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# DEVELOPMENT OF SOLAR COMMUNITY DISH COOKERS

Based on very encouraging experiences with SK-14 cookers, Prof. Ajay Chandak designed solar community cookers of 2.0 m and 2.3 m diametres. After removing few teething problems, a number of agencies were trained to manufacture these community solar cookers. Because of the huge cost advantage and simplicity in operation, these community cookers are gaining popularity in the private sector as well as in other organizations. There was a big breakthrough when Rahul Kulkarni bagged an order from the Government of Maharashtra for 300 community solar dish cookers for tribal schools. This might be the single largest solar cooking project in the world, which was executed in the record time

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of 45 days. Recently, new square- and rectangular-shaped community dish cookers, PRINCE-30 and PRINCE-40, have also been developed.

## Introduction

Even though cooking with solar concentrators is slowly picking up in India, there are very few community cooking systems. Most of the existing systems are based on the 'Scheffler concentrators'. This is one of the best possible options available for community cooking, but still, it is not practiced on a large scale by common people and organizations. The promotion of this technology largely depends on the subsidies. Because of financial constraints and operation and maintenance issues, the technology is not widely adopted by the private sector and the small organizations.

An effort was made by Prof. Ajay Chandak to design simple parabolic dish cookers – SK-20 and SK-23 – of 2.0 m and 2.3 m diametres respectively, on the similar lines of SK-14. The effort was fairly successful. This article gives details about the development efforts

and the success stories related to this simple product.

## Background

After participating in an eight-day workshop with Wolfgang Scheffler, Prof. Ajay Chandak and Rahul Kulkarni were fascinated with his engineering innovation. The idea of cooking indoors was amazing. After coming back from the workshop, Rahul Kulkarni manufactured one Scheffler concentrator, which was working well. Prof. Ajay Chandak got two Scheffler systems installed at his personal energy park. With enthusiasm, these systems were demonstrated to many people and organizations, but somehow, Rahul Kulkarni could not sell a single system in the first year. Few enquiries were generated but none of them materialized. After discussion with the prospective clients, the following hurdles were noticed in the promotion of Scheffler technology.

a. High capital investment: Scheffler concentrators typically cost Rs 100 000 for a concentrator of 10 sq m. Many customers feel that

this price is quite high. The existing kitchens do not suit the installation of Scheffler concentrators in most of the cases, and additional investment in a new kitchen retracts many probable customers.

- b. Product manufacturing is difficult and there are very few competent suppliers in the market.
- c. The system is a permanent installation. The tracking mechanism still has some teething problems.
- d. Area around the reflector needs to be always shadow-free, which may not be practicable in few cases.
- e. Operation and maintenance require some skill.

In the meantime, Rahul Kulkarni started manufacturing SK-14 cookers, which were receiving very good response. Hence, it was decided to manufacture a new community cooker, which is as simple as a SK-14, but will fit in the budget and other expectations of the clients. Two different models were designed with 2.0 m and 2.3 m diametres. Both the cookers were giving excellent field performance. These cookers were tested at the Regional Test Centre in Pune. And few successful installations and very promising test report from the Pune University helped in selling more and more systems.

## SK-23 community parabolic cooker of 2.3 m diametre

Because of the low capital investment, it was possible for the authors to convince few clients to adopt these new systems. Matoshri Vridhashram was the first client. Few teething problems were noticed and rectified in the new designs. Here are the common problems observed in them and their solutions.

a. The wheels for the cookers needed to be very strong. So, industrial grade wheels used for trolleys were provided.

- b. Some correction in the parabolic shape was required to balance the weight of the dish. The design was rectified with lower focal distance.
- c. The cooking place was too high for the cook for placing heavy cooking vessels. Small fabricated platform with a stair was provided.
- d. A hole of around 400 mm was kept at the centre of the cooker as an escape route for wind. This was working well even in high wind conditions.
- vi. Installation is easy and can be done within a day. Many installations in a short duration are possible.
- vii. These systems enjoy big cost advantage over other community solar systems. Cost per sq m of aperture area is about Rs 6000, as against the Rs 15 000 for most other concentrators.
- viii. Major limitations as compared to Scheffler concentrators are manual tracking every 20 minutes and one has to work in the Sun.

The installation at Matoshri Vridhashram is in operation from the last six years and is a demonstration site

Few installations were made for commercial organizations like R M Chemicals in Dhule, Hotel Emerald



for all prospective customers. Following are the salient features of SK-23.

- i. Easy manufacturability: Simple workshop set up with welding and drilling machine is required.
- ii. Very simple in operation and maintenance.
- iii. Manual tracking: Tracking is required every 20 minutes.
- iv. Concentrator is mounted on industrial grade heavy-duty wheels. These can be used for tracking and also, for shifting the system from one place to other. This is because at few sites, the Sun is available at different locations in the morning and evening.
- v. Intellectual property rights are with Prof. Ajay Chandak.

Park at Nasik, and so on. The savings reported at these locations were up to half a cylinder (around seven kg) of LPG per day. The repeat orders received from these commercial clients are a good indicator of the success of the systems. It is important to note that all these systems were installed without subsidies.

### Product promotion strategies

There is a mid-day meal scheme in operation in all primary schools and *Aanganwadis* in India. These schools serve *khichadi* in Maharashtra. It was noticed that 3 kg of *khichadi* by dry weight (2.5 kg of rice and 0.5 kg of pulse) is served for 50 students, with 60 gm per student as a standard norm.

Considering the large number of such schools in the state, it was decided to tap these schools as prospective clients. The authors focused on the tribal residential schools where access to fossil fuels is difficult and firewood is the main fuel. The Regional Test Centre at the Pune University was requested to carry out field cooking test with 3 kg of *khichadi* and add the result of this cooking test to the technical report. This proved to be the turning point. These test results helped to convince the tribal minister and his officers to adopt these cookers.

Apart from cooking, an effort was made to locate new applications. Uses of these concentrators for preparation of Ayurvedic medicines and for autoclaving by doctors were few other successful applications.

### Tests and results

Different tests were performed on the cookers at the Regional Test Centre at Pune University and many trials were conducted in-house. Special cooking test was recommended for 3 kg of *khichadi*. First trials were conducted in March 2005 by one of the manufacturers M/s Rajkamal Enterprises. Another manufacturer M/s Essential Equipments got the trials done in January 2007. Test results of both the manufacturers are compiled together, and are presented herewith.

### Performance tests

Performance tests reveal the most important information regarding cooking capabilities. Thus, performance tests were carried out for establishing field cooking test (*Table 1*).

### Stagnation temperature test

In 3-litre-capacity frying pans, 1000 ml and 1500 ml of oil were placed. Readings were recorded every minute (*Table 2*).

### Thermal Performance Test

In March 2005 and January 2007, 8000 ml and 6000 ml of water was used for tests, respectively.

The overall thermal efficiency was recorded at 37% and 36%, respectively. Considering the reflectivity of sheets at 80%, overall thermal efficiency of 36% can be treated as good. Thermal efficiency is higher at lower temperatures and goes on reducing as operating temperatures goes on increasing.

All tests and trials on the cooker carried out in-house are in the close range of the test results obtained from University of Pune.

### Adoption of technology by tribal ministry in Maharashtra

With test certificates from authentic test centers and field performance reported from the users, the state nodal agency of Maharashtra, MEDA (Maharashtra Energy Development Agency), published the success story of this new product in their news bulletin. It was possible to motivate tribal ministry authorities on this background to adopt this technology. MEDA proposed the utilization of this technology for residential tribal schools and a trial order for 60 cookers was placed in February 2006. This project was completed in March 2006. After encouraging feedbacks from the users, in 2007, tribal ministry made provision for 300 community cookers. Because of some administrative issues at the state nodal agency, there was a delay in placing the order. The order was placed by MEDA in February 2007 for 300 community cookers. With 300 community solar cookers, comprising of 1200 sq m of aperture area, this might be the single largest order for solar cookers in the world. This project was executed in record time of 45 days.

The challenges during the execution of the project were as follows.



- a. Strict time frame: Only 45 days were permitted to carry out all the functions of material procurement, manufacturing, transportation to sites of tribal schools, installation, commissioning, test and trial at the schools, and collecting feedbacks regarding 7 days trials.
- b. Inspection of the installed systems by MEDA authorities during the same time frame.
- c. All the installation sites were tribal residential schools, scattered all over Maharashtra. Reaching these schools itself was a big challenge.
- d. Many sites in the Gadchiroli district have naxal areas. Installation teams were not permitted to travel at night and stay at any tribal schools. There was a lot of interference from the police authorities. At one site, a bridge was blasted by naxalites and it was not possible to reach the site. Ultimately, the authorities gave alternative site.
- e. It was impracticable to get any payment during the execution of the project and hence, organizing the total amount of more than Rs 65 lakh in 20–25 days was a challenge.

The authors accepted the opportunity as a challenge and could complete the project in record time.

**Table 1 Results of the performance test**

Testing period	Recipe	Ingredient (in gm)	Water (in ml)	Time taken (in minutes)
March 2005	Khichadi (rice 2.5 kg + pulse 0.5 kg)	3000	6000	55
January 2007	Khichadi (rice 2.5 kg + pulse 0.5 kg)	3000	6000	60

\*A 22-litre-capacity pressure cooker was used for the test.

**Table 2 Results of the stagnation temperature test**

Test duration	Time to reach stagnation temperature	Stagnation temperature (in °C)
March 2005	32 min.	266
March 2005	42 min.	257
January 2007	55 min	246

\*Stagnation temperature depends on the wind speed and solar insolation during the test period as well. All test results indicate stagnation temperatures in the range of 250°C.

Following were some of the ways to overcome the different challenges.

- i. Prof. Chandak took over as the project coordinator and all activities were planned for 45 days. Adequate provision was made for uncertainties in the naxalite-prone areas.
- ii. Finance was raised from all possible sources, especially from friends and relatives. Credit purchase was obtained from routine suppliers.
- iii. All purchases were organized within first 15 days.
- iv. Three workshops were rented, apart from the manufacturing set up of Rahul Kulkarni.
- v. Twenty-five teams were formed with many temporary appointments. During the initial production time, these team leaders were given training for installation, commissioning, and test and trial of the system. Special 'daredevil' teams were chosen to work in the naxalite-prone areas and these teams did not let us down.
- vi. Special supervisory staff was trained and appointed for taking the MEDA staff around for inspection of the systems.

With all valiant efforts, it was possible to complete the assignment within the stipulated time.

This project gave confidence to the authors that projects of bigger magnitude with tight timeframes can be accepted and executed.



## Recent developments

The SK-23 cooker is gaining popularity and is now also available on rate contract of the Government of Maharashtra. With feedbacks from the existing manufacturers, it was noted that this system is to be transported as a unit and being bulky in size, transportation cost is high. Prof. Ajay Chandak has now designed and introduced new range of solar community cookers of 3 and 4 sq m aperture area as a substitute for SK-20 and SK-23. These are termed as PRINCE-30 and PRINCE-40 community solar cookers. Special features of these cookers are as follows.

- a. Available as DIY (Do It Yourself) kit. This feature reduces the cost of installation to a large extent. Also, installations in remote hilly region and border areas are possible.
- b. This is available in knock-down assembly and can be packed in small boxes. This has improved transportability. This feature makes it possible to transport and install the cooker anywhere on the globe.
- c. Unique square or rectangular dish shaped design.
- d. Design based on patent pending by Prof. Ajay Chandak.
- e. Cooking performance of PRINCE-40 indicates its suitability for around 40 people. It can cook 5 kg of rice in 45 minutes and 5 kg of potatoes in 65 minutes. This concentrator has been tested for other applications like Autoclaving at Shri Bapusaheb

Hire Government Medical College, Dhule, and results were satisfactory. The product has also been tested at the Pune University.

## Conclusion

With experiences during the develop-

ment and promotion of community parabolic dish cookers – SK-20, SK-23, PRINCE-30, and PRINCE-40 – authors are now confident that such simple technologies can deliver big promise in emission reduction when adopted on a large scale. These systems do not have the indoor operating convenience of Scheffler concentrators, but because of the huge cost advantage and the ease of operation and maintenance, these systems are easily acceptable.

Probably, world's largest solar cooking project was executed with very simple technology using 360 SK-23 community dish cookers, contributing to 1440 sq m of aperture area. It is projected that with 360 installations already made at tribal schools in Maharashtra, there can be LPG savings worth 54 tonnes per month.

The project with the tribal ministry also demonstrated that with proper planning and organizing of human resources, large numbers of installations are possible in very short time. The project demonstrated that all other schools where mid-day meals are provided can successfully adopt this solar technology. Few more entrepreneurs will be required to promote the technology in other states as well. With the introduction of these new PRINCE-30 and PRINCE-40 cookers, the transportation inconvenience of SK-20 and SK-23 is now taken care of. It is very likely that PRINCE-30 and PRINCE-40 cookers will replace SK-20 and SK-23 cookers because of better performance and transportability.

With some sort of subsidies provided for these promising products from the governments, large-scale implementation is possible. Recognition will be required for the product from MNRE (Ministry of New and Renewable Energy) so that the adoption of the product is possible by other agencies.