# Bio-medical waste

Toxics Link
**Factsheet**
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## Non-incineration treatment technologies for rural areas

One of today's major environmental concerns is the amount of waste material being generated and the insufficient means to dispose it. The most commonly used method continues to be incineration even though the health and environmental hazards linked with it have exposed its limitations.

Although many non-burn alternatives –large autoclaves, autoclaves with shredders, and microwave devices – are readily available in industrialised nations, developing countries and their largely rural communities rural communities have little or no access to these technologies.

### The problem at the grassroots

Currently, many rural hospitals and clinics discard their medical waste along with regular trash, thus risking the spread of diseases among scavenger populations. While some bury their waste contributing to groundwater or surface contamination, others burn their waste in make-shift incinerators thereby exposing communities downwind to toxic byproducts such as dioxins and mercury.

As immunisation and rural health programmes expand, the problem of medical waste treatment and disposal in rural areas will become critical.

### Worldwide efforts to provide a solution

Incineration has been recognised as an environmental threat of great magnitude, the world over. In order to promote clean, efficient and low-cost treatment technologies for rural areas Health Care Without Harm (HCWH) [1] launched a competition in consultation with the World Health Organization in April 2002. In response to this competition the committee received 58 design ideas from around the world. Out of these, 30 contestants were asked to submit a detailed description of their concepts. The judges selected three winning designs from these finalists. Five designs merited an honourable mention, which was announced during the World Health Assembly in Geneva.

### The winning entries of the competition

The first prize was awarded to an Australian team which developed a portable solar-powered autoclave. The second prize went to a team of doctors from NHS Trust Freeman Hospital in England who designed a boiling chamber with a mechanical grinder and compactor, while the third prize went to a team from Mississippi State University in the United States for a concept that involved lime treatment and encasement of the waste.

## AT A GLANCE

- **Developing countries and their largely rural communities have little or no access to non-burn alternatives to medical waste disposal**
- **As immunisation and rural health programmes expand, the problem of medical waste treatment and disposal in rural areas will become critical.**
- **Three designs of non-burn technologies from India have received an honourable mention in a worldwide contest launched by Health Care Without Harm in collaboration with the World Health Organisation.**

**First prize**

**The top prize went to the team of Rhys Hardwick Jones of Sydney University in Austria. Their design nicknamed Prometheus is a completely solar powered autoclave that can operate in both sunny and cloudy conditions**

**Honourable mention**

- Team of Wolfgang Scheffler of Solare Bruecke, Germany; in coordination with Michael Mazgaonkar of Paryavaran Suraksha Samiti, India
- Vikrant Chitnis of Choithram Hospital and Research Centre, India
- Team of Laura Robinson of North Carolina State University, USA
- Team of Carlos Fortune Cabello of the Universidad de Valparaiso, Chile
- Team of Abhishek Jain of the Indian Institute of Technology, Madras, India

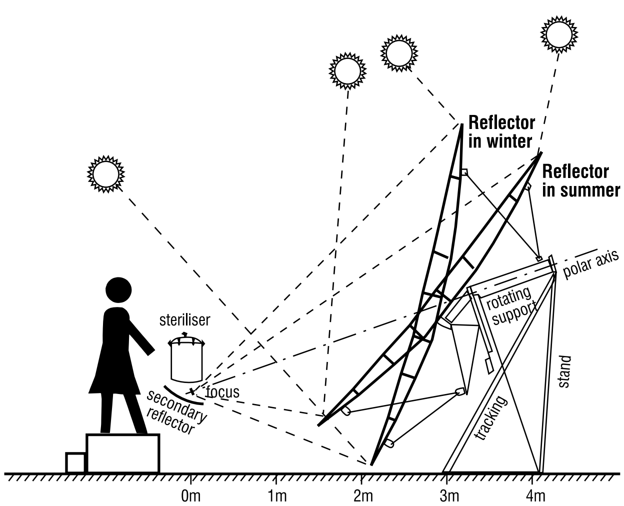
Below, we describe the designs from India that received an honourable mention. These designs will be field tested in rural areas by Srishti and Paryavaran Suraksha Samiti of Gujarat.

### Steriliser using a Scheffler Reflector

Adapted from the entry by Wolfgang Scheffler and Heike Hoedt, Solare Bruecke (Germany), and Michael Mazgaonkar of Paryavaran Suraksha Samiti (India)

**Design concept**

A Scheffler Reflector[2] is used to provide concentrated solar energy to render medical waste harmless through sterilisation at a suitable temperature. This can be done through dry heat, using hot air, or by pressurised steam. This part of the equipment will be a standard sterilisation unit, readily available in the market.




*Steriliser using a Scheffler Reflector*

The required heat energy to operate the steriliser is derived from renewable solar energy provided by a concentrating Scheffler Reflector. This is available in several sizes and is a universally usable heat source. The heat energy is delivered to a fixed focus-area beside the reflector over a wide range of temperatures, from ambient to about 1000 degrees celsius. The temperature is adequate to treat any bacterial or viral contamination.

**Operation**

The handling of the device is easy once the user is accustomed to the setting routine of the reflector – turn it from the westward evening position to the eastward morning position prior to use – and the seasonal setting procedures. The sterilising unit is placed directly in the focus of the 10 square metre Scheffler Reflector, on top of a small secondary reflector, which redirects most of the concentrated light to the bottom of the steriliser (pressure vessel). Water in the bottom of the vessel boils and builds up steam pressure until the pressure regulating valves opens. This is very much like the system used already in developing countries for cooking food, only the cooking pot is exchanged with the steriliser.

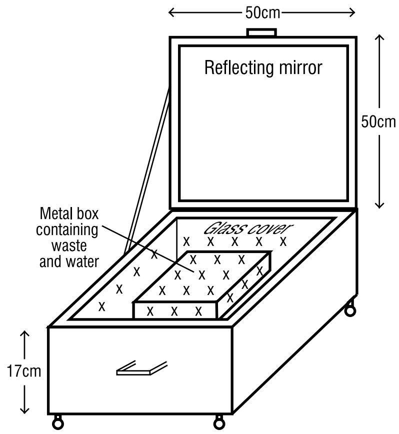
This technology is currently being field-tested in Tripolia Hospital, Patna, Bihar. The 150-bed hospital serves the city as well as five surrounding villages totalling 40,000 outpatients per year. The waste being managed is sharps, pathological waste and other waste.

### Box-type solar cooker for disinfection

Adapted from the entry by Vikrant Chitnis – Choithram Hospital & Research Centre, India

**Design concept**

The box-type solar cooker is made of galvanised aluminum sheets. It is mainly divided into two sections: the upper cover and the lower box. The upper cover holds the reflecting mirror, which is supported by wooden ribs. The lower box has a fitting of the electric heating arrangement, which consists of indicator lamps, thermostat and




***Box-type solar cooker for disinfection***

heating elements. The main heating area is painted black and has the capacity to hold the metal box. The lower box also has a lining of glass wool in the base to improve insulation. A transparent glass sheet covers this lower area, which is lined with clips. A rubber lining covers the periphery of the box on which the glass cover rests.

The single reflector mirror, facing the solar radiation, reflects solar energy on the heating area of the box. The glass cover sheet lined with rubber lining and glass wool in the lower box helps in raising the temperature. Immersion of waste in water has improved the heat penetration of the waste.

### Operation

The contraption is easy to operate; a nursing assistant or a ward boy could be trained to do the job. The box-type solar cooker is placed on a high-rise building top or open ground where plenty of sunlight is available. Preheating of box solar cooker with metal box is started at 7 a.m. in the morning by facing the reflector mirror in the direction of the sun. At 10 am the waste is added to the metal box and filled with water till the waste is immersed. Maximum five litres of water is used and it does not necessarily need to be potable water. The waste is exposed from 10 a.m. to 4 p.m. The direction of the reflector mirror is changed every two hours to align with the sun. After 4 p.m., the waste is allowed to cool. The water is drained into a sewer. After disinfection in the solar cooker, the waste needles and sharps can either be buried in a cemented pit or can be sent for metal smelting. The glass could be sent for recycling. Plastic wastes and other wastes could be shredded and sent for recycling. The biodegradable waste could be buried. On cloudy and rainy days, the electrical heating system is used.

### Autoclave with internal shredder as part of an integrated medical waste treatment system

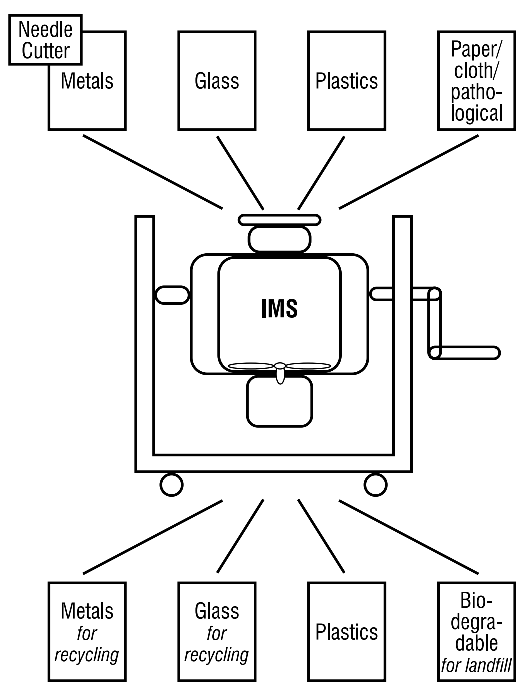
Adapted from the entry by Abhishek Jain, Sumon Datta and Dr. T. Swaminathan, Indian Institute of Technology, Madras, India.

### Design concept

The design consists of three stages:

- Waste collection and segregation
- Waste treatment in Integrated Medical Waste Treatment System (IMS), and
- Disposal of treated waste.

In the first stage of waste collection and segregation, different types of wastes are collected in separate bins so that they can be treated in separate batches. The second stage comprises of single equipment integrating size reduction with disinfection. For the final stage, waste may be disposed in different ways – some recycled, and some processed to be used for an appropriate purpose.




***Autoclave with internal shredder***

**Second prize**

**Dr Malcolm G. Holliday of Newcastle upon Tyne Hospitals, United Kingdom designed a manual grinder in which the waste is shredded prior to it being moved by gravity and a tamper into a rectangular treatment chamber. Locally available fuel is used to boil water in the chamber for 50 minutes to treat the waste**

[1] *Labunska 1999*

**Third prize**

**The design of Alissa Willis of Mississippi State University, USA uses the heat generated by mixing lime and water to treat the waste in a metal drum. The container is then covered with a mixture of lime and waste fly ash that react to form a cement-like material to encase the waste**

### Operation

The waste to be treated is loaded into the vessel by emptying the waste collection bins in the hospital into the top loading lid. The jacket should be checked for water height, which should be in the range of 25-30 cm, so that the heating coil (which is up to 15cm level), is completely immersed in water. After loading, the lid is bolted along with a full-face gasket. The electrical switch corresponding to the motor for the crushing/ grinding blades is turned on and the time set in the timer. The switch for the heating coil is turned on.

To begin with, the blades are rotated at low speeds; as the size of the waste is reduced, the speed may be increased. A motor which can rotate in either direction (clockwise or anticlockwise) is used. In one direction the blades shred; in the other they crush the glass waste. Thus, the direction of the rotation can be set depending on the type of waste. For metallic waste the blades are not used and the motor is not turned on.

While the blades reduce the size of the waste, the electrical heating element fills the outer jacket of the vessel with high temperature steam, which acts as an indirect heating medium for heating the waste. The jacket-steam converts the moisture of the waste in the inner vessel into steam, and the vessel starts to pressurise leading to a high level of disinfection. After this, the steam in the jacket condenses into clean, hot condensate which is reused again in the jacket. The steam in the inner cylinder is released through the Pressure Release Valve. At this point, the waste is broken up into small fragments, and all the material heats up rapidly, being evenly and thoroughly exposed to the hot inner surfaces.

Initially, no steam will be injected into the waste. If there is not enough moisture in the waste to pressurise the vessel, a small amount of water is added until the desired moisture content is reached.

For unloading, after all the steam has been released and the vessel has sufficiently cooled, the lid is opened. A bin is placed below the vessel and the vessel is rotated using the handle so that the waste falls into the bin. The technology requires about 4KWh of electricity per batch and very little quantity of water – an average of just less than one litre per batch.

### Conclusion

The idea of developing low cost, environmentally friendly treatment technologies for medical waste was to move away from methods like open burning and furnace-like small-scale incineration, which are used rampantly in the countryside for treatment of waste. With these new technologies in place, the way ahead would be to field-test them in rural settings where autoclaves or microwave units are not available due to limited resources. After being tested for disinfection efficacy, and various other parameters, a final approval would be sought from relevant authorities.

The above-mentioned treatment technology options fit into the rural operations, as they are cheaper to operate, environmentally safer and do not require skilled manpower or electricity.

With the thrust on auto-disable syringes in immunisation campaigns, there is an increasing urgency to have solutions for treatment of sharps generated during these drives. However, it should be kept in mind that choosing an appropriate technology for treatment of waste is only a small fraction of medical waste management. The real impetus lies on aspects such as waste segregation, minimisation, training of staff, etc.

### References

◆ www.noharm.org; www.medwastecontest.org

◆ www.solare-bruecke.org

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