How does heat kills bed bugs?

Heat kills insects by disrupting lipids, affecting water balance, damaging cell structures, and so on. For example, under normal situation, water loss from the body surface is kept at a slow rate by the wax layer. When the critical transition temperature is reached, increased kinetic energy cause the wax molecules to break the intermolecular forces - the van der Waals forces, and move apart, which in turn allows water to escape at a faster rate and cause dehydration eventually. Heat can also denature proteins inside the insect's body.

Once denatured, the protein loses its normal conformation and can no longer function properly. However, insects do develop physiological and behavioral responses to high temperature. The first line of defense is usually behavioral avoidance. For example, during structural heat treatment, as the temperature goes up, a bedbug would try to escape the heat and seek a cooler shelter. Insects also develop physiological heat tolerance.

The most common mechanism is the use of heat shock proteins. When an insect is exposed to high temperature, the synthesis of normal proteins is greatly reduced, while the heat shock proteins are induced and bound to denatured proteins to prevent or repair damage caused by heat.

Heat treatment normally refers to structural heat treatment. Super-heated air is released into the target area and circulated, and the temperature is raised to 140-160^{o}F for several hours. This is to ensure that the temperatures in the harborages are maintained above the thermal death point, which is about 113^{o}F. The biggest challenge is that, unless temperature can be raised up rapidly, bedbugs would try to escape the heat by moving into deep cracks or exiting the unit being treated. Therefore, the heated air needs to be well circulated to be able to penetrate into deep cracks, and the bedbugs have to be well contained either by caulking or insecticide dust.

Heat sensitive items such as electronics and plastics are either protected with thermal blankets or removed from the treatment area. But some items, such as vinyl windows and plastic parts of big appliances, are difficult to protect or remove and may get damaged. Depending on the temperature and the duration of the treatment, wood furniture might shrink or crack due to loss of moisture. Since not every item is treated, some bedbugs might survive if they hide in the untreated items.