

# A brief performance and safety assessment of a 24V DC Rice Cooker intended for the Chinese domestic market.

Author: Dr Richard Blanchard

Reviewed by: Dr Nigel Monk, Dr John Barton,

Author Affiliation: Centre for Renewable Energy Systems Technology (CREST), Loughborough University, UK

Status: Final

Type: Working Paper

Version: 0.1

Date: May 2020

Location: Wolfson School shared workspace, MECS\_Technical folder

This material has been funded by UK aid from the UK government; however, the views expressed do not necessarily reflect the UK government's official policies.

## Summary

The report presents a brief review based on a physical inspection and cooking tests of a 24V DC rice cooker. This follows the structure of previous working papers in this series [1-3]. The rice cooker was intended for the Chinese domestic market and is a brand called RMIER. According to a sticker on the bottom the cooker has the characteristics shown in Table 1 and is shown in Figures 1.

Table 1: RMIER Rice Cooker Characteristics

| Feature                | Factor                                      |
|------------------------|---|
| Car Rice cooker Model: | AR-1630                                     |
| Rated voltage          | 24V-28V                                     |
| Rated Power            | 220W-280W                                   |
| Rated Capacity         | 3.0L  |
| Manufacturer           | Foshan Shunde Airuier Electric Company Ltd. |



Figure 1 RMIER Rice Cooker

## Introduction

### Functions and Features

The device in question has a white plastic base with 3 leg supports. There are ventilation slots in the base and a screw (hidden by a sticker) to enable the removal of the base. The main body is metal finished in a gold colour with decoration. There is a plastic moat which would drain to a water receptacle at the hinge point of the lid. The lid as mentioned is hinged with a click lock at the front to keep it closed. There is a plastic window in the lid to view the food and a steam vent. The lid appears to have air insulation between the outer and inner surfaces. There is a convenient carry handle. See Figure 2.

Inside the cooker is a non-stick surface pan that can be removed. The inner chassis is also finished with non-stick coating. There is an air gap between the chassis and outer casing. There is a spring button in the centre of the heating plate. The heating element is raised above the chassis.



Figure2. Feature of the RMIER Rice Cooker (a) lid with viewing window, (b) Hinged lid and pan, (c) Chassis and heating element.

At the front of the appliance there is a 'control panel' with on/off switch. See figure 1 There are 2 lamp indicators. The red light pictogram translates as 'cooking' and the yellow light is translated as 'insulated'. However, the yellow light is illuminated when power is connected, and the cooker is switched off. When the cooker is switched on the yellow light goes out and the red light turns on. The front panel can be removed by the removal of internal screws. Interestingly there is a safety feature with the switch which turns off when the pan is removed. It is not possible to turn the cooker on with the pan missing or if the lid is open and the pan is empty. Furthermore, if the cooker is turned on with the lid closed and no contents in the pan, after a while the cooker switches off indicating there is a thermal control as when it cools down the cooker can be turned on again.

## Brief Performance Assessment

As shown in Figure 3 the cooking pan is stamped with measurements 0.4L to 1.2L and 2-6 cup. There is a circular ridge at the 1L level, which might be a useful to indicate it is full. However, the graduation does not correspond to actual volumes. Adding water, it was found that 1 litre of water corresponds to 0.6L or 3 cups on the graduation. After adding 1.7L of water the level in the pan corresponded to the 1.0L or 5 cups on the graduation. 2.0L of water corresponded to the 1.2L or 6 cup level, see Figure 4.



Figure 3 Volume graduations of pan



Figure 4 Comparison of measured volumes with pan graduations

(a) 1.0L water (b) 1.7L water (c) 2.0L Water

Underneath the cooker is a sticker that was translated as Certificate of Passing. Production date 2020, 1, (assumed January 2020).

### Appliance Power connector

A WARNING sticker, figure 5 states the voltage limitations, which was translated: “Rated voltage 24V-28V. It is strictly prohibited to use with a voltage of more than 30V. The correct method of use is to plug in the cigarette lighter power after the car is started because the electric current is very large when the car is started which may cause electrical products to malfunction. Car rice cooker Note 24V truck input current socket”.



Figure 5 Rice cooker voltage warning sticker

### Power Cable

Appliance supplied with a 1M cable. The cable is 2 core with an IEC type for plugging into the cooker and a cigarette lighter type connector to the source, see figure 6.

On the cable is stamped 60227 / IEC(RVV) 300/500V 2x1.0mm<sup>2</sup> GB/T 5023.5-IEC60227-5:2003

The IEC connector on the cable states 10A 12V/24V and 10A 250V, see figure 6

If this is correct the wiring is capable of supporting 10A. AWG Wire Gauge Current Ratings [4].



Figure 6 Power lead and IEC Connector.

## Wiring and heating element

The interior of the rice cooker can be accessed by removing a screw in the base of the appliance. The interior elements appear to be well made and designed for purpose, see figure 7. The wiring of the cooker is shown in the wiring diagram, figure 8. There is a relay switch JD2912 which actuates when the cooker is turned on. Figure 9 shows the on-off switch mechanism that is linked to the centre button shown in figure 2c.

The ohmic resistance of the heating element was measured as  $3.3\Omega$ . The measured data from the heating test gave a value of  $2.74\Omega$  ( $R=V/I$ ).

The IEC power connector is a panel mounting design and clips into the receptacle of the white plastic base. It is stamped 10A 12v 24V CCC (China Compulsory Certificate).

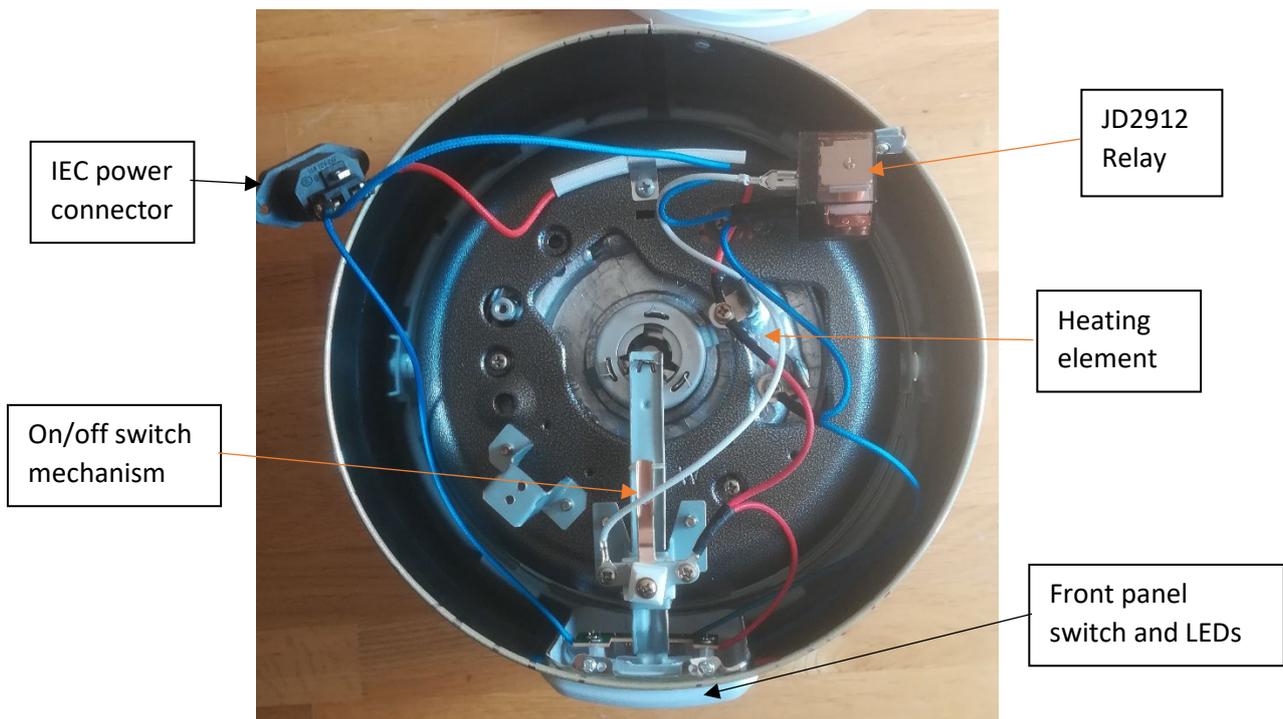


Figure 7 interior components of the rice cooker.

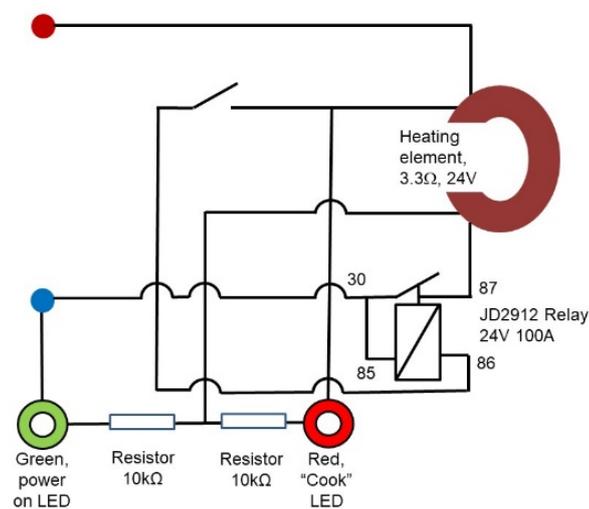


Figure 8 wiring diagram

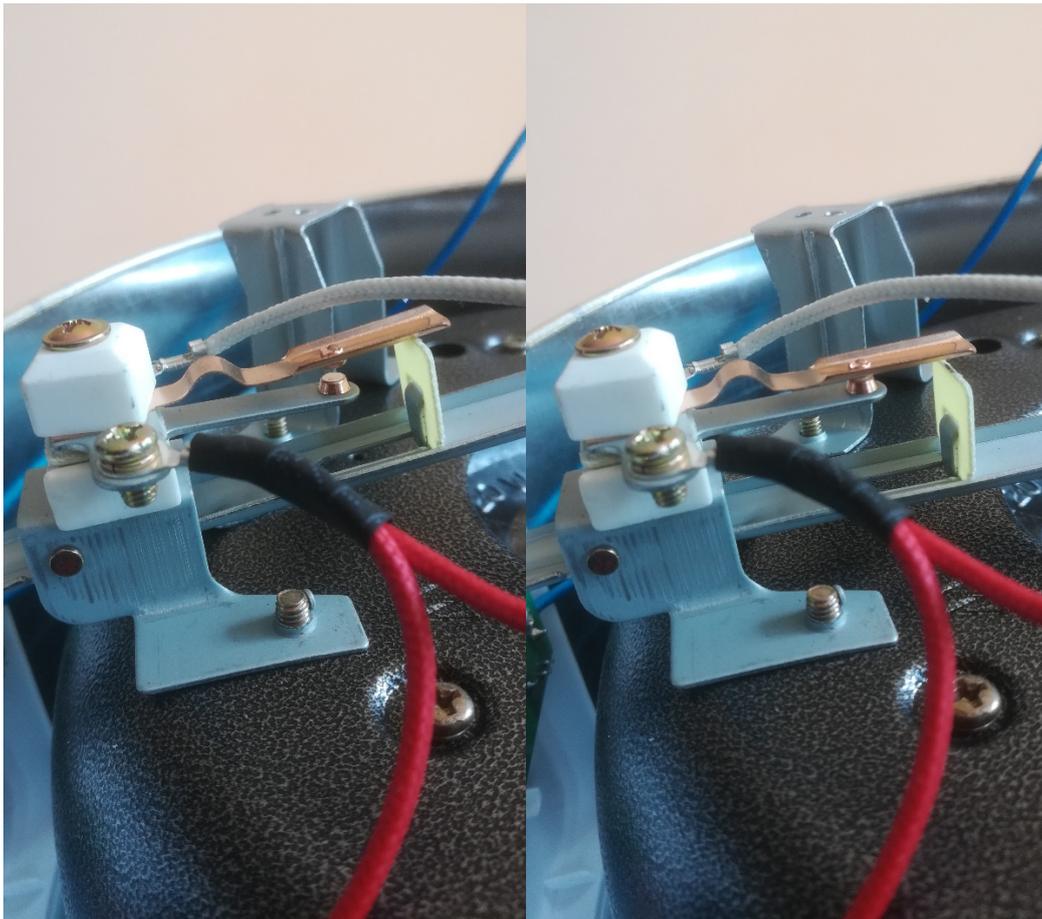


Figure 9 Switch cantilever, (a) off and (b) on.

## Performance Test

As part of this study a water boiling test (WBT) was performed. Taking into account the size of the appliance 1kg /1000ml water was measured and placed in the cooking pot of the rice cooker.

DC power was provided by a BOTERRUN BS-B3010DF 4-Digital LED Display Precision Variable Switching Regulated Adjustable Power Supply (0-30 V 0-10 A) that was connected to the rice cooker. The constant voltage power rating was set at 25.6V which is the voltage of a 24V LiFePo battery.

As no datalogger was available (Coronavirus lockdown Spring 2020) readings were taken every minute using the stopwatch on a Huawei P10 Phone and a TP300 digital thermometer with the sensor below the water in the rice cooker pot. Figure 10 shows the temperature profile and power rating.

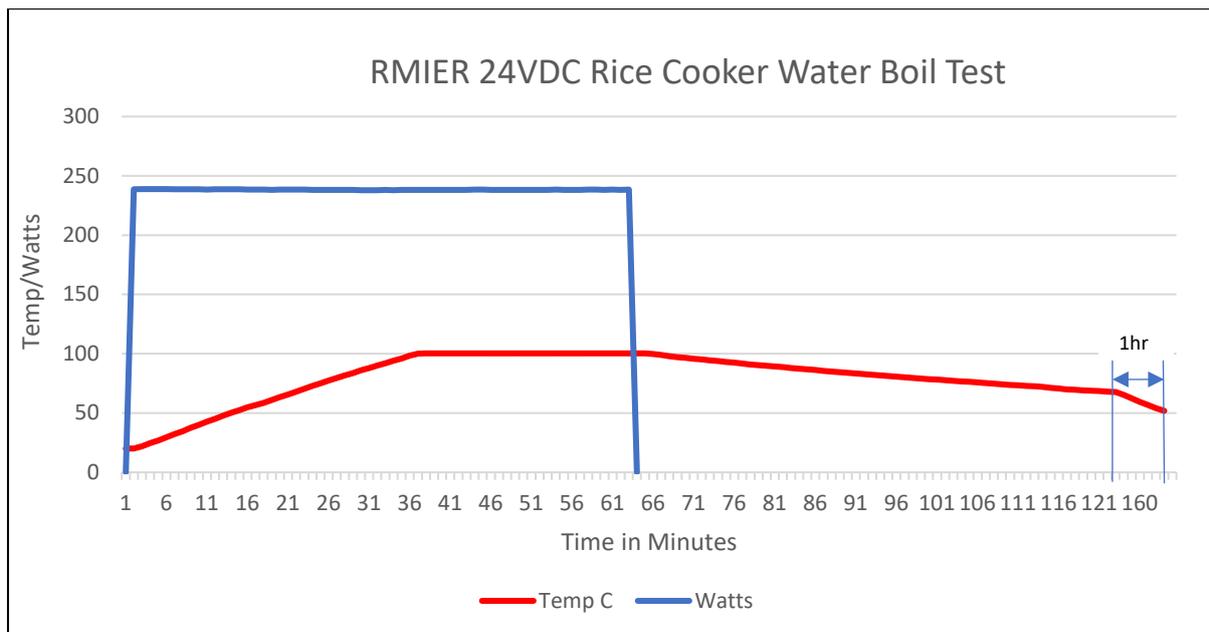


Figure 10 Water Boil Test for the RMIER 24VDC Rice Cooker.

The cooker ran for a total of 62 minutes. The power rating started at 25.6V, 9.31A and 238.4W with the voltage dropping to 25.55V, 9.33A and 238.3W by the end of the test. The temperature started at 20°C and reached boiling point after 36-37 minutes, rising at just over 2°C per minute. The cooker ran for a further 25 minutes at boiling point before being turned off, an estimated period for the time taken for food to have cooked. The temperature then fell to 51.9°C after a further 118 minutes at an average rate of 0.4°C per minute. The final hour is actually shortened in figure 10, but there was a steady state of temperature loss over the total cool down period. The total experimental time was 3hrs. 140g of water was evaporated during the test.

Following on from the WBT, a meal was cooked using the rice cooker, details can be found in the Appendix. What was interesting from the cooking was that the food was ready to eat after 15 minutes of boiling. The food would start to cook as the temperature rises, prior to boiling. So, the total cooking time was 50 minutes which would indicate around 200Wh of energy was consumed to make this meal.

## Modification Recommendation

“The following modification(s) will be required *inter alia* to enable a modified version of the product to meet the requirements set out *inter alia* within BS EN 60335-1 ‘Household and similar electrical appliances – Safety Part 1: General requirements’ in general, BS EN 60335-2-15:2016 ‘Part 2-15: Particular requirements for appliances for heating liquids’ in particular and BS EN 12778:2002 ‘Cookware – Pressure cookers for domestic use’ specifically. Independent testing would be required to prove product conformity against these standards. Additionally, CE marking assurance would need to be passed to an external organisation in order for the MECS programme and Loughborough University to be adequately absolved from product liability” [3].

1.” Replace the IEC60320 AC socket with a polarised DC inlet of suitable current capability and provide sufficient sockets and cabling of the same specification to connect the appliance through to the DC power supply. Ensure connections are made by competent persons” [3].

A solution could be the Anderson Power Products SAF-D-GRID range. These DC connectors are rated to 30A and 600V and are the same external length and width dimensions as an IEC socket so can be

a straight replacement. Figure 11 shows examples of these connectors which have different contacts to IEC connectors. However, there are cost implications.



Figure 11 Anderson SAF-D-GRID DC Connectors [5]

This report was written during the Covid-19 lockdown 2020. A 2<sup>nd</sup> edition will be published once normal service resumes. In this report further work will include, but not necessarily be limited to:

- Examining the internal wiring specifications
- Replacement / modification of DC connectors
- Dismantling and examining the materials for life-cycle assessment

#### References

- [1] Barton, J, Monk, N, Blanchard, R (2019) *A comparison of functions and safety features on electric pressure cookers*. [https://www.mecs.org.uk/wp-content/uploads/2019/09/Electric-Pressure-Cookers-Compared-WP\\_V1.0-1.pdf](https://www.mecs.org.uk/wp-content/uploads/2019/09/Electric-Pressure-Cookers-Compared-WP_V1.0-1.pdf) Accessed 2020-Apr-2.
- [2] Monk, N (2019) *An Investigation into the Functionality and Efficiency of an Electric Pressure Cooker Bought in Kenya Intended for the Domestic Market*. <https://www.mecs.org.uk/wp-content/uploads/2019/12/Sayona-EPC-Description-and-Test-Results-V1.0.pdf> Accessed 2020-Apr-2.
- [3] Monk, N and Mendis, S (2020) *A brief performance and safety assessment of a 24V DC Electric Pressure Cooker intended for the Chinese domestic market*. <https://www.mecs.org.uk/wp-content/uploads/2020/03/BES-24V-DC-3-litre-EPC-performance-and-safety-assessment-v1.0.pdf> Accessed 2020-Apr-2.
- [4] The Engineers Tool Box [https://www.engineeringtoolbox.com/wire-gauges-d\\_419.html](https://www.engineeringtoolbox.com/wire-gauges-d_419.html) Accessed 2020-Apr-2
- [5] Anderson Power Products Saf-D-Grid 600 VDC Receptacle & Power Cord (Up To 20 Amps). <https://www.peigenesis.com/en/anderson-power/saf-d-gridr-600v-dc-receptacle-a-power-cord.html#mechanical-drawing> Accessed 2020-Apr-24.

## Appendix 1 Cooking Trial

A meal was cooked based on the dish Kitchari. This is a rice and dahl mix.

### Ingredients

200g rice

200g of green lentils (soaked for 12hrs)

2 garlic cloves (crushed)

1tsp cumin powder

2 tsp oil

1 tsp salt

1-1.2 litre water

As noted, the rice cooker cannot be used for frying. So, the oil can be heated to fry the garlic and cumin separately if an additional heat course is available. This can then be placed in the rice cooker pan prior to adding the other ingredients.

Alternatively:

1. Add the oil, cumin powder and garlic to the pan.
2. Drain the water from the green lentils
3. Add the rice, green lentils, and salt to the pan and mix with the other ingredients. Add the water, it should not go above the max cooking level at 1.2L.
4. Turn on the rice cooker. It takes approximately 35 minutes to reach boiling point and cook for another 15 minutes checking the Kitchari. Stir to prevent sticking and ensure all the water is absorbed. The lid of the rice cooker can be open at this late stage, see figure A1.

Serves 6.



Figure A1 Kitchari cooking set-up and cooked kitchari