5 Biomass gasification for the silk industry: India

General information

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- **Implementation period**
  1995-2002.
- **Costs**
  US$1.25 million.

Summary

In recent years, the profitability of the Indian silk-reeling industry has been reduced by the import of cheaper raw silk and the high prices of cocoons. In addition, the productivity of the sector is low because there have been no systematic attempts to upgrade its technology, conserve energy or recover by-products. Even so, after China, India is the world's second largest producer of silk — the queen of textiles — producing about 14,000 metric tons a year. Most of this silk is reeled in the 35,000 charkha ovens and the 26,000 cottage basin ovens that are currently registered.

Annual fuel consumption of cottage basin ovens is estimated at 120,000 tons of fuelwood, while charkhas consume 105,000 tons of locally available biomass, such as groundnut shells, tamarind and rice husks and coffee beans. However, the consumption of these fuels by the silk industry is only 11.7 to 15.3 per cent efficient.

To tackle the problem of inefficient energy consumption, the New Delhi-based Tata Energy Research Institute (TERI) considered a two-way strategy that involved: (a) retrofitting existing ovens to improve their efficiency, and (b) introducing gasification technology. Efforts focused on developing gasifier-based cottage basins that could be commercialized. The main steps in the project were a preliminary energy audit, a survey of the silk sector, a more detailed energy audit, development and field-testing of laboratory prototypes, and development and demonstration of a commercial prototype. As a result, a cocoon cooking oven whose main component is a gasifier is now being marketed under the name of SERI-2000.

During field-testing, it was discovered that fuel savings were not the only benefit of gasifier-based systems. The new ovens also led to:

- improved silk productivity (in terms of both quality and quantity), probably as a result of the ovens' controlled processing parameters such as water level and temperature;
- reduced pollution;
- time, labour and water savings; and
- increased profit margins for users as a result of all of the above.

The main lesson learned from the project was that the success of the new technology depended on inputs from stakeholders, including oven users, silk experts, engineering consultants and manufacturers.

Background and justification

Mulberry silk production, which accounts for about 90 per cent of Indian silkworm breeding (sericulture), is concentrated in the States of Andhra Pradesh, Karnataka and Tamil Nadu in the south of the country. States towards the

northeast produce such non-mulberry silks as tassar, muga and eri. Sericulture has spread over the years and now provides employment for more than 5 million people living in 59,000 villages and covers an area of 282,000 hectares.

An efficiency survey of 236 cooking ovens found that charkhas consume between 2.44 and 3.20 kilograms of wood per kilogram of cocoons processed, while cottage basin ovens consume 1.5 to 2.0 kilograms. It was then calculated that charkhas need about 1,300 kilocalories of energy to process one kilogram of cocoons and that cottage basins require about 875 kilocalories. This difference in energy needs can be explained by the longer operating periods and larger cooking vessel areas of charkhas. The main drawbacks of the traditional ovens are that they do not allow fuel consumption to be controlled and that large fluctuations occur in such process parameters as water level and temperature.

There was plenty of scope, therefore, for improving the efficiency and design of the ovens. As a first step, existing ovens were retrofitted to control their burning rates, maximize their flue gas heat recovery and reduce other losses. Retrofitted ovens allowed modest energy savings of about 25 per cent, but this was not enough to encourage silk reelers to face the inconvenience and expense of retrofitting their ovens. To be economically viable, the project had to come up with an alternative design that was capable of meeting the energy needs of silk-reeling units while generating substantial fuel savings.

Description

Faced with the challenges of evaporation losses and the need for controlled burning, a gasifier system appeared to be the best option, and TERI started to develop a suitable gasifier-based silk-reeling oven. A downdraft, throatless gasifier was selected because less tar and particulate matter are produced in its raw producer gas and it allows the use of relatively large wood chips and other fuels compared with updraft and cross-draft gasifiers. A water seal tank is placed under the gasifier to collect ash and cinders.

The main goal of the project was to improve the productivity and profitability of post-cocoon processing in the silk industry, including reeling and dyeing. Project activities fell into five main categories: technology and system development, economic assessment, market development, entrepreneur development, and human resource development. The final product — the SERI-2000 oven — evolved from a process of prototype development and testing, which included inputs from silk experts, engineering consultants and manufacturers. The oven is now commercially marketed by two licensed manufacturers. The entire process, from laboratory prototype to final commercial model, was completed in just over three years (May 1995 to June 1998).

Before the ovens were put on the market, they were extensively field-tested to quantify their advantages over

traditional ovens. An economic assessment showed that the new technology had a payback period of less than a year in terms of reduced fuel consumption and increased productivity and profitability. In fact, the new ovens allow fuel savings of 70 per cent or more, representing nearly 300,000 rupees a year.

Development of the oven involved the design of a series of laboratory prototypes, each of which was field tested and adapted to create the subsequent improved prototype. Data regarding quality and yield improvements were collected, and reelers and silk experts involved in the testing provided feedback and comments at every stage. Comparative data for both the traditional and the new ovens — including cocoons processed, fuel consumed and silk produced — were collected. With the gasifier ovens, fuel consumption declined by 57.3 per cent, water consumption by 28.4 per cent and renditta (the number of kilograms of cocoons required to produce one kilogram of silk) fell by 3.6 per cent. Quality improvements included fewer breaks during winding and a cleaner, neater, stronger product. The project team also carried out studies to establish the most suitable capacity for each of the applications of the gasifier.

Patenting and commercialization

After the design for the gasifier-based oven had been finalized and a complete set of system specifications and drawings had been prepared, TERI filed a patent application for the invention in June 1998 and was allotted application number 1627/DEL/97.

Manufacturers and local marketing agents helped to test commercialization of the new technology through a direct marketing approach. To start with, a promotional test-marketing phase was initiated to generate awareness of the benefits of the new systems among potential users. Brochures in local languages were distributed to silk reelers, and demonstrations were held at cocoon markets. A team of consultants and project representatives then assessed the technical, financial and marketing capabilities of about 15 manufacturers to find the most appropriate partners for the commercial distribution of the ovens.

The two manufacturers chosen were 2M Industries of Bombay and Silktex Industries of Kanakpura, and the technology was transferred to them through a license agreement. Members of the project team trained the manufacturers in fabrication details and quality-control procedures, and stringent quality checks were carried out. Discussions were held with financial institutions so that a suitable marketing scheme could be worked out. One of these financial institutions, SDC, designed a financial package to facilitate the first stage of commercial distribution through awarding favourable credit facilities to the buyers of the first 100 gasifier-based systems.

Partnerships

During the system development, field-testing and marketing phases of the project, the team entered into partnership with the following individuals and public- and private-sector institutions and organizations:

- private manufacturers — 2M Industries of Bombay and Silktex Industries of Kanakapura;
- silk experts — D. Mahadevappa and T.S. Nagaraja;
- design consultants — the Industrial Design Center, IIT of Bombay and Kvaerner Powergas of Bombay;
- numerous potential users of the new technology;
- international experts — Sorane SA (Switzerland) and Ashton Court Consultants (United Kingdom);
- the donor — the Swiss Agency for Development and Cooperation; and
- Departments of Sericulture in Andhra Pradesh, Karnataka and Tamil Nadu.

Replicability

The successful development and demonstration of a gasifier-based system for thermal applications in the silk industry has had spin-off effects in many other industries that need to generate heat. The new technology is already being used, among other activities, for rubber drying, textile dyeing and large-scale cooking, resulting in reduced fuel costs and improved product quality because of better temperature control.

The system could also be replicated in many other small and medium-sized industries throughout India, including: puffed rice manufacture, tapioca making, baking, the hotel trade, lead recovery from used batteries, wire enameling, tobacco curing, lime kilns, mini cement plants, gur making, tea drying, brick drying, khoya making, small-scale cardamom production, coffee curing, food processing, carbon dioxide manufacture and copra drying. Other countries with similar conditions and large numbers of similar industries could also benefit, including Bangladesh, Malaysia, Myanmar, Sri Lanka and Thailand.

Lessons learned

The main objective of this project was to develop a commercial product based on gasifier technology for use in the silk-reeling industry. Its success was the result of designing a technology that was based on research into the processes involved and constant feedback from field-level interaction at all stages. The development and adaptation of renewable energy devices for small-scale rural enterprises are both time-consuming and expensive.

Over the years, the Indian silk industry has become highly dependent on government policies and interventions. Most of the technology upgrading and

improvement in the sector has been driven by government support and there has been very limited private-sector involvement. Machinery and equipment have also been marketed through government subsidies or incentives, and there have been no direct links between manufacturers and silk reelers. The project was innovative, therefore, in that it put manufacturers and their local agents into direct contact with reelers. This meant that the benefits of the new technology had to be made very clear to its potential users, who were used to the security of government financial support. Reelers expected to be able to buy the ovens with subsidies or through credit schemes, but they have a poor repayment record so bank loans did not seem to be a viable option.

To overcome this challenge, favourable credit arrangements were used to finance the distribution of a few gasifier-based systems within the silk-reeling community as a way of demonstrating their economic and other advantages. The idea was that, rather than using financial incentives to create artificial markets, potential users should be encouraged to adopt new technologies because of their inherent economic viability and the clear benefits of using them. In this way, renewable energy projects can become truly successful and sustainable because the people involved in them have a clear interest in keeping them going.

IMPACT

To date, about 35 gasifier-based systems have been installed in the silk industry for reeling and dyeing. Long-term testing of these systems has found that their use leads to savings of 745 rupees a day: 90 rupees from reduced wood consumption, 455 rupees from increased silk production and 200 rupees from improved silk quality. Overall, the systems are saving about 822 tons of fuel wood a year and generating an extra 2,490 kilograms of silk. In addition, pollution and water requirements have also been reduced considerably.

The long-term impact of the project is to increase the competitiveness of the Indian silk industry in international markets by improving productivity, profitability and environmental quality through the introduction of biomass gasification technology.

FUTURE PLANS

Small and micro enterprises contribute about 7 per cent of the gross domestic product (GDP) of India. In recent years, energy prices have been increasing rapidly. Diesel oil prices, for example, increased from 7.95 rupees per litre in January 1997 to 16.59 rupees per litre in August 2002. These price increases hit small-scale producers particularly hard. Biomass fuels can replace fossil fuels in several small industries that use large amounts of energy for thermal

applications. There are immediate plans to introduce the new technology into other applications, such as textile dyeing, rubber drying, hot water and steam generation, and non-ferrous metal treatments. However, this will not be a simple add-on process because much of the existing process equipment used by the small-scale industries will have to be adapted to accommodate the gasifiers. For this, the project will collaborate with specialized engineering experts from the various industries involved and will carry out extensive field-testing and demonstrations. Once suitable technology packages have been developed, the project team will turn its attention to the financing and marketing aspects.

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