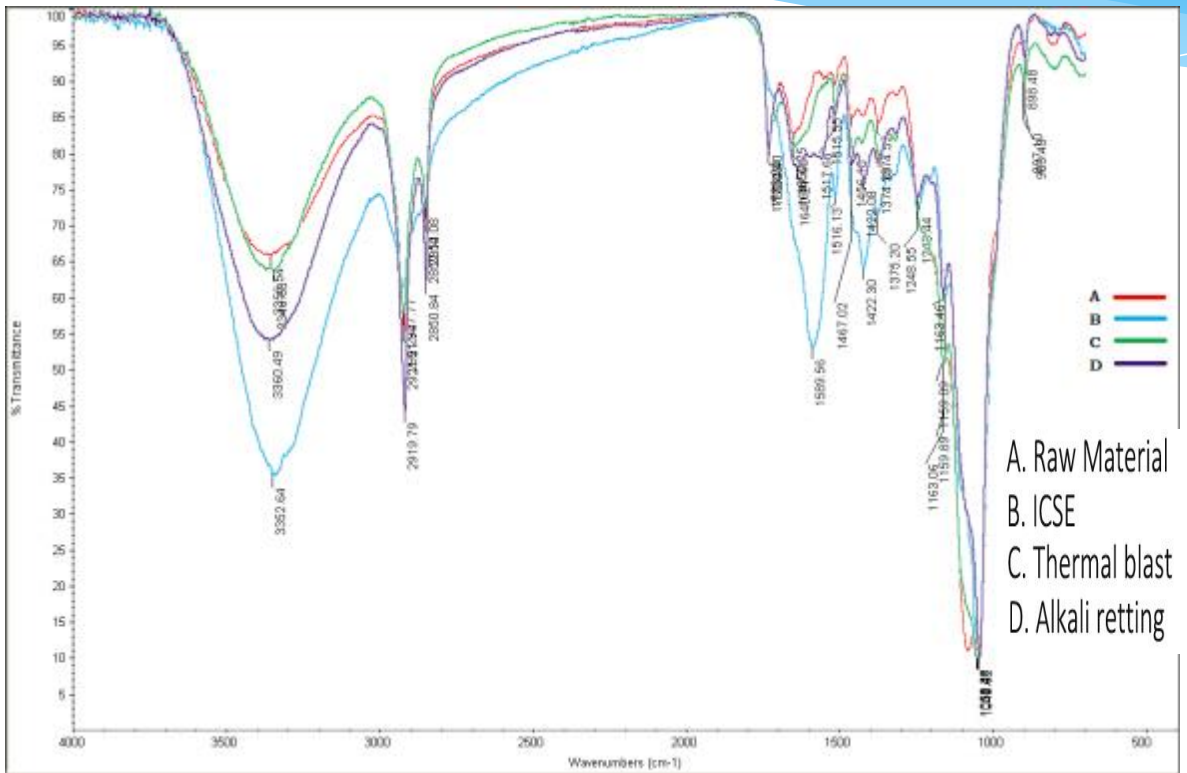
A. Raw Material
B. ICSE
C. Thermal blast
D. Alkali retting





Essential changes in biomass

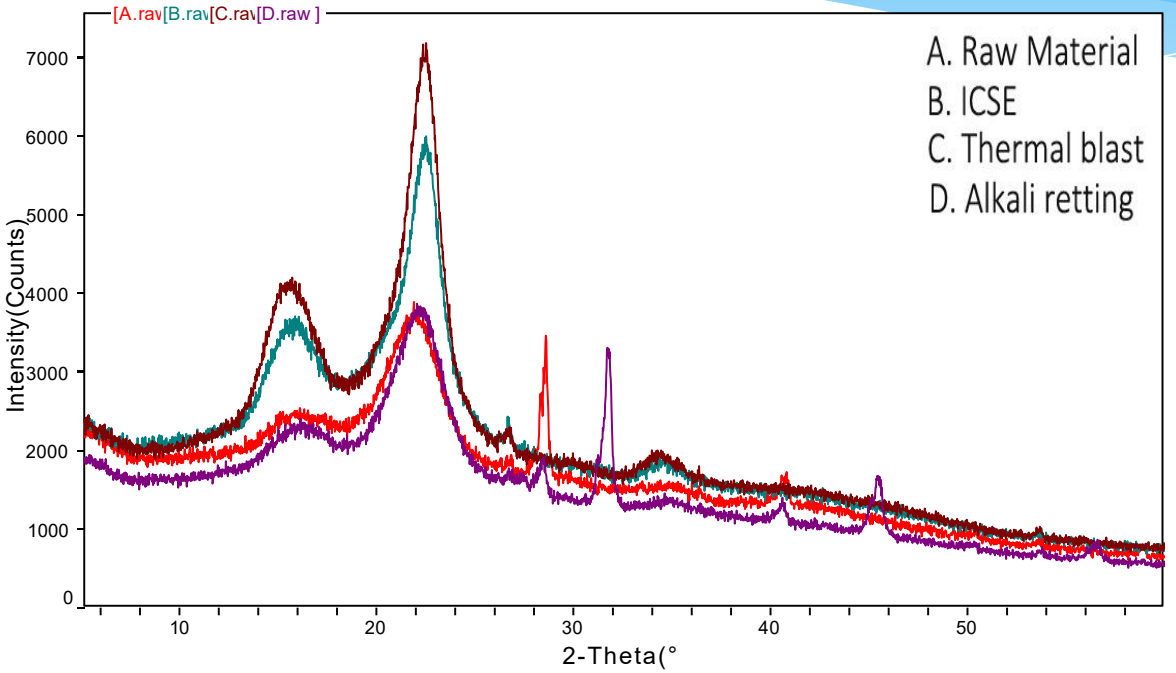
IX. Fourier transform infrared spectroscopic analysis



* The ICSE spectral lines have undergone some more obvious changes.
* Analysis shows that ICSE can significantly change organic functional groups and achieve fragmentation and reorganization at the molecular level.

Essential changes in biomass

X. X-ray diffraction analysis



XRD spectra of four samples

* The crystallinity of ICSE is lower than that of thermal Blast by 29.4%, which is 26.1% lower than that of alkali stack retting, which is the minimum value among the four samples.
* It also has the smallest number of peaks and the most obvious changes in material structure.

Steam Explosion Equipment

NB800, NB1500 and NB2000 series industrial application steam explosion devices have been used in many companies In terms of actual production, the application industry involves a variety of bio-based products such as fuel ethanol, butanol, xylitol, etc. Covering bioenergy, biofertilizer, biofeed, food processing, biopharmaceuticals, waste treatment, etc.field . The NB2000 series of large-scale instant ejection steam explosion machines has a single cylinder volume of 10 cubic meters and a single machine blasting power of more than 50MW, establishing the company and its technical team as an international leader in the field of steam explosion.

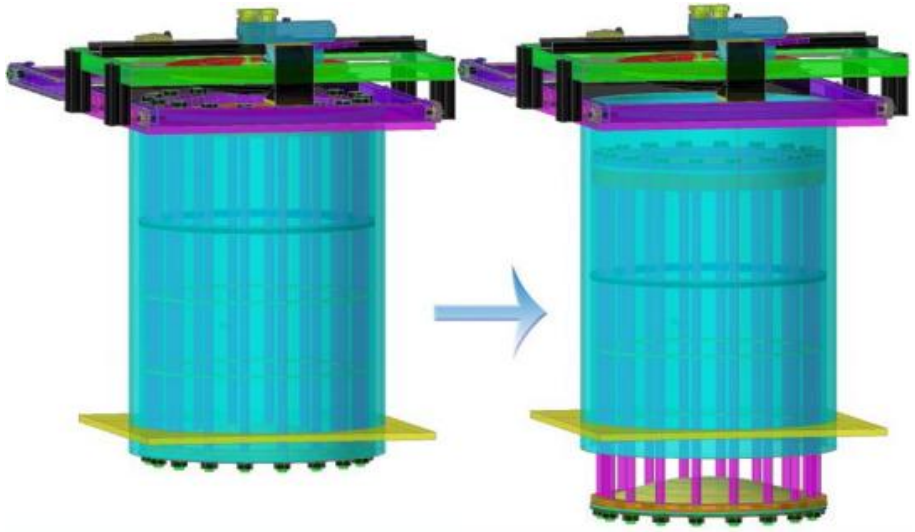



Advantage of OPM Steam Explosion : High Efficiency!

* The pretreated straw is in the form of a slurry that is completely miscible with water, eliminating stratification and floating phenomena, and smoothly realizing the fluidized transportation and fermentation of pure straw;
* When the temperature of the exploded material is lower than 50℃, it can be directly put into fermentation; there will be no blockage or bridging problems in the discharge;
* The anaerobic fermentation degradation time of pretreated straw is shortened from 60 days to three days;
*Compared with thermal blast equipment, the material is sprayed in tens of seconds, resulting in the problem of inconsistent biochemical properties of "premature and late"
* The new technology increases the blasting speed by three orders of magnitude; the blasting power density increases by six orders of magnitude;
* The processing cycle is thus shortened from tens of minutes to 90 seconds, which greatly reduces the pretreatment energy consumption. The steam consumption per ton of material drops from 1 ton to 0.1 ton.
* At the same time, the fast pace of pretreatment has greatly improved the efficiency of the equipment, and the scale of land occupation and equipment investment have also been reduced by 20 times.

Advantage of OPM Steam Explosion : Long Life Span!

The key components have a fatigue strength that meets 100,000 blasts.



Advantage of OPM Steam Explosion : Big Capacity!

NB2000 allow 10m3 one cylinder

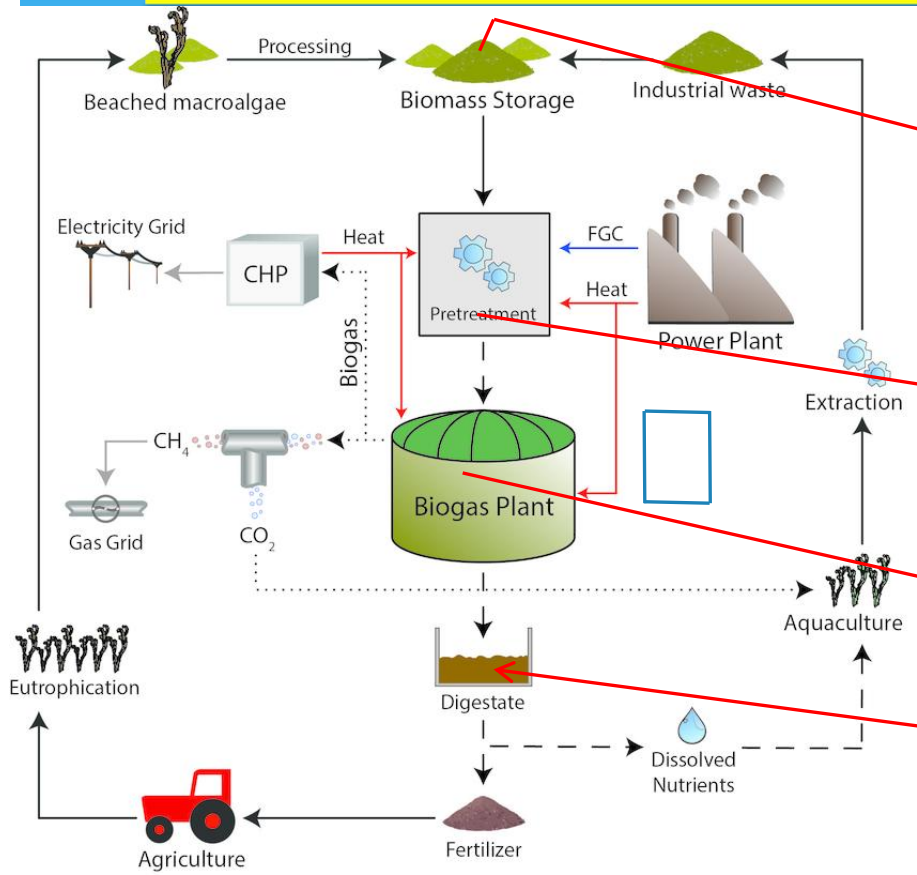
Thermal Blast :

400 units cylinder/project

OPM Steam Explosion :

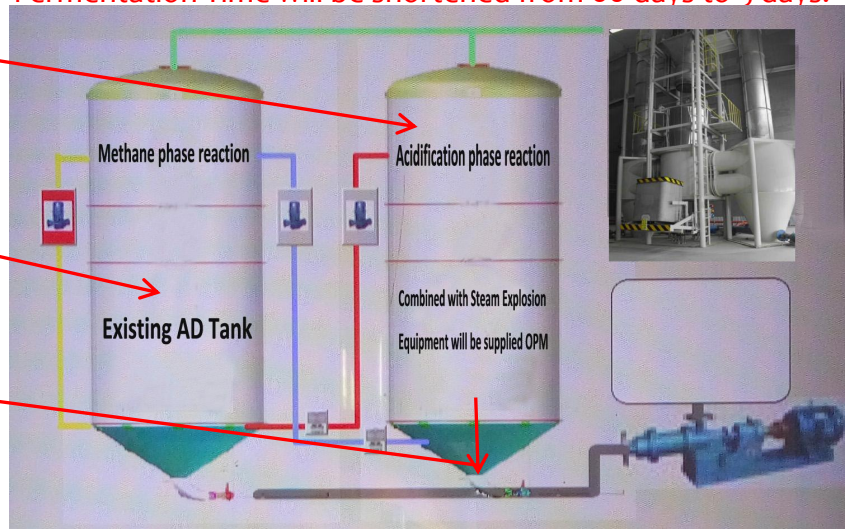
20 units cylinder /project

Application of OPM Steam Explosion : Bio-Methane



* Traditional Process:
(Particle size of RW from 30-50mm to 2-3mm):
if OPM complex pellet mill (combine grinding and pelletizing) is used, the biogas harvested can be 10-11% higher

* OPM Steam Explosion Process:
OPM Pellet mill--->NB Steam Explosion Machine:
Fermentation Time will be shortened from 60 days to 3 days.



Thank You!

OPPS GROUP LIMITED.

ICSE Technology Application