De Montfort Mark 9 Incinerator

Introduction

This incinerator is the recommended model for larger hospitals (generally more than 300 beds). It is a development of the Mark 3 and is to be built where high rates of combustion are required. It simplifies the construction, particularly of the steelwork, and thereby reduces the likelihood of failure due to distortion of the steel top plate.

It should be built on a concrete platform of at least two metres square, and should preferably have a roof to protect it from rain. The roof may also incorporate the support for the chimney stack.

The instructions which follow are meant to be used in all countries. The building instructions give the number and position of the bricks, but not the overall dimensions of the incinerator. This is because bricks differ slightly in size between one country and another, and it is simpler to adjust the overall size of the incinerator to the available bricks than to have to cut bricks to an exact dimension.

Similarly, only approximate dimensions of the steelwork are given. The correct procedure is to lay out the first two layers of bricks, and then measure the length and breadth of the steel which fits on top. The steel top can then be made to fit the finished brickwork.

The steel tunnel and ash door can also be dimensioned to fit the brickwork by taking measurements from the brickwork once the tunnel is formed in the first five layers of bricks.

Summary of characteristics

Use: designed especially for larger hospitals. (generally more than 300 beds)

Capacity: 50 kg/h

Lifespan (average): 3-5 years

Approximate unit cost in USD (materials only): 500 - 1'500 depending on the availability of refractory bricks

Time necessary to build: 5 – 6 days

Remarks: Only approximate dimensions of the steelwork are given. The correct procedure is to lay out the first two layers of bricks, and then measure the length and breadth of the steel which fits on top. The steel top can then be made to fit the finished brickwork.

The steel tunnel and ash door can also be dimensioned to fit the brickwork by taking measurements from the brickwork once the tunnel is formed in the first five layers of bricks.

List of materials

item	dimensions	quantity
Fire bricks	230x116x76mm	300
Cement (Portland)		250 kg
Ballast (for concrete base)		500 kg
Sand		1000 kg
Fire cement (high alumina)		100 kg
Rolled steel angle (mild steel)	40x40x3mm thick	42 metres
Rectangular section mild steel	75x75x3mm wall thickness	2 metres
Flat sheet (mild steel)	2400 x 1200 x 3mm	1 sheets
Mild steel pipe	150mm diameter x 3mm thick (approx)	3 metres
Welding rods (mild steel)		60
Steel cable	5 mm 7 strand	40 metres
Turnbuckles	M8 x 150 mm long	4 (not essential)
Rolled steel angle (mild steel)	50 x 50 x 3 mm thick	6 metres
Fuel tank with tap.	2 litres capacity approx	1
Fuel pipe, steel	350 mm long x 6mm diam.	1
Fuel pipe flexible	2 metres x 6 mm ID	
Bolts with nuts and washers	10 mm x 75 mm long	24
Wire Mesh	Any fine gauge	loose fill

Please note that the materials should be obtained before starting the construction !

Complete layout

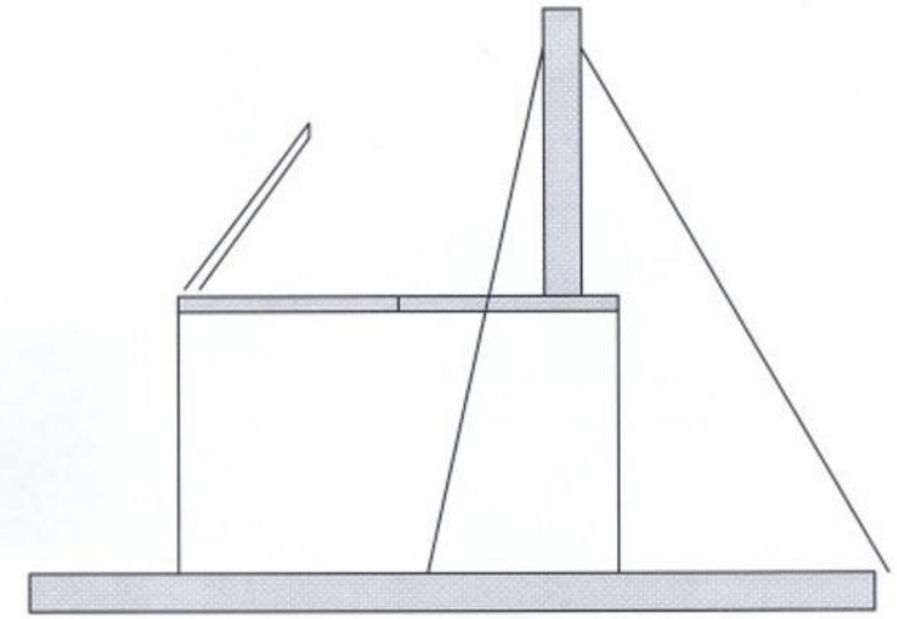


Figure 1: De Montfort incinerator Mark 9

Preparing the concrete base

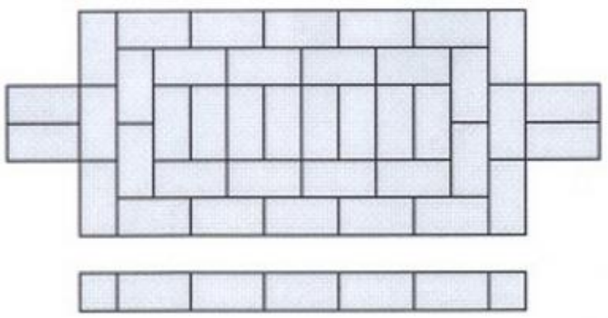
A concrete platform of at least 3 m x 2 m x 150 mm thick should be prepared on the chosen site, preferably with a roof about 3 m high to protect the incinerator and the operator from the effects of weather.

Once ready, the building of the brick body can start.

Building the brick body

The base layer of bricks should be laid on a bed of refractory mortar on the foundation. The bricks should be laid in the pattern shown below, with a minimum thickness (about 6mm) of refractory mortar between them.

When this is completed, the overall dimensions of the incinerator can be measured so that the steelwork can be started.



plan view of base layer

side view of base layer

Subsequent layers of bricks are then laid on top of the base layer as shown in the following diagrams. Care should be taken to keep all walls vertical and straight.

Build up the refractory brick body in layers as shown below, taking care to keep all walls vertical. Insert the two mild steel tunnels (3 bricks high x 2 bricks wide) and the air ducts (2 on the primary side, 1 on the secondary side) and fill the gaps with refractory cement and firebrick chips.

Photo 1: building the brick body

Diagram 2: layers 1&3

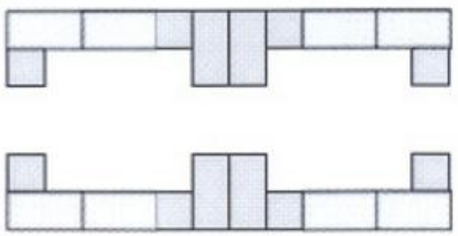


Diagram 3: layers 2&4

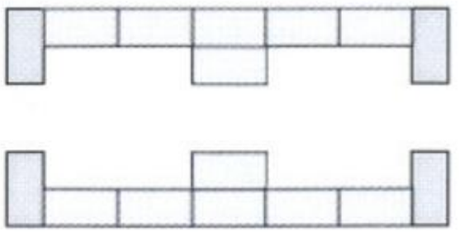


Diagram 4: layers 5, 7, 9, 11, 13

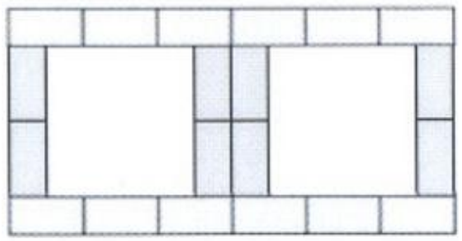


Diagram 5: layers 6, 8, 10, 12,14

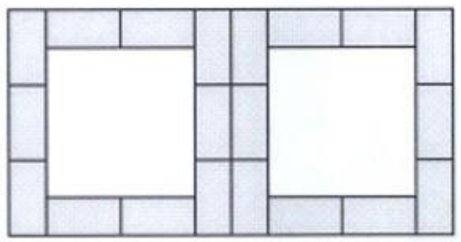
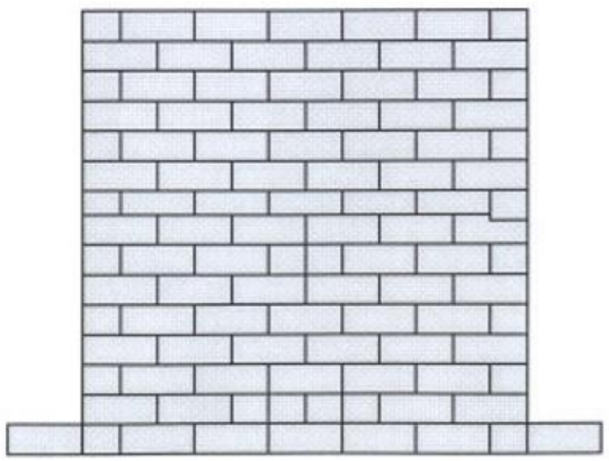


Diagram 6: Side elevation of completed brickwork



Preparing the steel top-frame

Once the base layer has been laid, the overall length and breadth of the incinerator can be measured. This gives the overall dimensions of the steel top frame. More importantly, after layer 5 has been completed, the dimensions of the two rectangular sand traps that make up the top frame can be fixed so that the frame can be made.

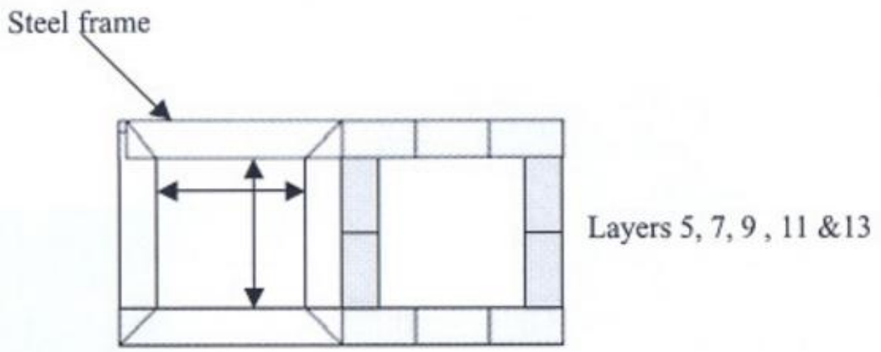


Diagram 7

The steel top frame consists mainly of two rectangular frames made from "U" section steel, one to fit over each of the combustion chambers. In many countries it is not possible to obtain "U" section steel, but these can easily be substituted by welding together two lengths of angle steel to make a "U" of roughly the correct dimension.

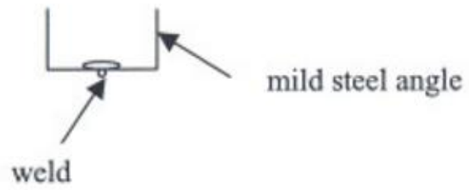
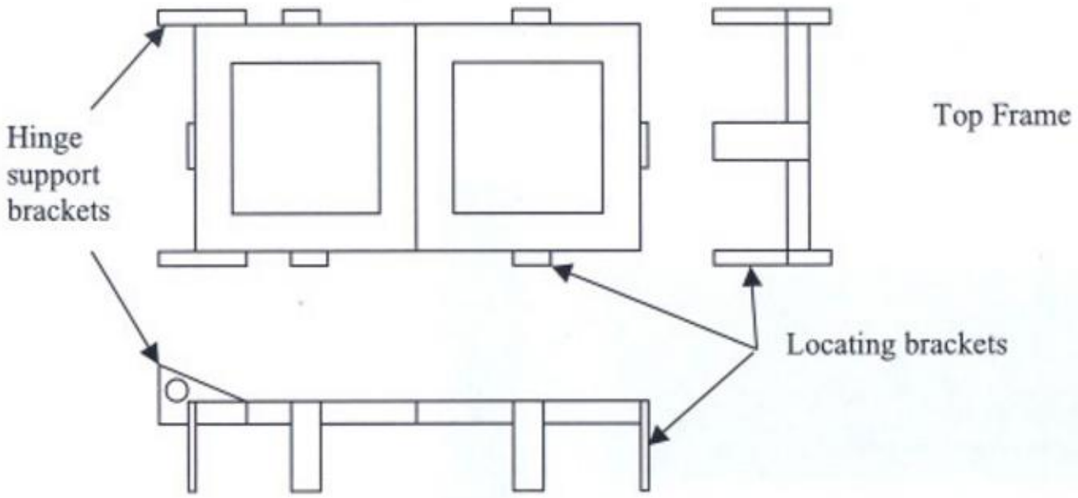


Diagram 8

The two rectangular frames are welded together, with the "U" facing upwards, and Hinge Support Brackets and locating brackets welded as in the diagram below.

Diagram 9: steel top frame



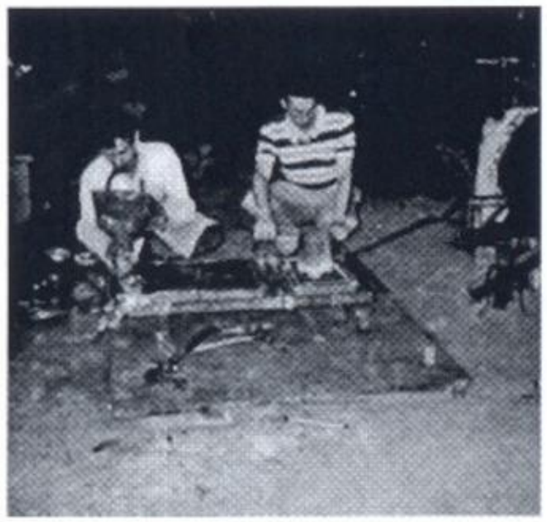


Photo 2: welding of steel top with door and chimney spigot

The Loading Door can now be made with a rolled steel angle frame of size to fit within the square channel top frame

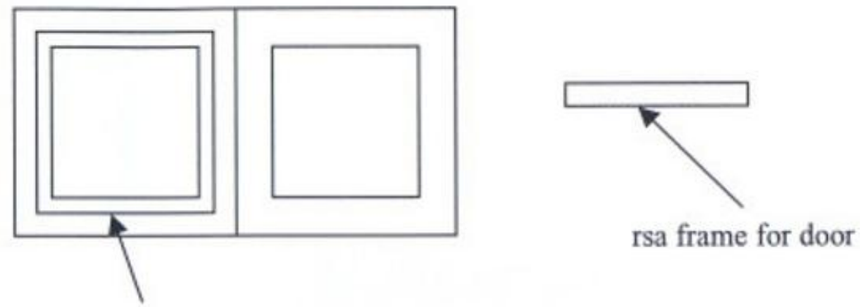


Diagram 10: loading door top view

The door may now be completed by adding a mild steel plate to the frame, a pair of hinge brackets and the handle, as shown below.

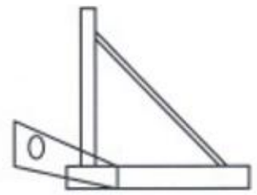


Diagram 11: Loading Door with handle and hinge bracket (side view)

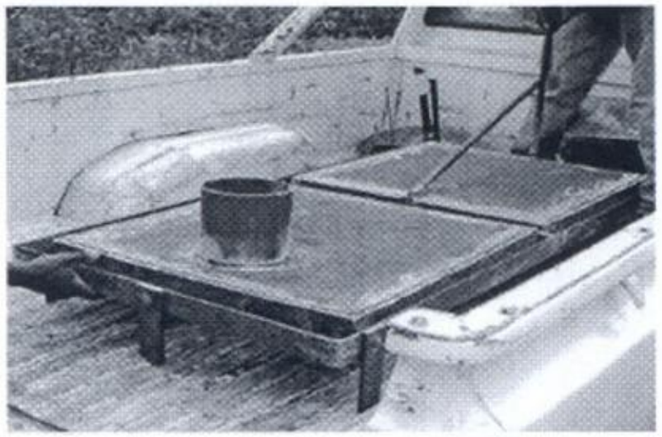


Photo 3: welded steel top with door and chimney spigot ready to be installed

The chimney support panel can be made in a similar manner to the door, but with extra rolled steel angle to support the chimney.

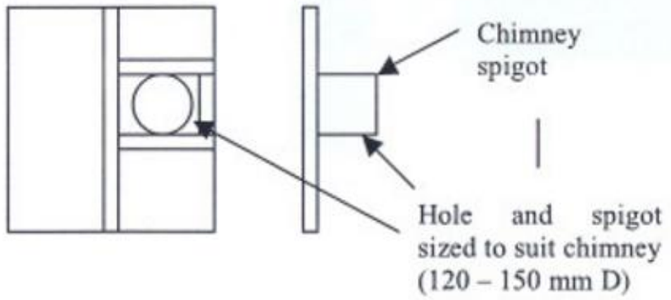


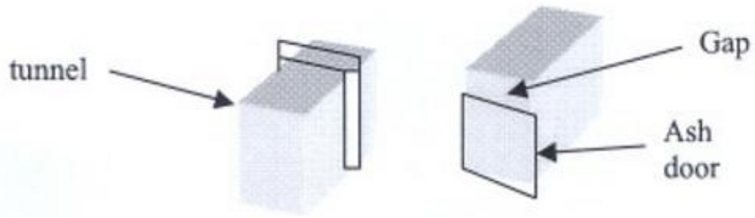
Diagram 12: chimney support plate and spigot

The sand frames of the steel top should be filled with dry sand so that the loading door and the chimney spigot plate can be sealed when closed.

The steel top may now be fitted over the firebrick core and sealed carefully with more refractory cement. This is best achieved by covering the top of the firebricks with a 5 mm layer of cement and lowering the steel top on to it, locating the top by means of the brackets already fitted.

Steel tunnels an ash doors

Two steel tunnels should be constructed, each to be a loose fit in the gaps in the brickwork at either end of the incinerator. An ash door should be fitted to the front of each tunnel, with a 30 mm gap above the primary chamber door, and a 10 mm gap above the secondary chamber door. A flange should be attached to each tunnel so that it can be fitted to the brickwork to a depth of one brick thickness.



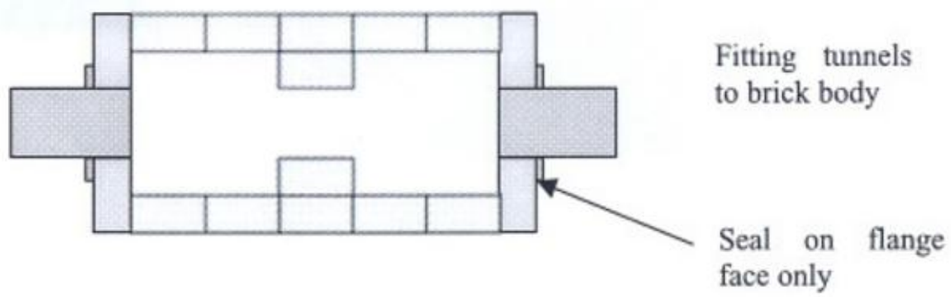


Diagram 13: steel tunnels and ash door

The tunnels are sealed to the brickwork only between the flanges and the brick face so that expansion of the tunnel will not crack the brickwork.

Photo 5: ash door, ash tunnel and air ducts

Photo 4: raising the chimney

The chimney is best made from a length of steel tube with a minimum wall thickness of 3mm and internal diameter of between 100mm and 150mm. It should be 4 metres long (more if it necessary to clear buildings. If steel tube is not available, the chimney can be fabricated by rolling lengths of mild steel plates and joining them together. It should be remembered that the thinner the plate, the shorter will be the life of the chimney, because it can get very hot at the base.

The chimney can be raised to fit over the chimney spigot and supported by the roof trusses or by steel cables anchored into the ground around the incinerator.

The outer case (if desired) can then be built up using common bricks with Portland cement mortar, as shown to a height just less than the inner core. Any space between the two types of bricks may be filled with Portland (white) cement. The top is then sealed with cement.

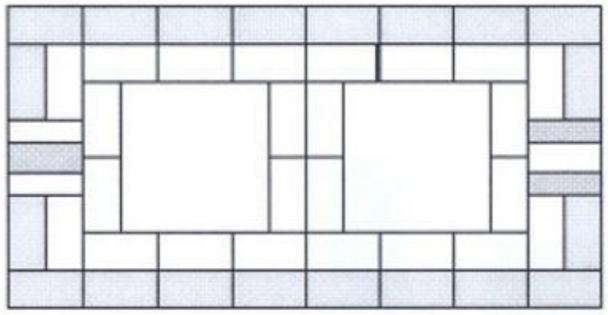


Diagram 14: incinerator outer case

A simple fuel tank, with tap should be fitted 500 mm above the incinerator top with a fuel pipe leading through both layers of brick into the primary combustion chamber,100 mm below the top.

Operation

The incinerator should be started by putting **waste paper, cardboard** or similar easily ignited material over the grate. Burning paper can then be dropped on top, and when a good flame is established, more combustible material added till the combustion chamber is half full. If available, about 100 cc of kerosene, diesel oil or used lubricating oil can be poured on top to speed the heating process. Only dry, non-infected waste should be added for the first 10 minutes or until a fierce flame is established.

The combustion chamber should be **kept at least half full**, and infectious and/or wet waste should be added above dry materials to ensure that it dries before reaching the combustion zone, Additional liquid fuel can be added if it is suspected that the combustion rate is decreasing. Any plastic waste available will also help to raise the temperature of combustion, but both this and the oil will give rise to black smoke if used to excess.

The incinerator will be most efficient if it is operated for fairly long periods once it is ignited. **The last load before closing down should be as dry and safe as possible**, so that no unburned material is left.

Maintenance

As with any type of equipment, there is a need to perform some regular maintenance to ensure both that the system will continue to work properly and to prolong the life span of the incinerator.

Before each operation.

- Check that ashes have been completely cleared from the grate and floor of incinerator.
- Check that loading door closes properly onto the sand seal in an air-tight manner. Loosen sand if necessary.

Annual inspection and rectifications

Component	Check	Rectify if necessary
Chimney	Vertical fixings	Reset or renew
	Corrosion	Repair any holes or weak points. Replace chimney or section thereof if necessary
Chimney support plate	Corrosion	Replace if necessary
Top sand seals	Cement seal to brickwork. Adequate sand level	Re-seal with refractory cement. Top up sand
Ash door	Corrosion, hinges, catch, blockage in door-frame	Repair and clean as necessary
Brickwork	Missing cement	Replace with refractory cement
	Evidence of thermal damage to bricks	Line inner surface of bricks with 10 mm refractory cement

Disclaimer

Since the safe and successful use of the incinerator, which operates at very high temperatures, is entirely dependent on the building, operation and maintenance thereof, the University and the organizations supplying the drawings and instructions can bear no responsibility for any mishaps to personnel or inadequate technical performance of the incinerator.

Information & questions

Any questions relating to these instructions should be referred to: Professor D.J. Picken (De Montfort University, Leicester, UK)

Contact formular available at:
http://www.mw-incinerator.info/en/601_contact_us.html

approx. 15.000 € ex works Cölbe.

Depends on - Spareparts
- Installation

Portable Clinical Waste Disposal under Field Conditions

The Problem

Efficient and safe hospital waste disposal is especially difficult under field conditions. This problem has persisted ever since disasters have made it necessary to deploy medical teams, Emergency Rescue Units or field hospitals. Burying large amounts of waste is often limited by available space, and it may contaminate the soil and groundwater resources. There is also the constant danger of contaminated waste being dug up by playing children or roaming animals. Open burning is often difficult due to weather conditions, involves long burning times, and is dangerous due to the possible formation of noxious or irritating fumes.

Open burning of clinical waste in Mongolia

The Approach

In 1999, the German Red Cross Society had gathered sufficient evidence from delegates that safe hospital waste disposal under field conditions was a serious problem. An investigation of the market revealed that no incinerator system was available that combined a powerful burning process with the possibility of easy transport, easy assembly, and easy operation and maintenance.

The German Red Cross Society commissioned "Technologie Transfer Marburg e.V. (TTM)" and Dr. Heino Vest, an experienced waste management expert, to develop a solution to the problem. The experts were to construct an incinerator with the following features:

- able to fit on a standard Euro-palette for easy air transport
- constructed in a modular fashion to facilitate easy on-site movement and assembly with a minimum of equipment and technical skills

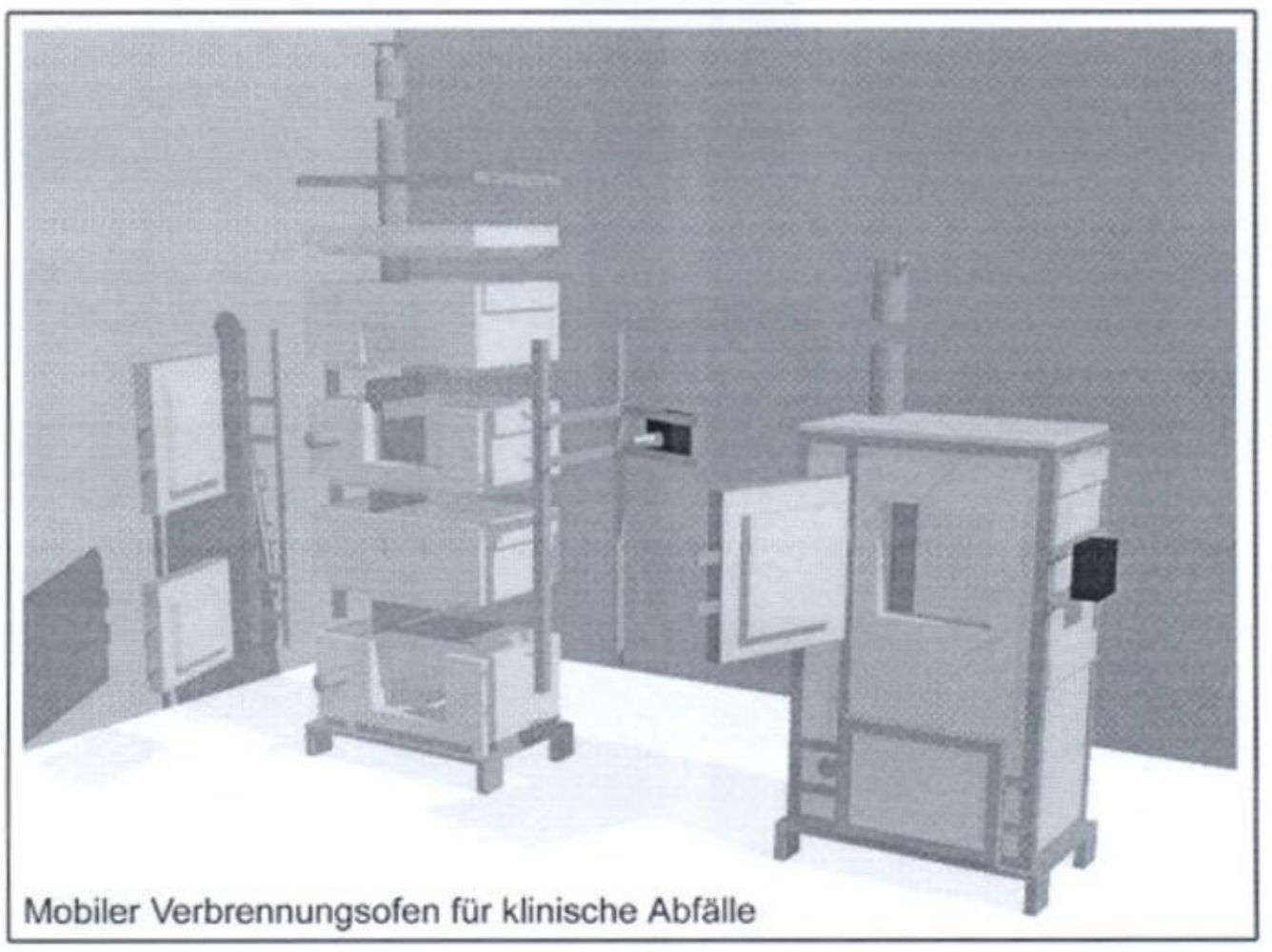
- sufficient capacity to deal with an average amount of clinical waste of field hospitals
- able to generate sufficient heat to ensure an effective and complete burning process and the safe destruction of problem waste like sharps, plastic, amputates and body parts, wet or moist matter
- assure a complete combustion of the generated fumes to minimise the air pollution

Several development steps - construction of a prototype in Germany, subsequent modification and a final field test in a Tanzanian hospital - led to an optimised design which became the basis of a first batch production starting in November 2004.

The Solution

The main features of this new incinerator are:

- its size will not exceed 80 x 120 x 200 cm, to make sure that its area fits on a standard Euro-palette
- the disassembled incinerator parts are packed on 3 Euro-palettes, one of which is later used as incinerator stand
- the incinerator body can be built up on-site, from only few pre-fabricated fireclay component
- none of the disassembled pre-fabricated parts will weigh more than 200 kg, thus being moveable without heavy technical gear; the assembled incinerator will weigh approximately 1 t



Mobiler Verbrennungsofen für klinische Abfälle

Portable clinical waste incinerator for field applications

TTM - Technologie Transfer Marburg e.V.

Auf der Kupferschmiede 1 · D-35091 Coelbe/Germany · Tel: +49 64 21 - 8 73 73 - 0 · www.ttm-germany.de

- the static stability of the incinerator is achieved by a steel frame on which the incinerator doors, the burner and the protective shielding are mounted
- the support burner of the incinerator is a standard diesel burner with a power of 10-13 KW and will consume approximately 3-4 l of Diesel per hour, thus achieving a maximum combustion temperature of 900-1000 °C
- an indirectly heated off-gas compartment in the incinerator secures a sufficient retention time and an almost complete combustion of the emitted fumes
- the stack of the incinerator is 6 m high and made of stainless steel
- the incinerator is operated batchwise and can incinerate 25-40 kg of waste (including large amputates) within 2 hours

The performance

During the test phase of the prototype in Tanzania, (see picture *a* below) several experiments were carried out to identify the conditions for an ideal combustion process. Ideally, the incineration should generate off-gas with only a minimum of smoke and smell. Since the incinerator is not equipped with special off-gas cleaning devices (to make it affordable for disaster relief operation as well as for small rural hospitals in developing countries), the amount and quality of the off-gas can only be influenced by controlling the combustion process.

The incinerator showed its best performance in a batchwise operation. The cold incinerator is loaded with a pile of waste, approximately 30-40 cm high. Depending on the composition of the waste (bulky light-weight plastic waste or heavy wet waste and body parts) it is possible to charge 25 to 40 kg of waste at one time. Then the Diesel burner is started and the waste is set on fire by using a torch. The combustion of the waste takes place from top to bottom. To correctly understand the incineration process, it is important to bear in mind that it is not the solids or liquids themselves that burn, but the gases which are produced or set free in the pre-heating zone before the fire zone proper.

Due to the cold starting condition and a lack of combustion air in the lower waste layers, the incineration progress at the beginning is fairly slow. This leads to a gentle gasification of the waste and a sufficiently long retention time of the combustion gases in the furnace, thus securing an almost complete combustion of all combustibles. During this phase, the off-gas fumes from the chimney are hardly visible.

After some time of operation the temperature in the furnace increases and the combustion process becomes fiercer. At this stage the gasification velocity increases as well and the retention time of the gaseous products in the furnace is reduced. Although the high temperature in the furnace supports a fast combustion of the gases, the short retention time and in particular the insufficient supply of combustion air (oxygen) may lead to remaining combustibles in the off-gas of the incinerator. During this phase of the incineration, which lasts for about half an hour, some traces of smoke (soot) can be seen leaving the chimney (see picture *b* below).

When the degassing of most of the volatiles (hydrocarbons) has stopped towards the end of the combustion process, the final incineration is almost smoke free. The remaining waste in the furnace has been converted into a charcoal or coke type of material which burns without smoke. This phase lasts for another half an hour.

The incineration of one batch of waste takes about two hours. During the incineration the furnace reaches a temperature of 900 to 1000°C. This temperature is high enough to destroy all pathogens and to melt glass. The remaining ash (approximately 5-10% in weight and below 1% in volume of the original waste) is totally mineralised and free of any organics (see picture *c* below). Sharp glassware is partly molten and no longer poses a danger of injury. Steel needles are not destroyed in this process, but since they have been sterilised, they are not infectious any more and only pose the threat of mechanical injury. Wearing protective gloves while clearing away the ashes will greatly reduce this remaining danger.

It is not advisable to charge the hot furnace with fresh waste immediately after one batch of waste has been incinerated. The high temperature in the furnace leads to a rapid gasification of the new waste, and the furnace is not able to cope with the large volume of gaseous products. Short retention time and incomplete combustion cause the generation of a large amount of black smoke that is emitted from the chimney. Therefore, the furnace must be allowed a cooling time of some hours before the next batch of waste can be incinerated.

If larger quantities of waste have to be incinerated, the following operation sequence can apply:

Loading and incineration of 1st batch:	2 hours
Cooling time:	4 hours
Loading and incineration of 2nd batch:	2 hours

Using this mode of operation, it is possible to incinerate up to 80 kg of waste during the day shift and up to 160 kg in a day and night shift operation.

a) *b)* *c)*

Prototype in operation in Tanzania:
a) the incinerator, b) emissions from the incinerator, c) combustion residues

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To maintain the good environmental results it is important to observe the following rules:

- PVC-plastic should be removed from the waste stream as far as possible to minimise the formation of toxic chlorinated hydrocarbons
- It should be avoided to charge new waste into the furnace as long as it is still hot
- Under no circumstances should the furnace be charged with any explosives (pressure vessels, bottles with burnable liquids, etc.)

The incinerator will be available on the market in early 2005

Summary of incinerator's features:

Price:	approx. 15,000 € / unit
Mode of operation:	batchwise, 25-40 kg
Incineration time:	2 hours
Max. temperature:	900-1000 °C
Cooling time:	4-5 hours
Capacity:	50-80 kg of waste (1 shift operation)
Consumption of diesel:	3-4 l/h or 6-8 l per batch of waste incinerated
Off-gas quality:	moderate smoke emissions during one quarter of the total incineration time; no visible emission during three quarters.

Contact

For further information or to place an order please contact:

Technologie Transfer Marburg e.V.
Lutz Kempe
An der Kupferschmiede 1
35091 Coelbe, Germany

Phone: (+49)(0)6421/87373-0
Fax: (+49)(0)6421/87373-7
e-mail: lutz.kempe@ttm-germany.de