

Fall 2008 Paint Test

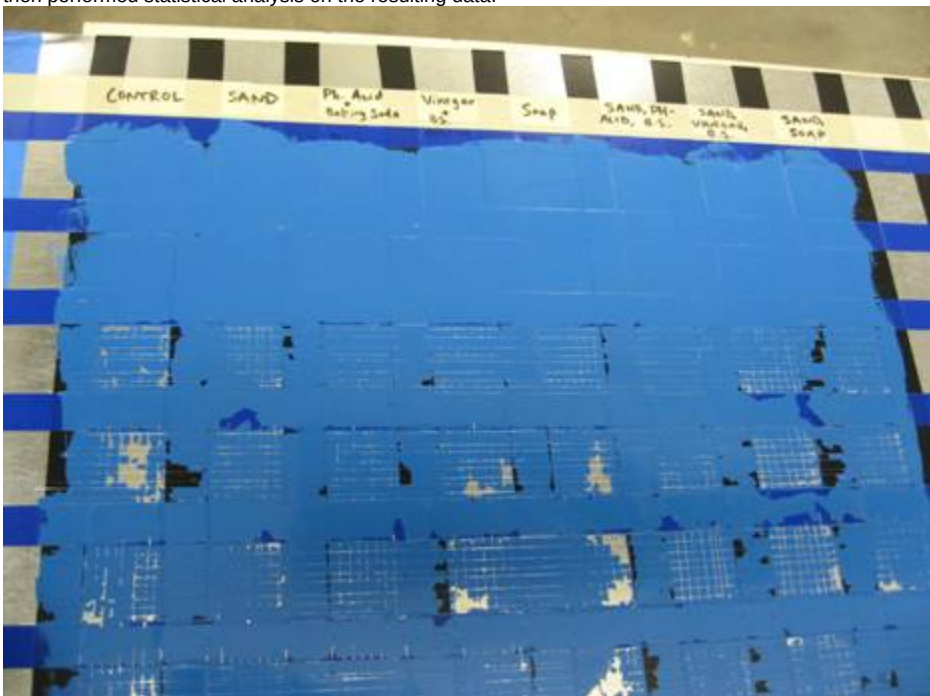
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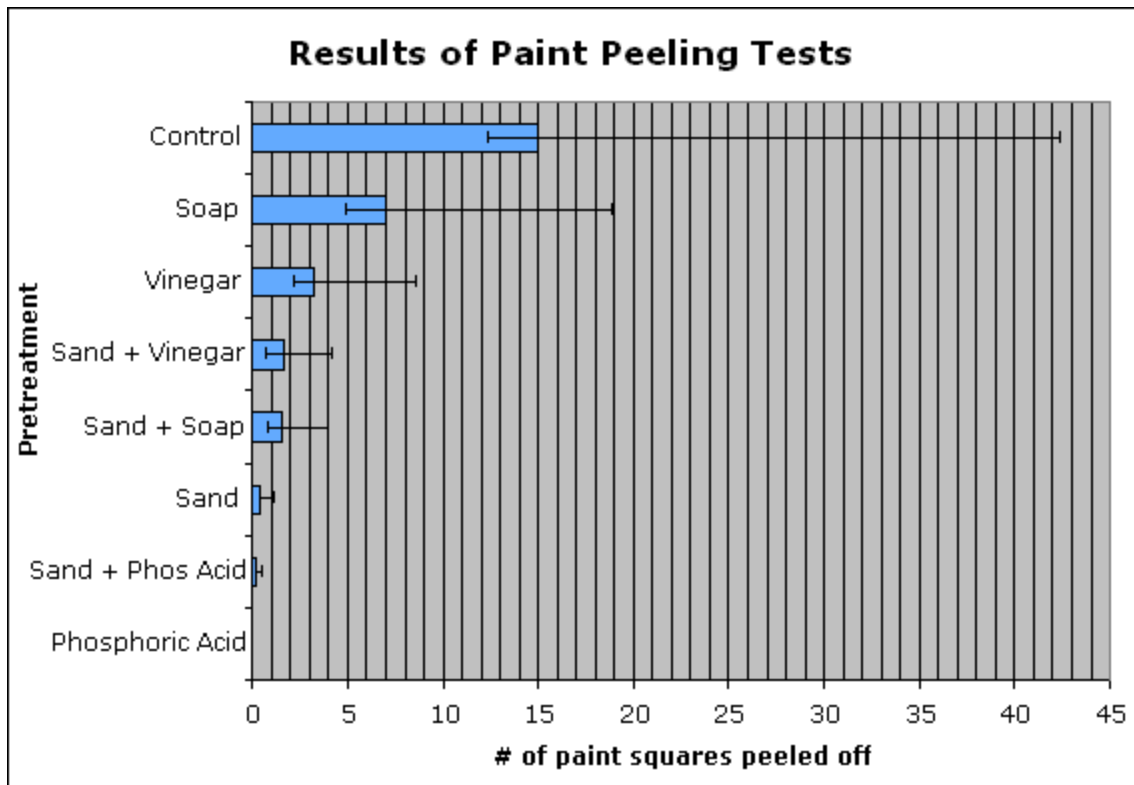
The problem that Nimia from Mujeres Solares presented us with is that the paint used on the exterior of the solar oven (and the black plate in the bottom) flakes and peels off very easily. This is mainly an aesthetic problem. As such, one could very well ask the question, "Why do we care?" The answer is that Mujeres Solares is trying to market these ovens, and have in fact sold a large number of them. If the ovens look nice, they will sell better, meaning more people will buy them and cook with them instead of using wood. In addition, the profits generated will allow Mujeres Solares to give more ovens to their members and fund new programs to help people in Sabana Grande.

In order to solve this problem, we first tried to replicate the conditions under which the paint peeled. After some communication and inference, we concluded that the metal Mujeres Solares is trying to paint is galvanized (zinc electroplated) sheet metal, similar to the metal commonly used for ductwork in the United States. We were able to obtain some of that material. Next, we tried to obtain the paint Mujeres Solares uses. They used Corona brand "dura" oil paint. After extensive telephone and e-mail communication with the various departments of that paint company, we concluded we could not realistically get the paint here before the end of the semester. So, we ended up using a similar brand of oil paint to do our testing.

We used a test modeled after an ASTM standard for adhesion (test D 3359-02). We applied various pretreatments to the metal prior to painting in order to test their effectiveness relative to each other and control (no pretreatment). For the sand pretreatment, we sanded the metal with sanding paper on a block of wood, first vertically then horizontally. In the phosphoric acid pretreatment, we wiped the surface twice with phosphoric acid soaked paper, let it sit for approximately one minute, then neutralized by wiping the surface with a saturated baking soda solution. Then we wiped the metal twice with damp paper and dried it off with clean paper. The vinegar pretreatment was similar except that we used vinegar in place of phosphoric acid. For the soap pretreatment, we wiped the metal twice with soap-and-water-soaked paper then twice with damp paper and then dried it off with clean paper. We also attempted several tests in which we sanded first and then applied another pretreatment. For general applications of this methodology in Nicaragua, reusable cloths could be used in place of paper.

Next we painted all the pretreated areas and allowed the paint to dry for several days. Using a sharp knife, we scribed 5x8 (~3 mm cell) grids into each pretreated area. Thus, each grid had 64 one square millimeter squares of paint that were not attached to each other. After that, we used the stickiest tape we could find (duct tape), adhered it to each grid, and then ripped it off. We counted the number of squares removed from each grid in that fashion and then performed statistical analysis on the resulting data.





error bars represent 95% confidence intervals

As can be seen from the above chart, the phosphoric acid pretreatment worked the best, followed by sanding plus phosphoric acid pretreatment, followed by sanding pretreatment. However, the difference between the results for phosphoric acid pretreatment and sanding plus phosphoric acid pretreatment were not statistically significant (their confidence intervals overlap). The difference between the sanding plus phosphoric acid pretreatment and the sanding pretreatment was not statistically significant either, however the difference between the phosphoric acid pretreatment and the sanding pretreatment was statistically significant.

Our recommendation to Mujeres Solares is that they use phosphoric acid as a pretreatment before using their solar ovens. However, for reasons of cost and availability, that may not be practical. In that case, we suggest the sanding pretreatment, which is nearly as effective, and would likely be cheaper and easier. Any pretreatment at all is probably better than no pretreatment (although the differences between soap pretreatment and control were not statistically significant). The probable reason why control performed so poorly, as well as the reason for its very large standard deviation, is that finger oils on the metal can cause the paint to peel quite easily wherever it has been handled. For this reason, we emphasize the need to not touch the metal between the pretreatment and the painting.

Because of the chemical differences in the paint we were using as compared to the paint Mujeres Solares uses, and because of the large span of testing time required, we decided not to try to perform a simulation of exposure of the paint to tropical sunlight using the lights testing apparatus. That is a possibility for future research, but future teams will have to weigh the practicality and utility of such a test.