

## THERMAL TREATMENTS FOR BED BUGS

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**Abstract** Thermal control is one of the possible control methods for bedbug infestations. It is however often assessed controversially. This assessment is not always based on objective arguments and rarely on own, practical experiences.

On the basis of practical trials and experiences from over 450 heat treatments in different room types we show how and where hidden hollow spaces can be opened and treated, how heat damage can be prevented or largely reduced and how the escape of the bedbugs from the treated rooms can be suppressed. We show the technical and commercial feasibility and the advantages of thermal bedbug treatment on the basis of the number of recalls (additional treatments).

**Key words** Pyrethroid resistance, lethal temperature, heat related damage, silica dust

### INTRODUCTION

The control of bed bugs with insecticides became more and more difficult after 2005, because the EU has systematically eliminated older active ingredients from the official registration list. Mainly synthetic pyrethroids remain, against which bed bugs have increasingly developed resistance (Boase et al., 2006, Pinto et al., 2007a; Boase, 2011; Romero, 2011; Pfeiffer, 2013; Zu et al. 2013; Miller, 2013). An increased effort for insecticide treatments of bed bugs and increasingly dissatisfactory results convinced the pest control company (PCC) Ratex to change to thermal treatments with Thermonox® heating devices in October 2011. For Swiss conditions Ratex is a middle sized family company with four pest control technicians and eight additional roofers to do marten and pigeon control installations. At present thermal treatment of bed bugs makes up around 15 percent of the company's turnover.

Heat is an excellent bed bug killer, is non toxic and only heat sensitive items have to be removed from the room (Miller, 2013). The company ranked these advantages higher than the disadvantages like high costs and no residual activity.

The head of operations has an education as electrician. This is an advantage, because the heat devices need high voltage current, which is not always available in many buildings. He can install a temporary connection immediately. Overall the PCC has made good experiences with this method. It is very important that all measures are taken to prevent heat damage of the infrastructure, equipment and furniture. Damage normally starts at temperatures above 60°C (140°F). All possible refuges of bed bugs and parts of buildings that they could disperse to have to be investigated and made accessible for the heat (Hasenböhler and Kassel, 2011; Hasenböhler 2012). Therefore the Pest control technician (PCT) inspects the rooms to be treated together with the customer and discusses necessary structural measures and restoration (Hasenböhler, 2012).

## MATERIALS AND METHODS

The company Ratex controls bed bugs with heating devices of the brand Thermonox® WEO 4.5 / 9 (Hasenböhler, 2006 / 2012; Hasenböhler and Kassel, 2011) and depending on the room size and architecture with one or more additional fans.

Before the thermal control the PCTs inspect the infested rooms just like before an insecticide control. At the same time they undertake all necessary measures to prevent heat damage and bed bugs from escaping. They also check the concerned structures for spaces that can't be reached by the heat (Pinto et al., 2007b, Hasenböhler and Kassel 2011). These measures can easily take up two and a half to three hours of work time.

The warm air current of the heating device is directed towards the highest heat demand and a fan is installed in the shadow of the heater depending on room size (Hasenböhler and Kassel, 2011). A maintaining period with a constant temperature between 50°C (122°F) and 60°C (140°F) for 24 hours follows a heating-up period of 8 to 15 hours. About all 8 hours supervising measurements are performed in the room (three for the whole heating period) to ensure that the needed temperature is maintained and to relocate the heating device or the fan if necessary (Hasenböhler and Kassel, 2011; Hasenböhler 2012).

The different materials of the building structure and the fixtures and fittings differ in their time to heat up because of their different heat conductivity and heat capacity. This monitoring during the maintaining period is necessary to make sure that the killing temperature interacts long enough in all parts of the treated room. Then a cooling phase of 12 hours follows. The thermal treatment process cannot be shortened, because of the risk of the killing temperature not reaching the eggs in deep cracks or other hiding places and of cold spots not heating up enough to kill the bed bugs or their eggs. This would prevent the necessary eradication (Hasenböhler and Kassel, 2011; Hasenböhler 2012; Hammond, 2012). After the cooling phase 1.5 to 2 hours are spent to reset the room. This includes remounting the light switches, sockets and lamp coverings, removing all the masking tape or plastic coverings and reinstalling the baseboards and other fittings. While reinstalling the fittings, silica dust (diatomaceous earth) is applied as a residue. The complete heat treatment costs add up to CHF 1500 (~USD 1660) per room. If three rooms have to be done at the same time the costs drop to CHF. 1200 (~USD 1330) and from five rooms up the costs drop to CHF 1000 (~USD 1110) per room. The house owner, the caretaker and the adjacent neighbors have to be informed about the heat treatment because especially in buildings with precast concrete slabs the ceiling or the floor will heat up to 30 °C (86 °F) or more (Hasenböhler and Kassel, 2011). Uninformed neighbors might call the fire department. Such a false alarm can amount up to CHF 1400 (~USD 1550).

## RESULTS

Between October 2011 and February 2014 the pest control company Ratex has heat treated overall 452 rooms with only 8 recalls that include a second guarantee treatment (Figure 1). The recalls concerned rooms of 4 different private apartments, one residential home, one backpacker hostel, one three star hotel and one emergency accommodation for the homeless.

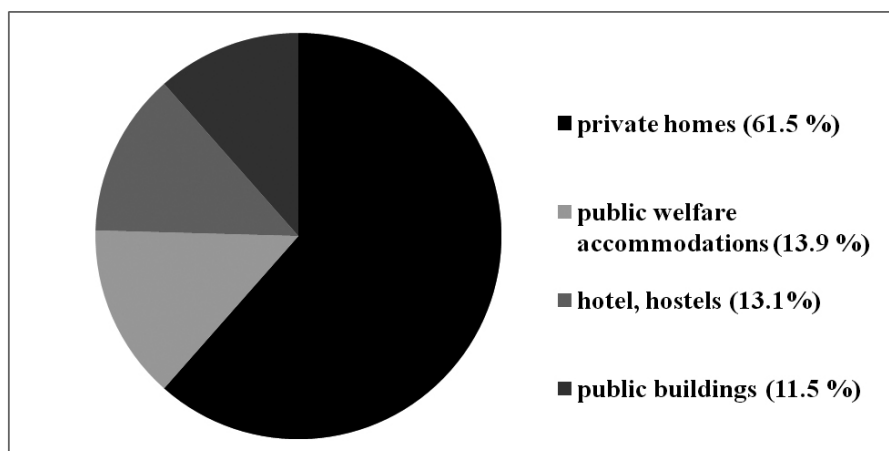
In three cases temporary sealing with tape was not performed or not done careful enough. The first concerned an old window, from which the bed bugs reinvaded the room after the treatment. In the second the opening to the roller shutter casing gave the bed bugs a refuge and a return possibility to the treated room. In the third case the cracks of the hangers of a radiator, which lead to an insulated hollow space, were sealed, but not thoroughly enough. This space was finally opened and heated up as well.

In two cases the wirings were not sealed or only sealed on one side, while in the latter case the bed bugs came out of the cable duct in the adjoining room. This then had to be treated as well after

sealing the other side of the opening. In the other case the cable duct that was not sealed belonged to a fire detector on the ceiling. To seal it, the detector had to be deactivated and removed from the ceiling. Two further cases concerned the ceiling. In one case the suspended ceiling was temporarily sealed off with a thin foil to prevent the bed bugs from spreading into this insulated area. The foil reacted to the heat with fissures and the bed bugs could wander off into the cooler zone behind. In the second case the owner had already sprayed the bed bugs unsuccessfully for four months without telling the company and a temporary sealing of the ceiling was in vain. Before the second treatment this ceiling containing sound reducing material was sealed off completely thus enclosing the bedbugs within. In the last case concerning an emergency accommodation, the power line was timed to turn off between 22 hours until 5 o'clock in the morning. The company however was not informed about this. The bed bugs were killed but after 2 weeks larva appeared, because the necessary temperature had not been held long enough to penetrate and to kill the eggs in the deeper cracks.

## DISCUSSION

Infested private homes make up for over 60% of the treatments, while the other three categories hotels, public buildings and public welfare accommodations each are treated at a low percentage of 11.5 to 14 % (Figure 1). These numbers are not representative and can change from one company to the next. There are over twenty PCC operating in Zürich and surroundings. Swiss people are very critical towards insecticidal contamination of their own home. Therefore a high proportion of people might prefer the heat treatment to the insecticide treatment in spite of the higher costs. This is also the case for public buildings and for most hotels. These additionally have their employees trained to get rid of infestations immediately and therefore avoiding customer complaints and lawsuits. This is in accordance to Robinson and Boase (2011) where most infestations are found in residential premises and hotels. However in contrary to the above mentioned research, in Switzerland there is no knowledge of infestations in premises visited or used by a broad range of residents such as shops, theatres, offices and administrative buildings. There are reports of bed bugs in train coaches with sleeping compartments. Heat treating of railway wagons is expensive and the risk of heat damage to the interior with all the different plastic materials is high (personal communication C. Zehnder). Therefore Ratex is not interested in treating railway wagons.



**Figure 1.** Percentage of bed bug heat treatments in accommodation groups.

Public welfare accommodations = accommodations paid by public welfare, asylum- and supervised accommodations. Public buildings = hospitals, old people's homes, school camp houses.

Our experiences from 452 heat treatments and the eight recalls showed that the most important points to be checked before treatments are as follows.

### **Avoid Heat Damage to Furniture, Equipment, and Fixtures**

If fire alarms are installed, they have to be deactivated, to prevent unnecessary alarms. The duct of the electric cable to the alarm has to be sealed off. If there are fire extinguishers in the treatment area they have to be removed.

All heat sensitive objects have to be removed by the residents. These are for example oil paintings, candles, records, perfumes, sprays (aerosol cans), medicine, plants and all food. This is selectively checked by the pest control technician. The residents are however responsible for this task. All other items stay in the room to be treated and to prevent the displacement of bed bugs into other rooms (Hasenböhler, 2006; Hasenböhler and Kassel, 2011). All electric devices like the television, refrigerator, stereo equipment or computer have to be turned off and plugged out. They normally endure these temperatures without any problem. A backup on an external hard disk is strongly recommended. Furniture with edge-jointing adhesive are fixed with masking tape so that they cannot slip or peel off when the adhesive (on the base of thermoplast) becomes soft during the heat treatment.

### **Prevent Bed Bugs From Escaping and Dispersing**

All plug sockets, switch boxes and emergence points of electric cables of ceiling lamps in the room are treated with silica dust. Then they are sealed with heat resistant acrylic silicone. Each electric line out of the room to be treated is followed to the next cable exit and sealed here as well.

Baseboards are removed and checked for bed bugs. If there are traces or live bed bugs, all cracks and crevices in this area are treated with silica dust and again sealed with acrylic silicone. Wooden structures in the ceiling area, e.g. beams, old, untight windows, shutter covers, cracks in the wall at heater pipes or hangers for the radiator, ventilation shafts and the room door have to be temporarily sealed with tape to prevent the bed bugs from escaping.

The thick electric cable for the heat device has to be inserted through the door opening. This prevents the door from closing tightly and sealing of the door is made more difficult. Nowadays there are flat cable joints fitting under the door and allowing the door to be closed and sealed off correctly. Cable ducts are sealed off with fire protection material. Some of the panels of suspended ceilings are removed to heat up the space above. If the bed and the kitchen are in the same room, the kitchen can be sealed off with a lock of plastic sheet. Inaccessible areas are checked with an endoscope and if necessary treated with silica dust and sealed.

### **Open Thermally Protected or Insulated Spaces**

All furniture close to the wall has to be moved away so far that it can be heated up sufficiently. Fittings like beds that are fixed in the wall or built in closets have to be dismantled because the area behind cannot be heated up enough and will otherwise be used as retreat by the bed bugs.

Multiple floor layers have to be removed completely or the top layer has to be sealed completely because the heat will not penetrate through these layers. Floors can be heated from both sides, from the bottom and from the top, but that is more costly. Bay windows and window boards have to be closely examined. If there are cracks they have to be picked out or sealed with acrylic silicone. Temporary sealing with tape is necessary for cracks in parquet floors, the shaft with the setting valves of floor heating systems and air ducts.

Following these rules will result in a successful heat treatment. If one escape possibility or one hiding place is missed or the chosen length of heat impact is too short like in the eight recalls, not all the bed bugs are killed and therefore complaints and expensive secondary treatments on the costs of the

company will follow. Heat treatments in combination with insecticides (Boase, 2011; Hammond, 2012; Miller, 2013) are not necessary except in cases with inaccessible cold spots for the bed bugs to find refuge. In all cases the company applies silica dusts in hollow spaces, behind fittings and baseboards, into electrical fittings and ducts and any obvious cracks and crevices. Lots of the latter are sealed permanently and if the rooms are reinfested with bed bugs, the preparation time and the treatment price is lower. Silica dust alone can rarely eradicate a bedbug population, but its presence before an infestation might stop it or at least slow down the population growth (Potter et al., 2013).

### ACKNOWLEDGMENTS

We thank Dr. Gabi Müller for the reading and very useful comments on the manuscript.

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