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Preliminary Exploration of an Eco-Friendly Binder for MgO-C Bricks and Its Performance Evaluation

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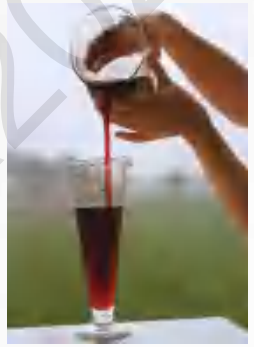
1. Background

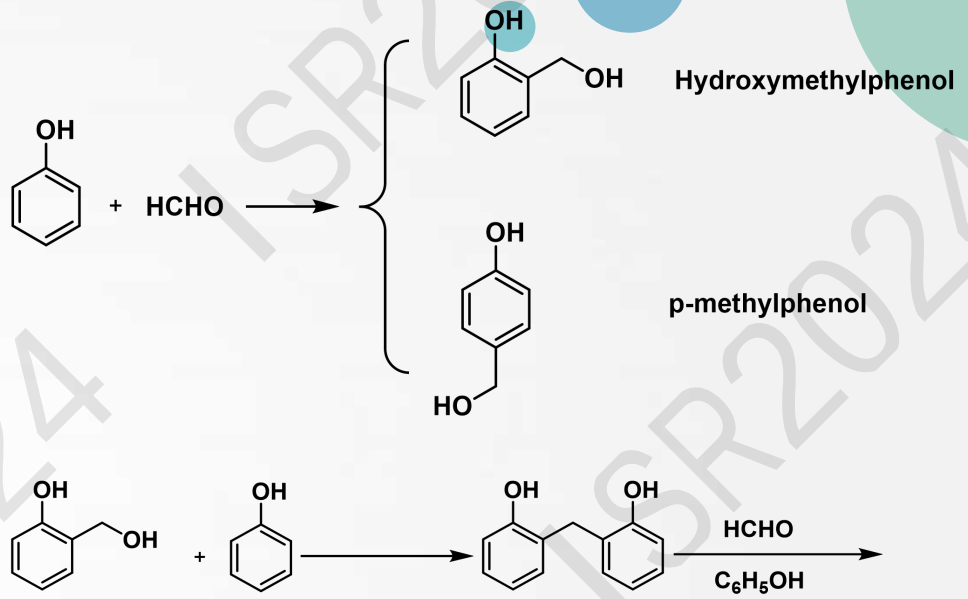
Converter Furnace

Steel Ladle

MgO-C Brick



Phenolic Resin Binder



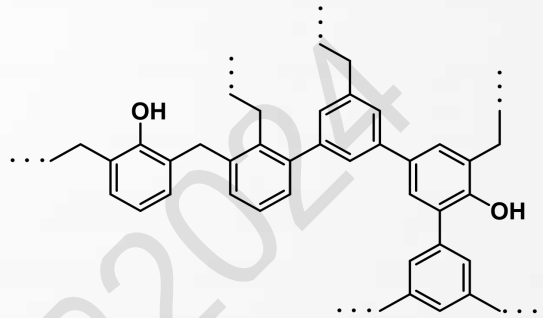


Fig. 1 Reaction Process of Phenolic Resin

Advantage

- High Strength
- High residual carbon
- Good wettability with graphite

Disadvantage

- Toxic
- High viscosity
- Long mixing time

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2. Design concept and design principle

2. Design concept

Eco-friendly binder's Advantages:

1.Non-toxic; Odorless; Harmless;

2.Viscosity controllable;

3.Short mixing time;

4.Long shelf life (7 days);

Eco-friendly binder test results:

Moisture : 0.8-1.0 %

Solid content : 83.5-86.5 %

Carbon residue : 3.5-4.5 %

Viscosity : 200-400Pa.s

Can be adjusted according to customer requirements

Fig. 2 Eco-friendly binder sample

2. Design principle

Eco-friendly binder uses **a variety of vegetable oils as raw materials**. According to the principle of valence bond, **the effective components are extracted from the fruits, rhizomes and germs of plants**, and the catalytic cracking is carried out at different temperatures.The carbon bond is initiated and the process parameters are strictly controlled, so that the vegetable oils with different valence bonds react quickly to generate **unsaturated fatty acids**. Under the action of **dehydration and coupling agent**, it reacts with **saturated polyols and polyacids** to produce finished products with different viscosity stability.

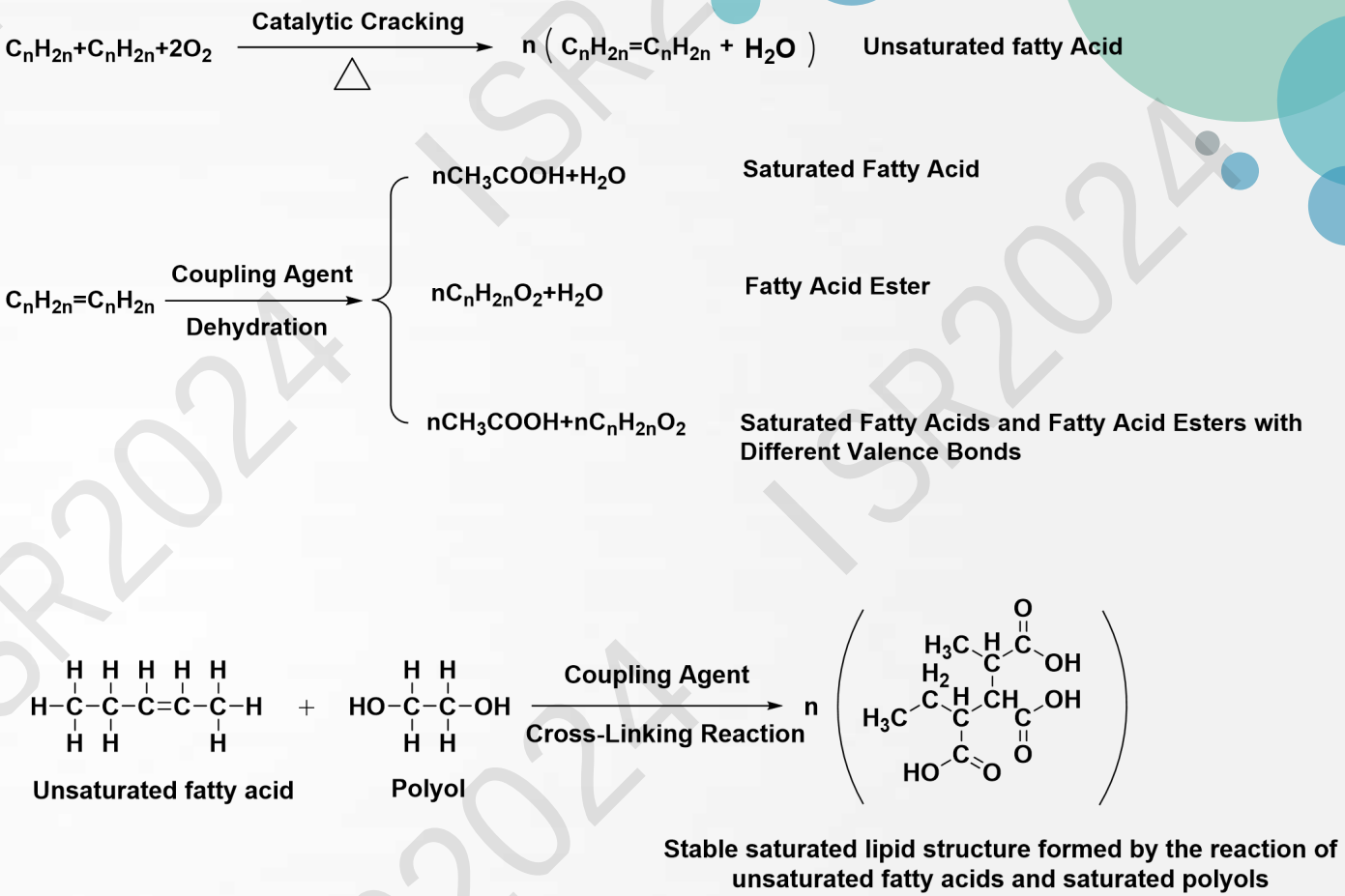
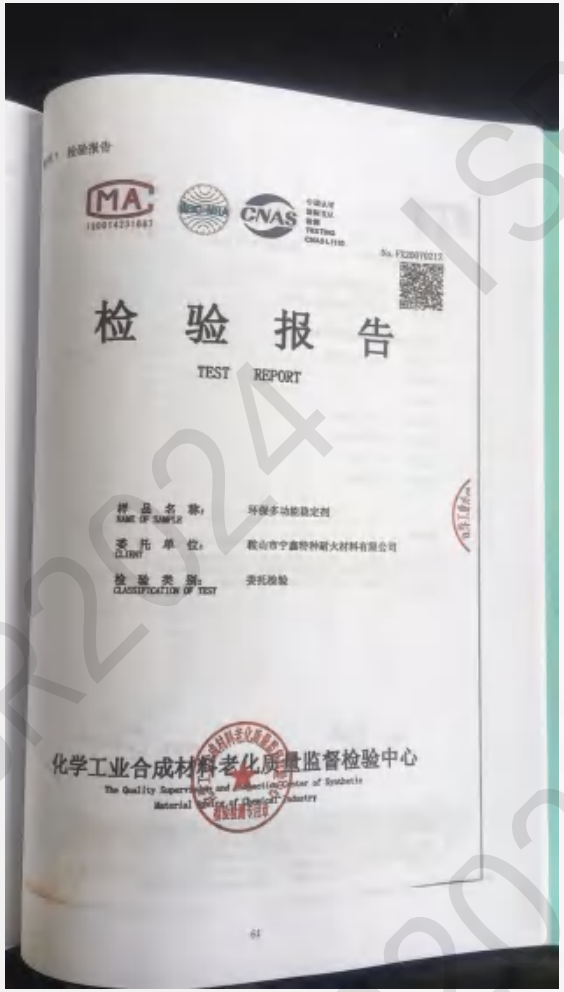
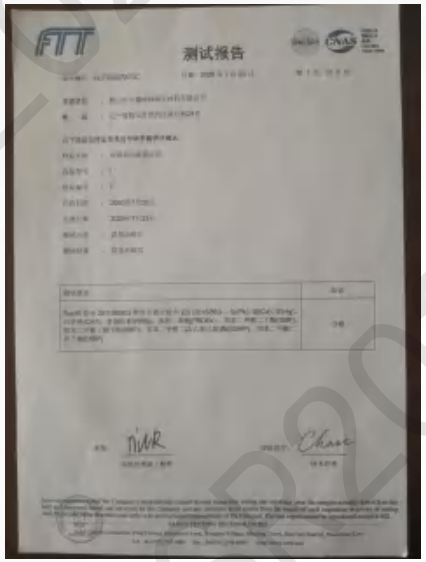


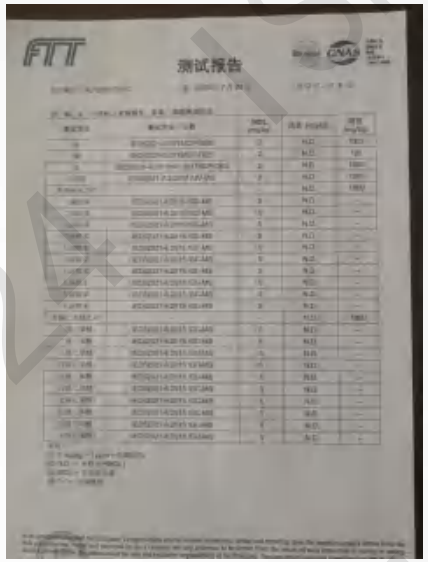
Fig. 3 Reaction principle of Eco-friendly binder

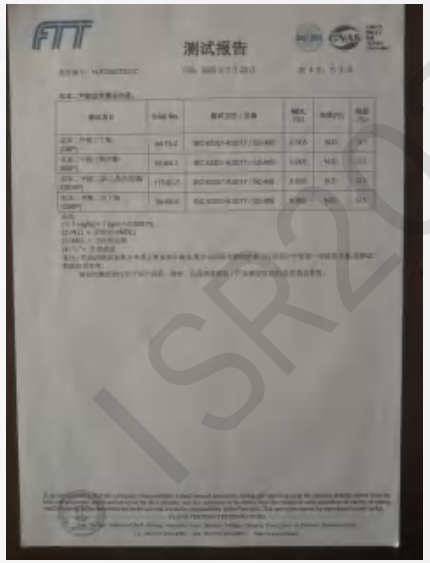
2. Design concept and design principle

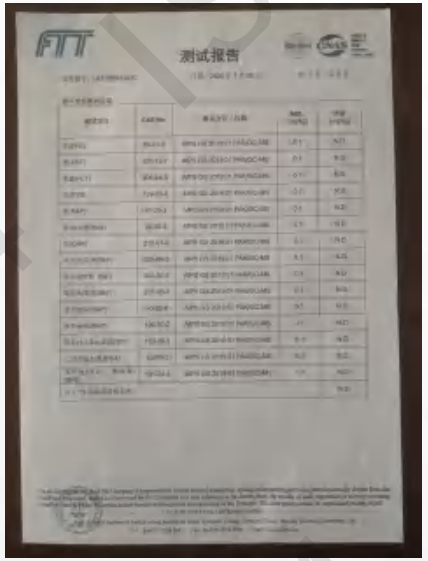
Authoritative test report

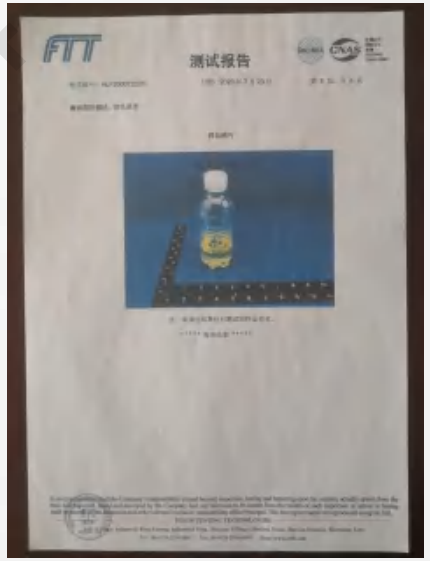












3. Sample preparation

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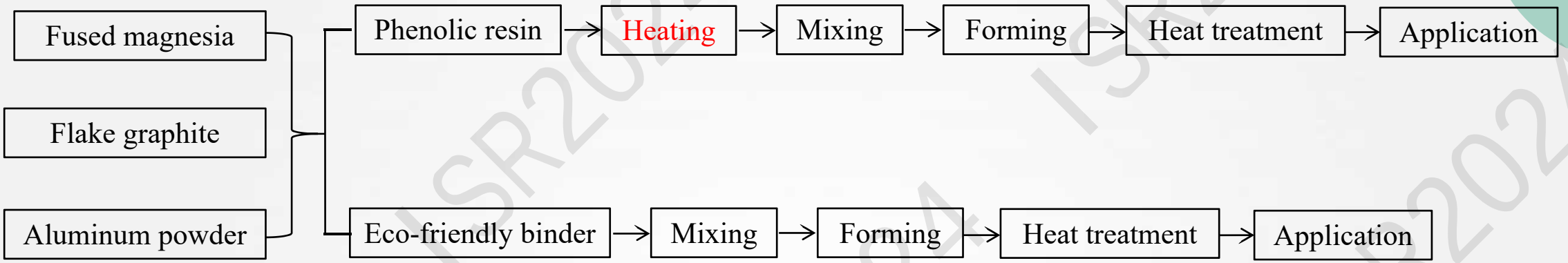

Fig. 4 Fabrication process of sample bricks

Fig. 5 sample magnesia-carbon brick prepared by Eco-friendly binder

4. Comparison of properties

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Factory A

Smelting metal：235B、30MNSI、S400

Workplace：LF（30min-40min）、RH（15min-20min）

Service life：72 times during a minor repair

The thermal turnover period of the ladle is one month, and a minor repair was carried out during this period.

There are no problems such as melting hole, crack, erosion, circular seam and rolling steel.

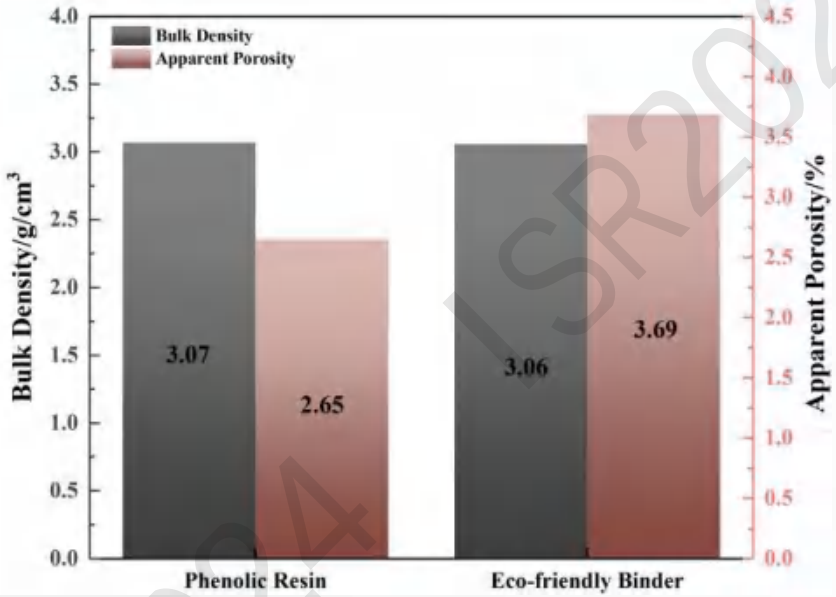
Table 1 The amount of binder added, the single weight of semi-finished product and the chemical composition of the two sample bricks

Porject	Additive Amount/%	Weight of Semi-finished Products	MgO	C
Phenolic Resin	2.8	8.9/8.44	81.4	13.7
Eco-friendly Binder	2.4	8.96/8.5	80.2	13.2

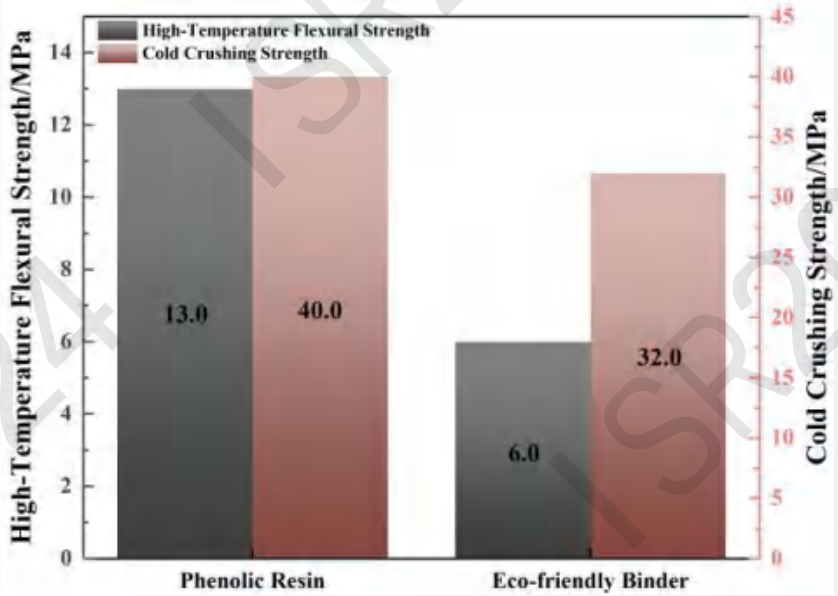
Table 2 Residual thickness of two sample bricks

Porject	Residual Thickness/mm
Phenolic Resin	112
Eco-friendly Binder	102

4. Comparison of properties



(a) Bulk Density&Apparent Porosiity



(b) HTFX&CCS

Fig.6 Physical properties of Eco-friendly binder sample brick and phenolic resin sample brick

The comparison results show the physical properties of the samples prepared by Eco-friendly binder are not much different from those prepared by phenolic resin at room temperature.

However, in terms of high temperature performance, the sample prepared by the Eco-friendly binder is slightly behind that of the phenolic resin sample.

05 Application data of Eco-friendly binder

5. Application data of Eco-friendly binder

Factory B

Service life：34 times and minor repairs.

Factory C

Service life：43 times.

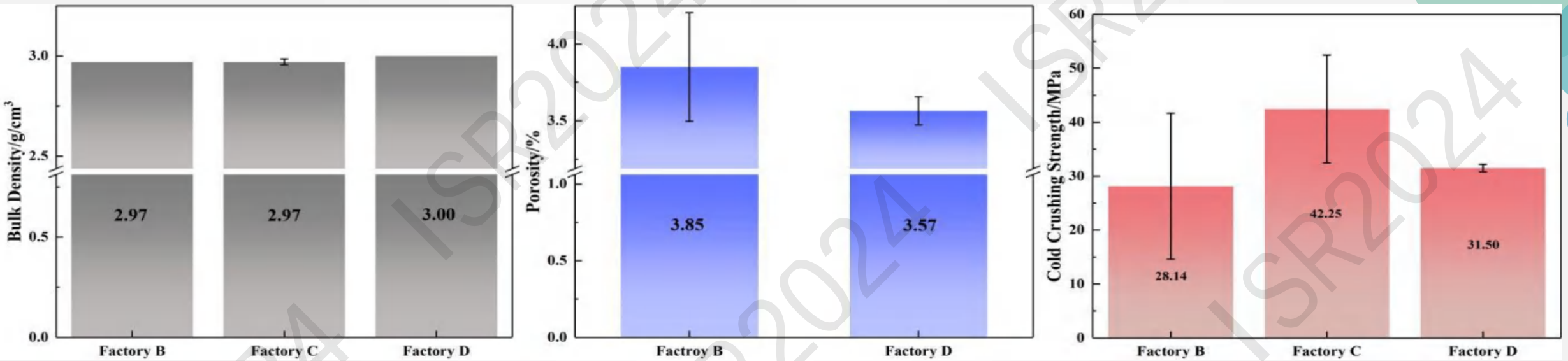
Factory D

The mixing time was reduced by 20 minutes and the power was saved by 1/3.

Table 3 Chemical composition of Eco-frienfly binder sample brick in different fractories

Project		MgO	C	SiO_2	Al_2O_3	CaO	Fe_2O_3
Factory B	1#	78.92	17.61	0.87	0.4	0.47	0.67
	2#	79.05	17.02	0.87	0.97	1.44	0.65
Factory C	1#	79.70	14.92	1.87	1.27	1.32	0.92
	2#	80.85	13.98	1.84	1.09	1.2	0.91
Factory D	1#	80.09	16.23	1.41	1.17	1.14	0.95
	2#	79.09	14.67	1.24	3.32	1.01	0.8

5. Application data of Eco-friendly binder



(a) Bulk Density (b) Apparent Porosity (c) Cold Crushing Strength

Fig. 7 Physical properties of Eco-friendly binder sample bricks

Fig. 7 shows the comparison of the data after the application of Eco-friendly binder in different factories.

As shown in the **Fig. 7**, the bulk density and apparent porosity data from different factories are almost the same, the Cold Crushing Strength is not much different, and the data performance of the product is relatively stable, further verifies its superior performance in industrial applications.

6. Microstructure comparison

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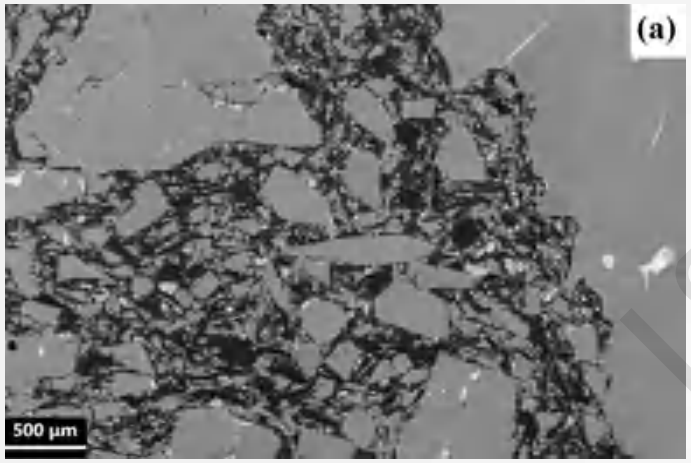
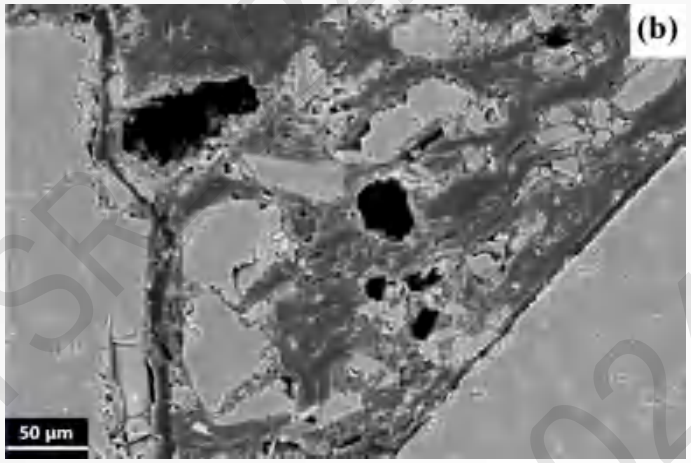
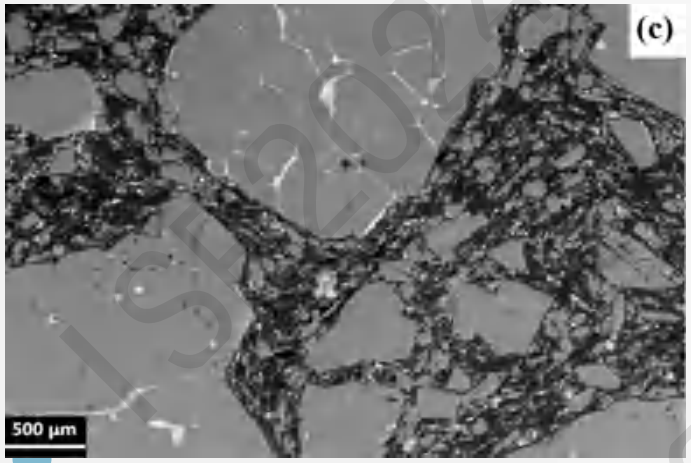


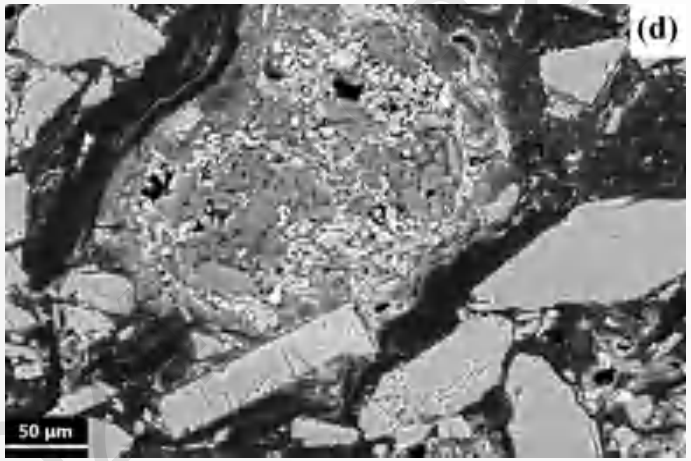
(a) Phenolic resin sample brick before using



(b) Phenolic resin sample brick after using



(c) Eco-friendly binder sample brick before using



(d) Eco-friendly binder sample brick after using

Fig. 8 Microstructure of sample brick with Phenolic resin and Eco-friendly binder

Similarities :

1. Aggregate and matrix are both fused magnesia.

2.The structure of the two sample bricks is dense and uniform.

Difference :

The metal aluminum powder inside the phenolic resin sample brick is oxidized to leave holes.

The sample bricks using Eco-friendly binders still retain a portion of the metal aluminum.

6. Microstructure comparison

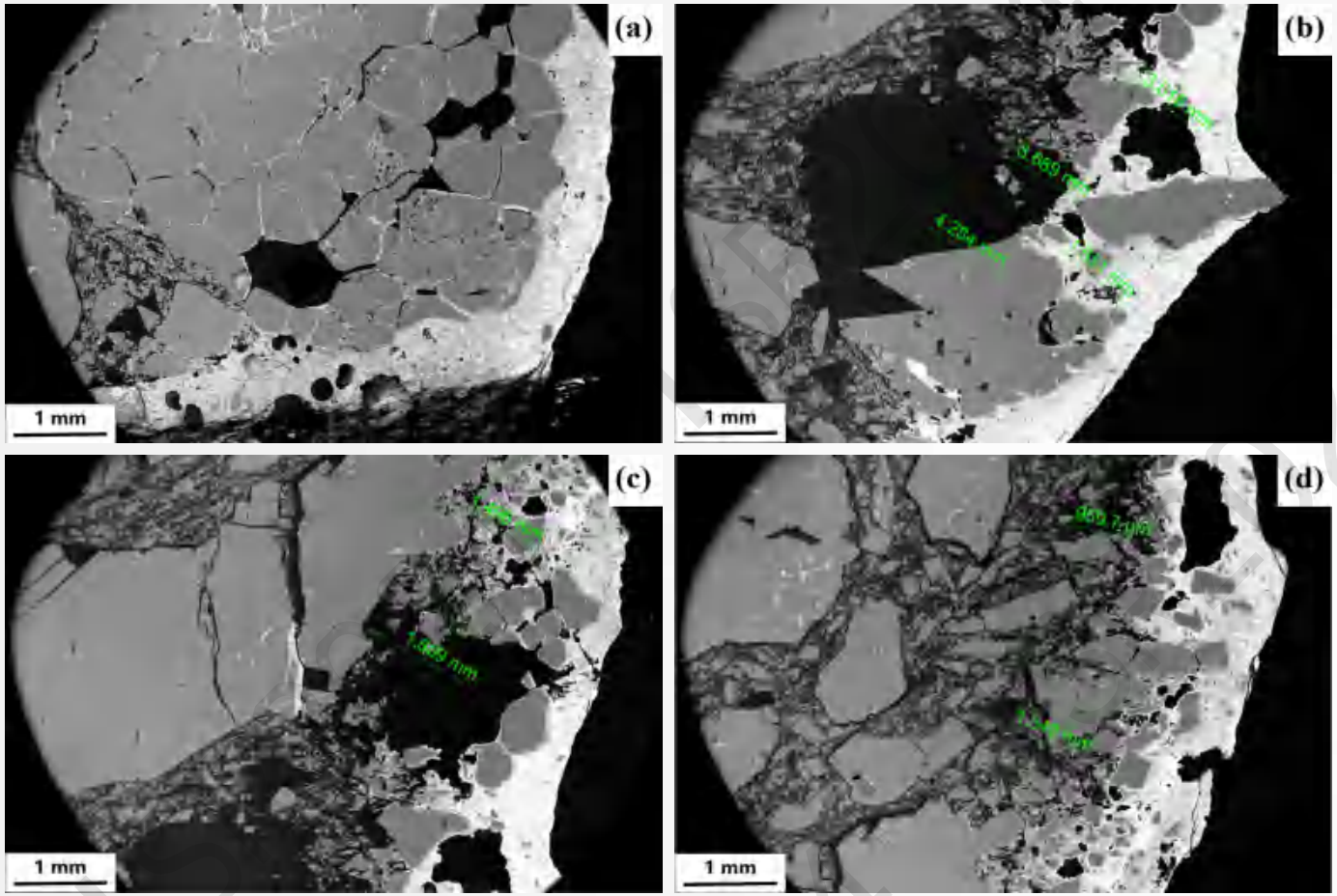


Fig. 9 Microstructure of sample brick with Phenolic resin after using

There is almost no sticky slag layer after use.

There is a decarburization layer of 1 ~ 4mm.

Decarburization layer structure becomes loose.

6. Microstructure comparison

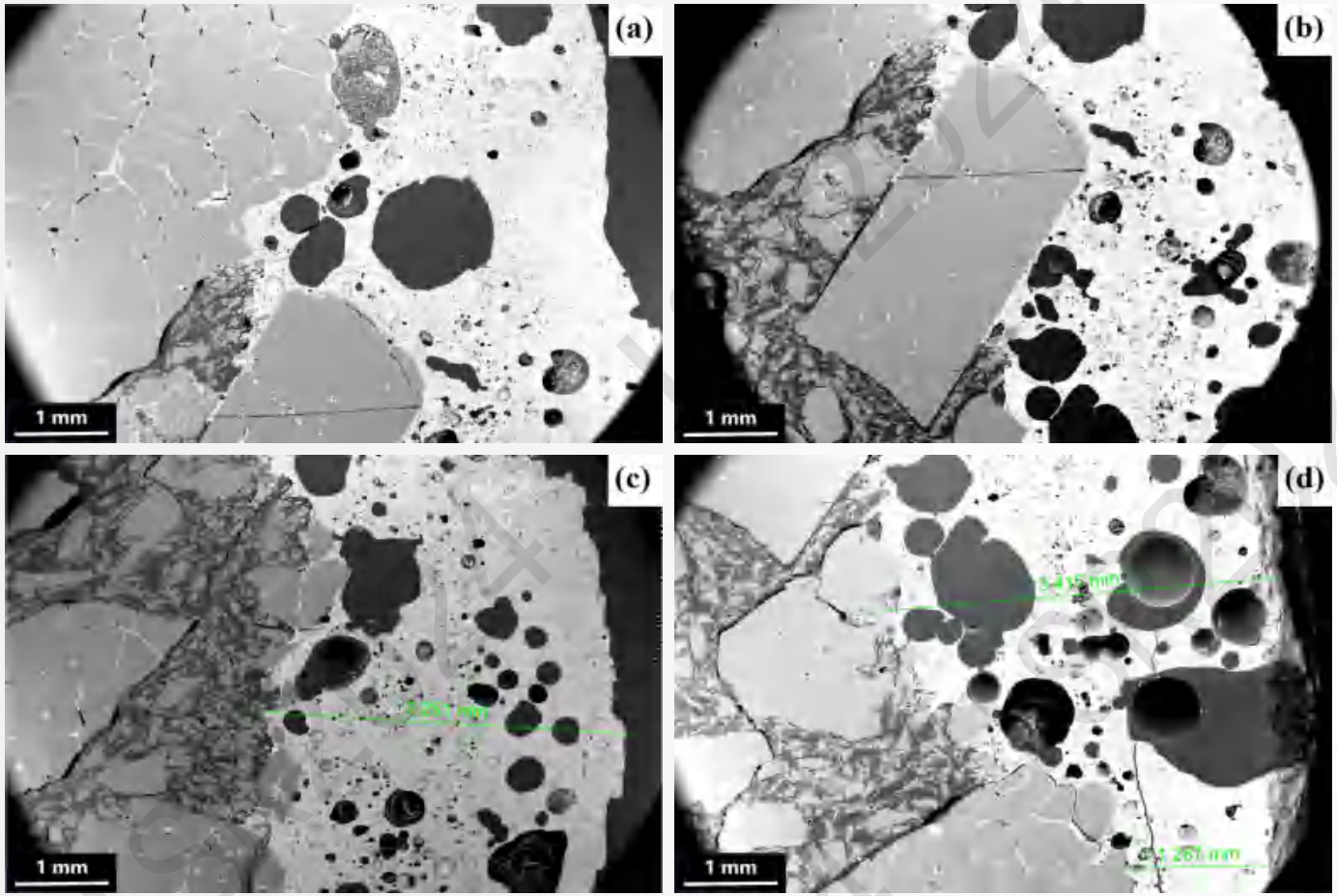


Fig. 10 Microstructure of sample brick with Eco-friendly binder after using

Eco-friendly binders Sample bricks form a sticky slag layer of about 3mm at the slag line, and there is almost no decarburization layer.

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7. Conclusion

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1. After testing by the national authoritative department, the new binder is environmentally friendly, non-toxic, formaldehyde-free, and phenol-free, ensuring safety and environmental protection in the production process.

2. The eco-friendly binder has a long shelf life, maintaining good performance even after 7 days, without needing adjustments to the production process. It reduces binder usage by 0.5%, reduces the material cost, and shortens mixing time by 5-10 minutes, improving production efficiency.

3. The actual application results show that the performance of the Eco-friendly binder is equivalent to that of the traditional phenolic resin binder, and even better in some aspects, it can meet or exceed the requirements of the existing products, and provide a more efficient and competitive choice for production.

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THANK YOU ALL FOR WATCHING