

ENCLOSURE (B) 14

PRACTICAL TESTS  
OF SUBSTITUTE BOILER FUELS  
(COPRA AND COPRA PRESSED RESIDUE)

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SUMMARY

It is confirmed that copra and copra pressed residue are suitable as boiler fuels, and it is recommended that they be used by mixing with coal or coal briquettes, the ratio of mixing being as follows:

Copra 70%, coal (in pieces-about 1" diameter) 30%  
 Copra 50%, briquette (egg-shaped) 50%  
 Copra pressed residue 50%, coal or briquette 50%

I. INTRODUCTION

To utilize the products of South Sea Islands for fuel, copra and copra pressed residue were tested as the substitute for coal for marine and land boiler use. Samples were prepared beginning June, 1942, and the tests finished in October, 1942.

II. DETAILED DESCRIPTIONS

A. Sample analyses are shown in Table I(B)14.

B. Boiler Used

Stationary type cylindrical boiler, fire tubes, return flame type.

Working pressure: 7.0 kg/cm<sup>2</sup> (gauge)

Tube size: 7.0cm diameter; 2 meters long.

C. Test Procedures1. Tests of Lighting Fire.2. Tests of Steaming at High Rate of Combustion (Hand-stoked).

These tests were compared with the tests using only coal or briquette as standards.

In the tests of lighting the fire, 4 kg of fire-wood and 100 kg of sample were used in each case and the ease or difficulty of lighting and flaming up, and the density of smoke were observed.

In the steaming tests, the rate of combustion was kept at 107.6 kg/m<sup>2</sup>/hr, and keeping the working steam pressure constant, the evaporation, degree of smoke conditions, etc. were measured.

D. Experimental Results

1. Tests of Lighting Fire. The fire was very easy to light when copra was used. Mixing the copra with briquette, the difficulty of lighting fire was considerably reduced. Consequently, the utilization of copra was very effective for quick steaming.

The copra pressed residue was also effective for the same purpose. (See Table II(B)14)

Note: It was advisable that the size of copra pressed residue be 50 mm<sup>2</sup> if a plate of thickness 15 mm was used as the sample, (50 mm x 50 mm x 15 mm).

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2. Steaming Tests. It was advisable that the ratio of mixing copra or copra pressed residue with coal or briquette be as follows:

Coal (in pieces) 30%, copra 70%  
 Briquette 50%, copra 50%  
 Coal (in pieces) 50%, copra pressed residue 50%  
 Briquette 50%, copra pressed residue 50%

In the case of copra, evaporative power of boiler was nearly equal to coal or briquette alone, but when copra pressed residue was used, the evaporative power was decreased about 20%.

When the copra or copra pressed residue was used, less smoke, less clinker, and easier lighting was obtained. (See Table III(B)14)

3. There was no danger of spontaneous combustion with copra or copra pressed residue in storage at the temperature of 100°C and below.

### III. CONCLUSION

It is very easy to light the fire when copra is used together with coal. For steaming purposes, copra with coal is effective as this combination gives less smoke than coal alone.

When copra is mixed in the ratio of 3:7 for coal, 5:5 for briquette, the evaporative power of a boiler is nearly equal to that for coal alone.

From the standpoint of fire bed thickness, clinker, flame color, and length, it is preferable to use a mixture of ratio 5:5 for pressed copra residue with coal or briquette, but in this case the evaporative power decreases about 20% compared with coal or coal briquettes alone.

In summary, copra and pressed copra residue are suitable for boiler fuel when intermixed with coal or briquettes.

Table I(B)14  
 ANALYSIS OF SAMPLES

Property	Raw Copra	Copra Pressed Residue	Coal (in pieces)*	Coal Briquettes**
Moisture %	3.6	5.4	2	2.5
Volatile matter %	92	76	41	14.6
Fixed carbon %	2.5	14	50	70
Ashes %	1.6	4.8	7	13
Calorific value (cal)	7300	4300	7200	7600

\* Grade C<sub>2</sub> (by Navy Specification)  
 \*\* Egg-shaped briquette

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Table II(B)14  
RESULTS OF LIGHTING-FIRE TESTS

Fuel	Time required from lighting fire till steaming (A)	From lighting fire till working (B)	Temperature		Fuel consumption (B) (kgs)	Ease of lighting
			Room (°C)	Feed water (°C)		
Coal in pieces only	2 <sup>h</sup> -25'	3 <sup>h</sup> -50'	26.5	26.5	280	Slightly difficult
Coal 30% Copra 70%	1-0	2-20	27	29.5	290	Slightly difficult
Coal 40% Copra 60%	1-10	2-40	21.5	27	270	Very easy to light
Coal 50% Copra 50%	1-05	2-10	21.5	27	245	Very easy to light
Coal 30% Copra pressed residue 70%	1-20	2-25	13.5	14.5	400	Very easy to light
Coal 40% Copra pressed residue 60%	1-20	2-15	7.5	16	350	Very easy to light
Coal 50% Copra pressed residue 50%	1-30	2-30	7.5	10	360	Very easy to light
Briquette only	3-20	4-20	25	27.5	380	Most difficult to light
Briquette 30% Copra 70%	0-55	2-0	23.5	27	300	Easy to light
Briquette 40% Copra 60%	1-05	2-10	23	24	300	Easy to light
Briquette 50% Copra 50%	1-10	2-25	19	25	320	Easy to light
Briquette 30% Copra pressed residue 70%	1-10	2-30	8	31	340	Easy to light
Briquette 40% Copra pressed residue 60%	1-30	2-50	5	15	410	Easy to light
Briquette 50% Copra pressed residue 50%	1-40	3-0	17	16	320	Easy to light

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Table III(B) 14  
RESULTS OF STEAMING TESTS

Fuel	Fuel consumption (kgs)	Rate of combustion (kgs/hr)	Quantity of feed evaporated (kgs/kg of fuel)	Temperature		Flamed colour	Length	Caking or non-caking	Smoke
				Room (°C)	Feed water (°C)				
Coal in pieces only	450	1076	8.3	30	27	yellow	long	non-caking	poor
Coal 50% Copra 50%	450	1076	7.4	28	25	yellow	long	non-caking	rather poor
Coal 40% Copra 60%	450	1076	7.8	29	25	light yellow	long	non-caking	poor
Coal 30% Copra 70%	450	1076	8.5	32	26	light yellow	longest	non-caking	fair
Coal 50% Copra pressed residue 50%	450	1076	7.2	16	14	yellow	short	non-caking	very good
Coal 40% Copra pressed residue 60%	450	1076	7.0	12	14	yellow	short	non-caking	good
Coal 30% Copra pressed residue 70%	450	1076	6.4	25	23	yellow	short	caked	very good
Briquette only	450	1076	9.3	31	25	light yellow	long	caked	rather poor
Briquette 50% Copra 50%	450	1076	8.9	31	25	light yellow	long	caked	fair
Briquette 40% Copra 60%	450	1076	8.3	33	26	light yellow	long	caked	rather poor
Briquette 30% Copra 70%	450	1076	9	32	25	light yellow	long	caked	rather poor
Briquette 50% Copra pressed residue 50%	450	1076	7	32	27	yellow	short	caked	best
Briquette 40% Copra pressed residue 60%	450	1076	6.7	33	26	yellow	long	caked	very good
Briquette 30% Copra pressed residue 70%	450	1076	6.6	32	26	yellow	long	non-caking	very good

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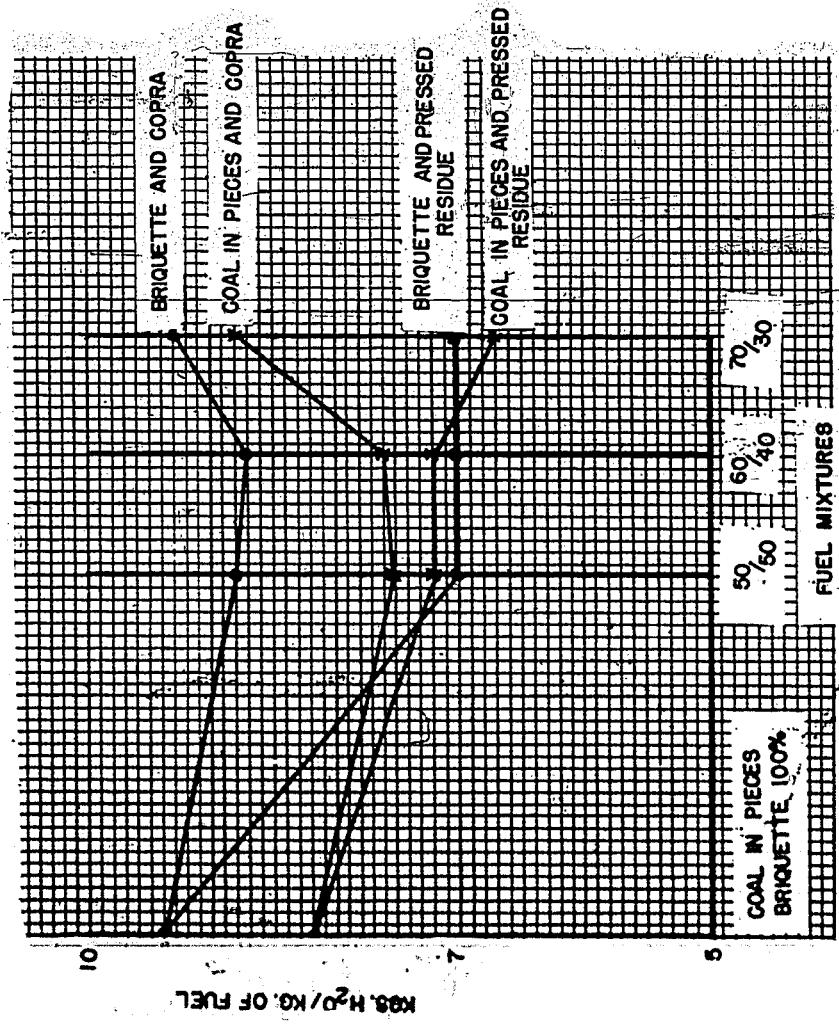


Figure (B)14  
EVAPORATIVE POWER